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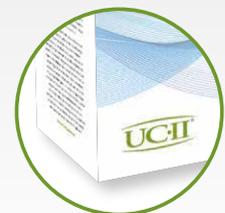
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(1) Bagchi D, Misner B, Bagchi M, et al. Effects of orally administered undenatured type II collagen against arthritic inflammatory diseases: a mechanistic exploration. Int J Clin Pharmacol Res. 2002;22(3-4):101-10

(2) Lugo JP, Saiyed ZM, Lane NE et al. „Efficacy and tolerability of an undenatured type II collagen supplement in modulating knee osteoarthritis symptoms: a multicenter randomized, double-blind, placebo-controlled study.“ Nutr J. 2016;15:14.



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Greetings from the publisher

The team from thesportgroup looks back on 7 years of good cooperation with the Isokinetic Conference. We are proud to be part of this innovative and strong network in football medicine. The exchange of knowledge and the exchange between experts has always been important to us. So we will continue to support and expand this in the future. For this issue Robert Erbelinger, publisher & director of thesportgroup talks with Dr. Francesco Della Villa, Sports Medicine Physician and part of the Isokinetic Education and Research Department about the Players Voice, Prevention of ACL-injuries and the importance of the patient.

Best regards yours thesportgroup-Team!

Prevention program is like a vaccine

Robert Erbelinger (RE): Dear Francesco, the 29th Isokinetic Medical Group Conference will be held at the Lyon Convention Center on April 2021 with the motto "The Players Voice". Why did you use especially this topic?

Dr. Francesco Della Villa (FDV): Dear Robert, for us this is a very important point. We will seek to deliver an innovative vision. One involving patients. This will set the conference apart and offers a unique perspective on the work that the players deserve in research and practice. The Patient Voice will be stitched into the heart of the Scientific Programme. Our new conference format will not seek to be superficial, and the aim is a clear statement of intent to introduce patients into the collective discussion. We want the real protagonist of our work (the patient) at the centre. Also, as medical practitioners, the feedback of our players and patients is a very important part for our work. The patient perspective is one of the most im-

portant point. We need to summarize on what the patient wants. Clinically we work mainly with injured players, so hereafter I will speak referring to patients, but the concepts are similar for uninjured players management.

RE: Because after all of it, we do it for the patient. I think this is very innovative because in the past of sports medicine nobody was talking about the patient. He has to accept the treatment and it has to work.

FDV: Yes, that's right, the patient is an active part of the team. The exchange of energy between the patient and the rehabilitation team is really important. If there is trust and confidence between the rehabilitation team and the patient, compliance and probability of success increases. You can achieve this trust and confidence only if you have a good team with a comprehensive treatment plan for each patient. In our vision and clinics multiple professionals' figures (Doctors, Physios, Trainers) works to-

Dr. Francesco Della Villa is a Sport Medicine Physician (MD). Grown up academically in Bologna, the oldest university in world, he graduated in Medicine and subsequently completed his specialization (residency) in Sport and Exercise Medicine. He started soon to collaborate scientifically with the Isokinetic Medical Group and International societies, as International Cartilage Repair Society (ICRS) and European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA), serving as member and sub-section board member. His education was completed around the world, including a fellowship in Santa Monica (CA) where he lived for one year. Dr Della Villa is working in the Education and Research Department of Isokinetic Medical Group, as the head of Research and Development. Passionate clinician, researcher and speaker his main interests are the optimization of the rehabilitation process following knee injuries, and in detail ACL injuries, with a particular focus on Biomechanics.



gether sharing the same method that is based on a strong organization and culture of rehabilitation medicine. This culture is based on a deep and updated study of current best evidence practice and the study of our results too. At Education and Research Department we study patient's functional outcomes aiming to treat better the future patients, keeping our practice updated. What we do with the conference from many years is exactly the same. We want to engage the football medicine community, to be altogether under the same roof for two to three days, to exchange culture and to better treat patients worldwide.

RE: Football is a global topic and the experience in football medicine is like a model that strengthens compliance in exercise medicine?

FDV: It is. Football is good for your health, sports and exercising are good for your health in general. People that regularly exercise live better and longer. On the other side, there is an increased risk of injuries, as a price to pay. So, as a sports medicine community we need to take care about injuries, both in term of primary prevention (reduction) and treatment. Many years ago, FIFA Medical took the lead on this aspect developing the FIFA 11+ program for injury risk reduction. Years of studies demonstrated clearly a reduction of non-contact injury risk (up to 50%) with player compliance being one of the key factor for success.

RE: Yes, sure. As always in life. You have the side effect.

FDV: Basically, through our conference, we want to teach everybody how to take these football side effects – the risk of injuries in football. There are two main topics that generally are mainly discussed. The first one is the key area of muscle injuries (the most frequent injuries in football) and the second topic are traumatic or overuse joint injuries, like knee ligament injuries which can take you long time to recover properly. In football is the most discussed severe injury is the Anterior Cruciate Ligament (ACL) injury. One of the first elements of the ACL injury is the huge mediatic dimension of ACL injuries, this create fear around around ACL injuries and the patients reaction to the diagnosis can be very bad. I recently read a paper from my Swedish colleagues Markus Walden and Martin Hagglund, in which they investigate the experience of sustaining an ACL injury

from two women footballer perspective. One of the participants reported that when the doctor reported the diagnosis, it was the worst day in her life. In this context it is important to say that (even if they can be ameliorated) results of ACL injury treatment are good and you can resume your activity effectively doing the right things in the recovery process

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are relevant but not crucial, the main character is the patient that can take the lead on his or her life protecting from injuries. As part of the medical community, we really fight for players and patients health.

RE: Because this is such an important message Francesco, from you and your group and all these people engaged in this conference. Let me talk about prevention or prophylaxis, maybe the better word. What we see in COVID-19 at the moment is that we need more attention on prevention and prophylaxis of health-related problems.

It's independent from the kind of medical condition. We need more engagement of the society and football medicine is an example to spread this message. I think this is a great message in this time.

FDV: Yes, it is COVID-19 pandemic is a very tough and important life lesson with our emotions changing continuously. It is a lesson from many points of view. The main aspect you said is the aspect of preventative measures of medical conditions. As a global society, we really need to follow a preventive medicine approach (e.g. vaccinations), respecting our environment and protecting the at-risk individuals. This goes beyond medicine and it is rooted in the empathic nature of man. If we translate this to sports injuries, actually compliance in prevention programs is enough to cut a good part of injuries. Barriers in the application of this approach (either in general life and specifically in sports medicine) do exist both in youth and professional football. The challenge is to overcome these obstacles.

RE: Getting back to ACL injuries, we know that this injury has such a high impact in the patient's life (both physiologically and psychologically). In this context, how important is the player lifestyle in the rehabilitation?

FDV: In general, having a healthy lifestyle is very important for the player and for the patient (injured player). The body of the professional player must be a sort of temple. We have had many examples in recent football history.

You need to take care of your body (temple) at 360° and if you do not, the outcomes or success can be challenging. High level professional players dedicate extra time for preventative or performance training and keep a rigid schedule in life. Basically, you need to respect your body, also finding a good balance in sleeping and nutrition. Players that stick to these rules are also generally more prone to complete additional training and they optimize their possibility to succeed or recover after an injury (when it happens). This is massively important. An example above all is Cristiano Ronaldo. Cristiano is keeping his body fit as a 25-years-old player, with notable personal dedication that reflects on football practice. He is prepared for the demand of playing. All footballers, whatever the level, should be prepared for the physical demands of a football match. First, they are athletes, not just footballers.

From the football academies it is important to think about it and prepare the youngest to a sustainable performance. Sometimes the community skip this process directly creating very young football players. This early sport specialization can promote at risk mechanics and movement patterns generating an overload of some structures. If you facilitate the capability of the athlete to tolerate the demands of playing before, then you can ease also the footballer. We believe that this is an important point. As a Medical community our primary target is the health of our players and patients. All these concepts perfectly apply also in the recovery process after ACL injury. Another and often overlooked aspect to mention is the psychological readiness to RTP. As I told you above ACL injury can have important psychological consequences on patient, in the rehabilitation process it is suggested to test and progressively promote the player psychological readiness to RTP. Alongside other important objective criteria, this is often cited as one of the major determinants of patient's success after ACL surgery.

That's perfect and a good finishing. Dear Francesco, thank you so much for the interesting discussion and good luck for your conference in Lyon.

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Literature
Francesco Della Villa, Marco Gastaldo, and Matthew Buckthorpe (2020): "Prevention Strategies in Traumatic and Overuse Injuries" in *Injury and Health Risk Management in Sports* (pp.67-74) https://www.researchgate.net/publication/340823027_Prevention_Strategies_in_Traumatic_and_Overuse_Injuries

Regeneration processes

Adjunct to the daily training process with minimisation of stress parameters



Dr. Stefan Pecher,
Sportmedizin Pecher, Fichtelberg

The increase in the number of competitions, increased performance density and more marked differentiation in individual disciplines are having a sustained effect on regeneration in competitive sport. Training methods are becoming increasingly more complex and more intensive to achieve even higher levels of performance. As many processes in competitive sport have already reached the point where further improvement is hard to achieve, there is now increasing focus on regeneration and the optimisation of recovery processes.

Regeneration is a process to restore physiological balance. It is related to the preceding loading and to restoration of the preceding function. Training processes and competitions result in fatigue, which is the prerequisite for adaptation processes that subsequently increase performance. Fatigue and recovery processes take place on various levels. These include the muscles, the autonomic nervous system, the neuromuscular system, the central nervous system and the endocrine system. Stress minimisation is playing an increasingly important role in the optimisation of repair processes. The measurement of fatigue indicators in sports medicine comprises laboratory values, psychomotor tests as well as straightforward motor tests. These tests must be repeatable and as independent of influencing factors as possible.

Diagnostics regarding fatigue processes is a fundamental part of sports medicine care. High levels of training are also becoming more com-

monplace in performance-oriented popular sport. This is something that both my team and I have observed in ergospirometry tests and the resulting training consultations. 25 hours or more of training a week are not uncommon even in working amateur athletes. This leaves increasingly less time for regenerative processes, susceptibility to injury is increased and the desired increase in performance is not achieved. Furthermore, athletes admit to enormously high levels of stress, which has a sustained negative effect on further performance. In recent years, many studies have confirmed the impact of stress factors on immunocompetence. In Nordic ski sports, 90% of absence from training and competition is caused by upper respiratory tract infections, which shows that stress management in competitive sport also plays an important role in preventing infection.

From a current sports medicine perspective, regeneration comprises several elements:

- 1. Training planning, 2. Diet,**
- 3. Stress avoidance and sleep**

1. Training planning

Training planning is a hugely important aspect in regeneration. Physiological variables need to be considered here. Training planning also needs to be individually designed to prevent overtraining. It is important as the point at which the athlete confers with the trainer and sports medicine practitioner. Many laboratory tests that can measure fatigue indicators have been available for years. These include the parameters creatine kinase (CK) as an indicator of micro-muscle damage, free testosterone levels and cortisol as parameters of anabolic-catabolic balance. Urine tests also of course provide important indicators of metabolic de-

mand and protein catabolism. Carrying out urine tests during the daily routine training does, however, require a high level of routine and accurate use. Urine values, on the other hand, are hugely important and useful in daily training management. A significant correlation between training-induced fatigue and proper recovery has been demonstrated in numerous studies [1, 2]. One benefit of urine and CK tests is their relatively low cost. On the other hand, close monitoring with frequent testing is required. The categorisation of CK values as more useful in strength and high-speed strength sports and of urine tests as more useful in endurance sports no longer applies due to the increasing complexity of training loading. The example of cross-country skiing shows that with new techniques and improved material, what was once considered more of an endurance sport is now associated with many strength endurance elements and thus requires complex laboratory testing. However, this requires a high level of experience both on the part of the sports medicine physician and the trainer.

Heart rate measurements of course continue to be important indicators of training loading. It is essential that resting and recovery heart rates are meticulously recorded by the athlete. Resting heart rate has been an established autonomic nervous system parameter for decades and is easy to measure. It should be measured by the athlete early in the morning when supine. Increases in resting heart rate are the first sign of overloading. However, they may also occur at the start of an infection. A further indicator for measuring fatigue is heart rate variability (HRV), which can also be shown non-invasively. However, due to the complexity of the measurement procedures involved, this is not easily integrated into the training routine and hence is hardly used on a daily basis.



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Diet to minimise stress

Any training loading results in catabolic processes. With proper regeneration and appropriate training loading, these effects can be used to achieve increased performance and supercompensation. What is important here is the speed of signs of adaptation. These can be significantly affected by diet. It is important to ensure here that the diet is already individually adapted to the respective training unit before the start of training as well as during and after training. This includes applying what has been learnt in sports nutrition science. The digestive tract contains just as many nerve cells as the spinal cord. The gut has an effect on the vagus nerve, among others, and constantly releases hormones. It therefore has a huge effect on brain activity. Stress, emotions and mental capacity are therefore substantially determined by the gut and accordingly by diet. There are studies that show the links between disturbed gut flora and stress. Many studies suggest that the administration of probiotic bacteria to strengthen the gut has great effects on the psyche and emotional balance. The composition of the gut microbiome affects, among others, the emotions and mental performance. Behaviour and happiness as well as pain tolerance and hence sports performance are also influenced by the nervous system. Half of the happiness hormone, dopamine, does not originate in the brain but in the gut. This neurotransmitter plays an important role in the body's own reward system and triggers feelings of happiness.

and sports enthusiasts taking part in the traditional Vasa run, a cross-country skiing event over 89 km in Sweden, have been given bilberry juice both during and after the competition. The regenerative effect has been scientifically proved [4].

Example of a stress-reducing meal:

- Post-workout shake immediately after training
- 30 g powder = 22 g pure protein
- Vegetable protein without chemical additives and sweeteners
- Carbohydrates approx. 6 – 10 g per kg bodyweight
- Quinoa, millet, kamut noodles, jasberry or whole meal rice
- Protein, approx. 1.5 g per kg bodyweight
- Salmon, steak, poultry, tofu, pulses, mushrooms
- Vegetables approx. 200 g, depending on the season, ideally organic
- Fats: linseed oil, hempseed oil, chia seeds, nuts, avocado

The subjects of regeneration and protein belong together. It is essential, however, to also bear in mind the biological value when selecting the protein. The ORAC list provides helpful guidance for the athlete on the nutritional value of different foods. It gives a summary of the most nutrient-dense foods with high antioxidant capacity. The maintenance of the acid base balance is an important element in the optimisation of regeneration.

3. Stress avoidance and sleep

Stress is a biological and psychological response to loading events and involves the activation of the autonomic nervous system and the release of stress hormones. It also involves delayed regeneration. Athletes experience stress not only during competition but also in strenuous training. Stress minimisation is thus an important element in the optimisation of regeneration. Psychometric scales and their evaluation are useful tools in training science for determining fatigue. The results of different tests must be pooled together to achieve objectifi-

ble results. These tests must allow the rapid and objectifiable representation of the psychophysical demands placed on the athlete at the time the tests were taken. In this respect, REGman [Management of Regeneration in Elite Sports] questionnaires [5] are useful as a reliable and objectifiable parameter. The advantage of these questionnaires is that they can be repeated and are relatively easy to use. In preparing for the Olympic Games in PyeongChang in 2018, a regime was developed in the German Ski Association Nordic combined team to minimise stress also in relation to the difference in time zones, as sleep is an important factor in performance capacity. A week before flying to South Korea, the athletes began taking 3 mg melatonin daily and moving their bedtime by one hour every day. We also administered Neurexan tablets to improve sleep quality and minimise stress levels, based on the randomised, double-blind, placebo-controlled study on the mechanism of action of Neurexan published in 2016 [6]. In this study, 64 subjects underwent the Trier social stress test, taking either Neurexan or placebo before and after the test. The increase in stress cortisol levels in the saliva was lower under Neurexan compared to placebo, as was the increase in plasma cortisol following stress loading (Fig. 1). This study also showed that adrenalin levels remained constant during intake of Neurexan. A further study [7] (Fig. 2) – a randomised, placebo-controlled cross-over trial – showed that intake of Neurexan results in a significant reduction in amygdala activity compared to placebo. This means that the stress response in the amygdala is reduced following Neurexan intake.

huge importance of the competitions. This allowed optimum results to be achieved in the Nordic combined events. Even after the stressful competition phase during the Olympic Games, the athletes continued to achieve excellent results in the subsequent world cup competitions.

The bibliography can be requested from info@thesportgroup.de.



Dr. Stefan Pecher in surgery and general medicine. He opened his own practice in Fichtelberg in 2004. As head team doctor for the German national ski team, he has provided medical support for the World Cup nordic ski team in over 100 World Cup events, 4 Olympic Games and 10 World Championships since 2004.

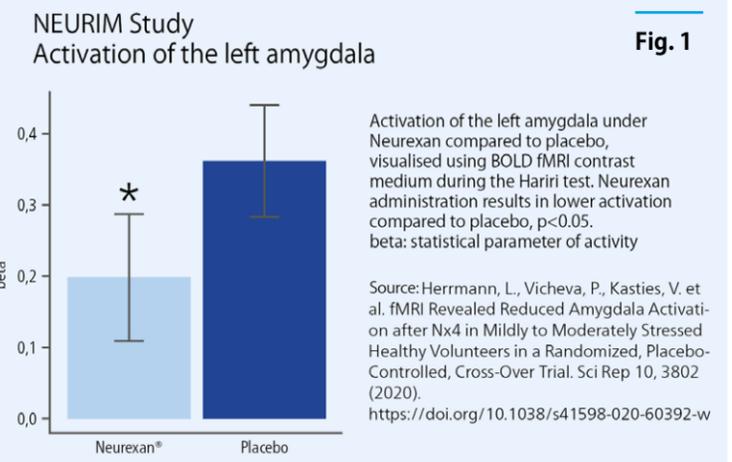


Fig. 1

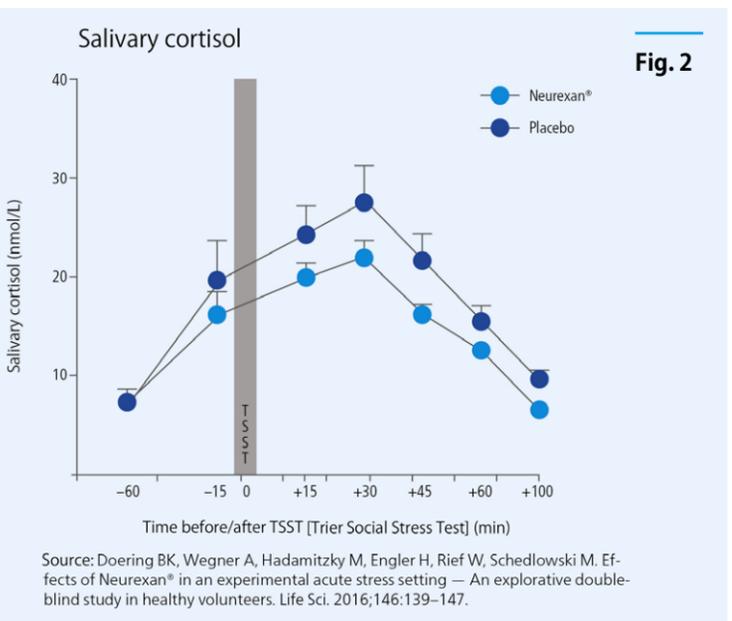


Fig. 2

Conclusion

Stress factors influence physical and thus sports performance capacity. Experience at the last Olympic Games in 2018 showed that the athletes who had carried out the treatment with Neurexan, melatonin and light lamps demonstrated high levels of performance, also in the second week of competition. Surveys and tests conducted with the athletes revealed very low stress perception, considering the

Stay & play after injuries

– the most important decision on field



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Task Force Sports Medicine German FA
(DFB) and German Football League (DFL)

Minor severe injuries have a high incidence in football and also lack of sufficient evidence-based data with regard to treatment options. Most important reason for the lack of standards and guidelines is the variety of conservative treatment options. The main criteria for a successful stay & play on field is an adequate emergency management with immediate exclusion of severe injury types. The treatment steps on field include mainly symptom-adapted strategies to enable for the players a pain-free stay & play on field.

Classification

Previously published classifications of injuries for the stay & play-decision on field (Krutsch et al 2018, 2020) defined different minor injuries regarding their potential to stay & play on field. All injury types without any substitution of the injured player and a continuously stay & play on field were defined as Type 1. Type 2 was defined as minor injury with direct substitution of the player after injury mechanism and no further time-out in training or match in the following days. Type 3 of stay & play injuries resulted in minor injuries with a stop of football playing in training situations, but to return to play in the next official match.

Healing potential

Different body localisation have different types of tissue and thus vary in healing and regeneration potential, but also in vulnerability after hits. To understand the healing process of each injury, a fundamental knowledge about sports-related anatomy or tissue regeneration in different injury types is essential. Typical stay & play inju-

ries in football are ankle sprains, contusions on different body localisations, muscles strains and any kind of overuse complaints on back, groin or the lower extremity. A relevant problem of a stay & play-decision in such situations is the potential for aggravation of symptoms and consecutively occurrence of recurrent injuries. The potential for such negative consequences should be considered in an adequate risk assessment on field by players and medical staff.

Pain killers

For the goal of an immediate stay & play on field is the use of pain killers a potential option. Thus, pain represents an important alarm signal of the body and both pain ignorance and the immediate use of pain killers may result in negative influence on the neuromotorical adaptation and proprioception of the players and a higher risk for further injuries. Therefore, an immediate single use of painkillers on field to reach a stay & play on field generally is not recommended.

Decision-maker

The decision-making on field depends in football on the playing level. Amateur football players have no medical staff on field and have to provide the stay & play-decision after injury for their own. Sometimes is the support by the team coach possible and also recommended, if objective physical limitations in the performance of the player are obvious. Professional football players have the opportunity with the support for this decision by medical staff on field. With a specific short anamnesis and standardized objective clinical examinations by medical physicians or physiotherapists is it rather possible to differentiate between various injury types and a stay & play on field.

Stay & play treatment

Sufficient treatment starts with a correct clinical diagnosis without further imaging. The huge number of available conservative treatment strategies cannot be provided at highest level by just one person. To offer football players the highest standard of treatment options for a stay & play on field, the medical staff in professional level have to be educated and handle a clinical diagnosis on field and a variety of treatment options for the most common football injuries. Important treatment strategies to provide succesful stay & play on field are:

- Manual therapeutics
- Oral medications
- Invasive treatment (needles/injections)
- Non-invasive treatment (shock waves, ultrasound, etc.)
- Unguents and lotions
- Tapes and bandages
- Early rehab principles (physical therapy, etc.)

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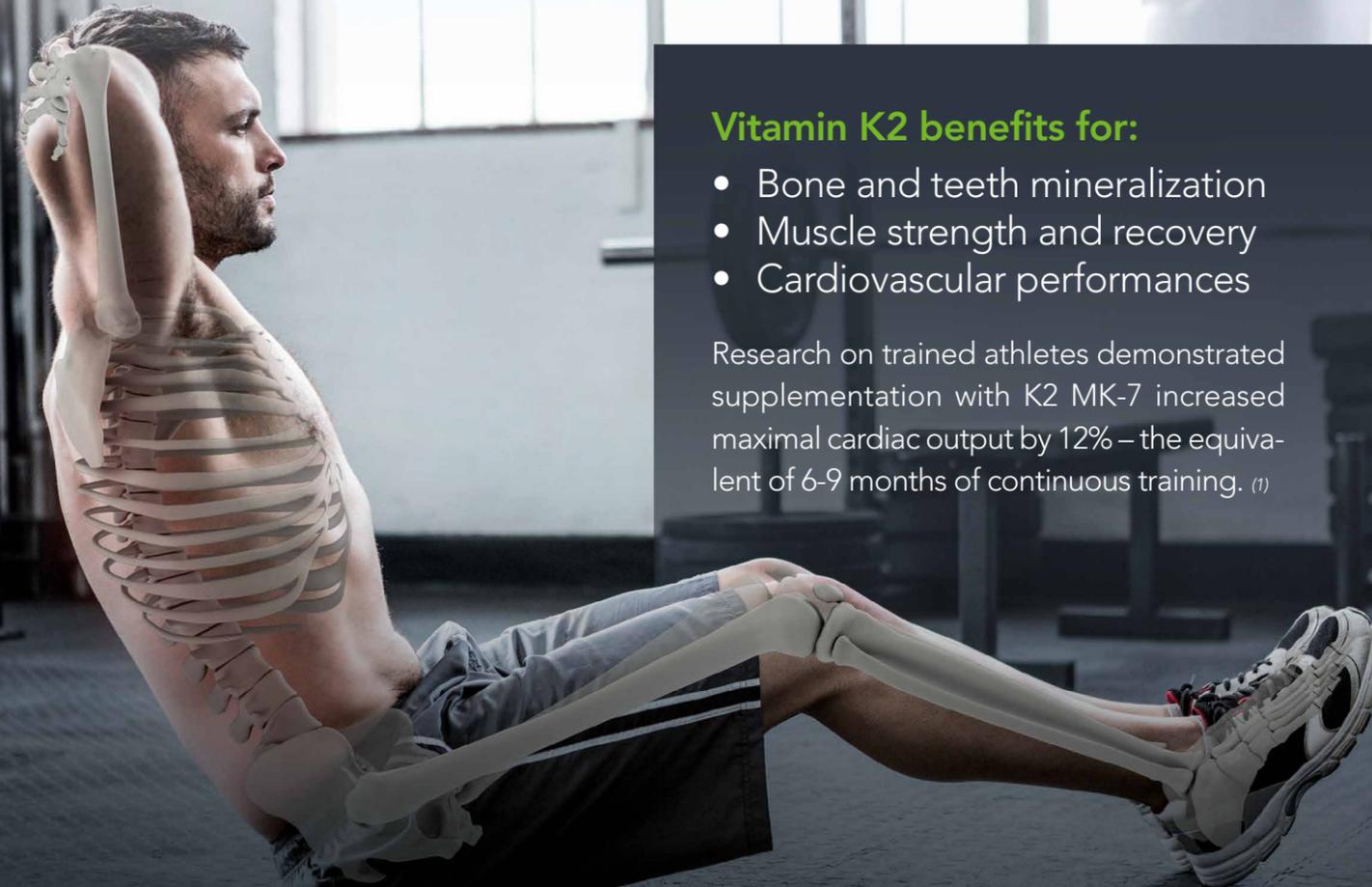
It is important for sports physician and physiotherapists in football to „find your way“ in the selection of conservative treatment strategies. In absence of standardized evidence-based guidelines for a stay & play on field is it essential to make own experiences in practical routine and to share experiences with colleagues. Additionally, it is not disadvantageous, if medical staff has own experiences in football playing. Each stay & play-decision is individual, depends on the players' character, the match situation and many other criteria.



Assoc. Prof. Dr. Werner Krutsch is an Orthopaedic and Trauma Surgeon at SportDocsFranken/ Nuremberg and at the Department of Trauma Surgery, University Hospital Regensburg. He is also a member of the German Football League (DFL)/German Football Association (DFB) Sports Medicine/Special Match Operations Task Force and is Co-Director of the Football Medicine Programme at the DFB.

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Flywheel Training

Innovative training, not just for athletes



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Flywheel, inertial or kinetic training is a form of training that is attracting increasing interest. It is becoming increasingly popular due to sound scientific results and practical experience. It can be used in many different ways, not only in fitness and sport but also in patient rehabilitation.

What is flywheel training? The simplest way to explain the principle behind it is to think of how a yoyo works, even if with a yoyo the position of the spinning axis changes. Flywheel training is based on the physical principle of inertia. The person training sets a disc in motion by pulling on a cable as on a pulley. This is equivalent to the concentric phase. Once the cable has been pulled to its full length, the disc rotates in the opposite direction and winds the cable back to its original position. This is equivalent to the eccentric phase. The externally applied torque and the change in rotation direction of the disc result in alternating concen-

tric and eccentric muscle work. Loading in this form of training is controlled by adjusting the weight and acceleration of the disc and the length of the cable.

Small/lighter discs are easier to set in motion and rapidly accelerate to a high speed – larger/heavier discs are harder to set in motion and do not readily accelerate to a high speed. Shorter cables result in a smaller range of movement and a shorter concentric/eccentric contraction time - longer cables result in a larger range of movement and a longer concentric/eccentric contraction time. Higher load values can therefore be achieved with a heavy disc and a longer cable, faster acceleration with a lighter disc and a shorter cable. The parameters can be set accordingly, depending on the goal.

Three different types of equipment are used for training:

- platform (cable is pulled upwards)
- pulley (cable is pulled forwards/backwards at different heights)
- fixed equipment (cable can be adjusted and pulled in the desired direction)

NB: Flywheel training requires a sense of rhythm from the person training, which must first be acquired to ensure smooth movement. Smooth and even relaxation in the eccentric phase results in smooth movement. If there is excessive resistance, movement stops abruptly. If the person training does not have enough sense of balance, movement continues, which may force them to step to one side for movement to stop.

History and providers

The first descriptions of this form of training go back to the year 1913. In 1994, a flywheel ergometer was developed in Sweden for astronauts to reduce loss of muscle mass and

Scientific results

strength in space. As with much other equipment that originated in space research (AlterG, Vacumed etc.), the benefits were later also used for training on earth. There are now a large number of different manufacturers on the market. Most of them specialise in pulley and box equipment. There are also manufacturers that have adapted the principle to conventional fixed gym equipment. Price and quality vary considerably. One manufacturer offers the option of measuring maximum strength (isometric and dynamic), strength endurance, work, performance and speed on its equipment. Weight distribution can also be measured on box equipment. The measurement of this data opens up many new possibilities for the flywheel principle. It allows accurate measurement and comparison of functional and sportsspecific exercise.

As there is physically a focus on eccentric muscle activation, studies with eccentric training should also be considered in scientific results as well as conventional flywheel studies. In studies and reviews, research groups have demonstrated a wide range of improvements in different target groups compared to conventional training:

- increased muscle activation (post-activation potentiation, Beato 2018)
- hypertrophy in the elderly, trained and untrained (Onambele 2008, Tesch 2017, Petr  2018)
- improvement in maximum and high-speed strength, balance and chair raise in geriatric individuals (Sanudo 2019, 2020)
- improvement in step height and sprint speed (Maroto-Izquierdo 2017, de Hoyo 2015)

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- greater EMG activity and muscle control (Tesch 2017)
- reduced injury rate and sick leave in patients with hamstring injuries (Askling 2003, De Hoyoy 2015)

These are just some of the positive effects demonstrated with flywheel training.

Possible applications in clinical practice

The scientific results show that flywheel training can be used in many different ways. This form of training can be used in prevention and rehabilitation as well as in fitness and competitive sport. As eccentric muscle activation plays a crucial role, not only in many kinds of sport but also in the everyday life of both young and old, focussing on eccentric activation makes good sense. It is particularly the option of training at high speed and strength in loading and movement patterns common in sport and everyday life that makes flywheel training so interesting.

Wound healing phase

How can this form of training be usefully integrated in the wound healing phase following injury or surgery? Generally, flywheel training can also be used, with or without additional weights, just like any other form of training. The training parameters and the associated

subjective loading of the person training are crucial. The general principles of training and wound healing apply. In the inflammatory phase, in most cases characterised clinically by resting, night and/or permanent pain, this form of training can only be used on the affected side in exceptional cases. In the proliferation phase, the focus is primarily on coordination-dominant training, but not to the point of extreme tiredness. On a modified Borg scale of 0–10 (0-not tired, 10-exhausted) training should take place within the range of 1–4. From the remodelling phase onwards (the time depends on tissue damage) it can be used for strength training. Subjective values of 5–10 on the Borg scale should be encouraged. It is undoubtedly in this phase that the effectiveness of the principle is most apparent. The dominance of the eccentric phase is of great importance both for prevention and rehabilitation as well as for training specific to the type of sport. Be it step training in the elderly or reactive strength training (throwing, sprinting, jumping, etc.) in professional athletes, these activities are largely determined by the quality and quantity of the eccentric phase. The increase in loading during training should be verified with adequate checks on the device. It is important that loading on body structures increases as resistance and speed increase. This is why training should be methodically and appropriately increased as in medical training therapy (Diemer/Sutor 2018).

Invoicing options

Various invoicing options are available for flywheel equipment under the German Medical Fees Regulation (GOÄ). Section 842 could be applied for equipment with test mode (e.g. Desmotec) for the initial and final examination. This service can also be delegated to physiotherapists. Sections 558, 506 and 510 can be used for other services within the scope of therapy. However, for physiotherapy treatment with the additional item KGG, equipment with a flywheel can also be used as equivalent to conventional equipment. This means that pulley, vertical and – after consultation with cost-bearers – other equipment can be substituted.



Volker Sutor is a physiotherapist (Msc.) and sports therapist. He is the owner of several rehabilitation centres (Gesundheitsrondell) and co-founder of FOMT (Fortbildungen für Orthopädische Medizin und Manuelle Therapie [Training Courses in Orthopaedic Medicine and Manual Therapy], www.fomt.info).

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Tendon Insertion Disorders

Laser and shockwave therapy – effective combination as an adjunct to functional treatment

Use of focussed shockwave therapy (ESTW) on the patellar tip; intensity and treatment duration should always be adapted to the individual athlete's tolerance threshold (manufacturer: EMS)



Hendrik Schreiber¹, Knut Stamer², Dr. Ralf Doyscher³

- ¹ **Head Physiotherapist Borussia Mönchengladbach,**
- ² **Sports Physiotherapy Rehabilitation FC Bayern Munich,**
- ³ **Team Doctor Borussia Mönchengladbach**

Although laser therapy has been used in physiotherapy for decades and is now a well-established physiotherapy treatment, it is in our view not so well-established in scientific circles and medical practices as it should be.

It is particularly in the treatment of insertion tendinosis and tendonitis that astonishingly rapid and good outcomes have been reported in therapeutic indications with the high-energy lasers developed by some manufacturers in recent years. Laser therapy seems to be particularly effective when combined with radial or focussed shockwave therapy (ESWT).

Mechanism of action of laser therapy

As the literature on the use of laser in humans is very sparse, the mechanism of action can be inferred from only a few fundamental research papers on laser physics in cell cultures and laboratory animals. The fact that a distinction must also be drawn between low-level laser therapy (low-energy laser applied over a prolonged period) and high-energy lasers further complicates interpretation of the literature. On the one hand, it has been shown that there are photoactive target molecules in the mitochondria, such as cytochrome C, which are sensitive to light in much the same way as the chlorophyll in plants, albeit to a lesser extent, and

which can be stimulated by the absorption of photons. Cell culture studies have shown increased intracellular ATP levels following laser exposure. To what extent this observation is clinically relevant cannot be assessed from the available study data. However, it may partly explain, at least theoretically, the clinically observed effect in addition to the stimulation of the circulation with the application of heat.

Moreover, frequent reports of marked pain reduction in the target area after just a few laser treatments suggest that high-energy laser may well have a further and more likely non-specific effect. Whether this is due to a direct effect on inflammatory cells, an impact on nociceptors or a direct impact on tissue metabolism is purely a matter for conjecture and one that requires scientific study. But one thing is clear: in our daily work with the athletes in question, we and many of our colleagues have observed a clinically relevant pain-relieving and circulation-stimulating effect that manifests itself after a few treatments and in most cases often after one or two days. The effect is significantly more pronounced and manifests itself earlier than that achieved with shockwave therapy alone without laser therapy. This article makes no scientific claims. We merely wish to share and discuss our observations with colleagues reading this article on this user-oriented platform.

Indications

We have observed rapid and positive outcomes with combined high-energy laser and focussed shockwave therapy in the following indications:

- achillodynia (including and especially insertional forms)
- epicondylopathy of the elbow (medial and lateral)
- patellar tip syndrome
- iliotibial band syndrome
- biceps femoris tendinitis
- myofascial trigger points
- muscle injuries

Example: patellar tip syndrome

Procedure and settings for the use of high-energy laser in combination with focussed shockwave therapy, taking patellar tip syndrome as a practical example. As with any orthopaedic symptoms, early passive treatment options, such as laser and shockwave therapy in this case, are most effective when combined with an individually adapted active training programme – eccentric exercise, trunk stability training, mobilisation, etc. In the case of patellar tip syndrome, an area of approx. 7 x 5 cm, for example, should be selected for high-energy laser treatment at an energy density of approx. 100 joules/cm², which is equivalent to a total energy density of 3500 joules. Both the area and the applied energy density must of course be individually adjusted and also modified in the treatment course, as applicable.

For focussed shockwave therapy, a depth of 5 to 15 mm can be selected, depending on the localisation of the irritation on the patella and tendon – reference to diagnostic ultrasound is useful here for accurate localisation of the structural change. Depending on the course, two to five treatments a week with combined laser therapy and ESWT are administered to the affected knee of the athlete after training, with at least 4000 – 8000 impulses per treatment and at an intensity that varies considerably and is dependent on the individual pain threshold of the athlete. It is always essential to ensure that the treatment is appropriate for the individual characteristics of the patient – in particular, skin type, pain tolerance, which often changes daily, and the evolution of symptoms in the treatment course should always be considered. It is important to note that despite the effectiveness of laser and shockwave therapy in providing early pain relief, they generally do not provide a cure by themselves. As with any pathology, it is a matter of identifying the biomechanical and local causes underlying the condition. This should also be considered in the functional diagnostics, see diagram.

A functional and passive examination of the affected area and the musculoskeletal system



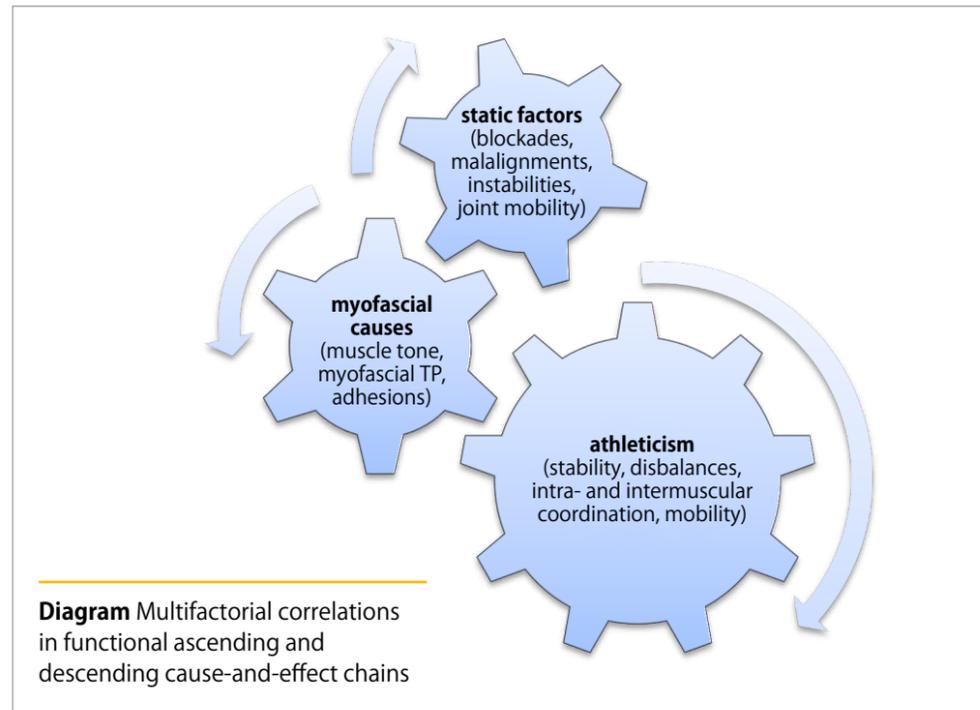
Hendrik Schreiber has been head physiotherapist at Borussia Mönchengladbach since 2018. Before that, he was head physiotherapist and rehabilitation trainer at 1. FC Union Berlin. Earlier, he provided physiotherapy to the TSG 1899 Hoffenheim youth team and various amateur sports clubs.



Knut Stamer is a sports physiotherapist, osteopath and rehabilitation trainer employed at various sports clubs and associations. Up until the Olympic Games in Rio he was employed by the Chinese Athletics Association and was head therapist at Medical Park St. Hubertus, Bad Wiessee for over 20 years. He has been a therapist at Sports Physiotherapy Rehabilitation FC Bayern Munich since 1 January 2020.



Dr. Ralf Doyscher has been the permanent team doctor at Borussia Mönchengladbach since 2018. Before that, he worked as an orthopaedic and trauma surgery specialist in various departments of the Charité Hospital Berlin, working at the end of his time there in the Department of Sports Medicine and Conservative Sports Orthopaedics, Charité University Hospital Berlin. He was also the team doctor at 1. FC Union Berlin and the association doctor of the German Athletics Association (DLV) and the German Bobsleigh, Luge and Skeleton Federation (BSD).



in general should always be performed. Manual therapy expertise is essential. It is only when the underlying mechanical causes are treated and resolved or at least reduced that the early pain relief provided by passive measures can be used to allow functional therapy management and thereby provide long-term alleviation of the symptoms.

NB

Due to the rapid pain relief, laser treatment should not be performed before intensive training units, as the pain relief may result in overloading of the damaged structure and in-



Treatment of radial epicondylitis with high-energy laser (manufacturer: Zimmer)

jury. Wear protective goggles and use in lockable rooms with the displayed warning that high-energy lasers can cause serious eye injury. High-energy lasers have a strong thermal effect – ensure appropriate temperature and duration as otherwise burns may result. As described above, skin colour pigments are one of the structures targeted by laser. This means that the thermal reaction in patients with liver spots and tattoos and in dark-skinned athletes is very rapid and can be painful for them and may even result in local burns.

Conclusion

Laser therapy combined with radial and focussed shockwave therapy is an effective combination in sports physiotherapy, which often leads to rapid pain relief in the early treatment phase. This symptomatic treatment, however, is no substitute for manual therapy and/or osteopathic treatment and targeted functional training in resolving dysfunctional chains and the frequently distal cause(s).

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Univ.- Prof. Dr. Christoph Schmitz is holder of the professorial chair of Anatomy II at Ludwig Maximilian University of Munich.

Osteochondral defects of the knee, often associated with trauma or degeneration of the knee, are relatively common. The patella has been identified as the most common localisation of chondromalacia. Focal, chondral and osteochondral defects of the patella are characterised by reduced function of the knee and pain. The disorder can substantially limit common movements in daily life such as rising from a chair or going up and down stairs.

The pathogenesis of primary, focal osteochondral defects of the patella (PFODP) is still not fully understood. It is thought that negative stimulation due to overuse of the knee and local microcirculatory disturbances play a crucial role in the pathogenesis of PFODP. A wide variety of conservative/physical and drug treatments are used to treat PFODP. Surgery to repair the cartilage is indicated when symptoms of cartilage damage persist despite conservative and drug treatment. In summary, the therapeutic approach to PFODP largely mirrors that to osteoarthritis of the knee. However, it is still largely unclear whether combinations of conservative/physical and drug treatments for PFODP really result in better outcomes than individual measures. This question has now been investigated by a team of researchers from Germany and China (note from the editor: our scientific advisor Prof. Christoph Schmitz MD (LMU Munich) was also a member of this team). Specifically, the researchers performed a retrospective analysis of the medical records of all 81 patients with unilateral symptomatic PFODP who received treatment with either five intra-articular injections of hyaluronic acid at weekly intervals (iaHA) (n=45) or a combination of 5x iaHA and 5x radial shock-wave therapy (iaHA+rESWT) (n=36) at the Center for Joint Surgery of the Third Military Academy in Chongqing/China in the period 1 January 2014 to 31 January 2018. Each intra-

articular injection of hyaluronic acid was performed using 2.5 mL ARTZ Dispo (Seikagaku Corporation, Tokyo, Japan); the rESWT involved the use of a Swiss Dolorclast (Electro Medical Systems) with an EVO Blue handpiece and a 15 mm applicator (2000 radial shock waves per treatment); working pressure 1.8–2.5 bar; 6–8 Hz). Follow-up was performed after 6 weeks (W6), 3 months (M3), 6 months (M6) and finally (F) after a minimum of 12 months (mean: 37.6 months; maximum: 59 months).

Results

Compared with patients who received treatment with iaHA alone, those treated with iaHA+rESWT had statistically significantly lower mean VAS pain scores at W6, M3 and M6 (each 7.0 at baseline), significantly lower mean WOMAC scores at W6, M3 and F (59 and 62 at baseline) and a significantly smaller mean area of bone marrow oedema on sagittal MRI images of the patella at M3, M6 and F (no MRI was performed at M3) (69 mm² and 75 mm² at baseline). The decrease in the mean values between baseline and final follow-up in the patients treated with iaHA+rESWT was 82% (VAS), 66% (WOMAC) and 75% (area of bone marrow oedema). No serious adverse reactions were observed.

Conclusion

The results of this study indicate for the first time that the combination of iaHS+rESWT to treat PFODP is safe and more effective than iaHA alone. This outcome, which is also of great interest for the treatment of other forms of osteoarthritis of the knee, is now also being further investigated in adequate, randomised controlled studies.

The preprint of the study is available at <https://doi.org/10.1101/2020.07.29.20164111>.



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Polyarticular arthritis of both hands

Peter Stiller,
Allgemeinmedizin Lechhausen &
MedWorks – Privatärztliche Praxis

Medical history : This case involves a 54-year-old full-time secretary with severe hand symptoms suffering from polyarticular arthritis of both hands and bilateral basal thumb osteoarthritis.

The patient first presented in February 2019 approximately 3 months after full manifestation of characteristic symptoms with pain and swelling in individual finger joints. There was a history of the disease in both the mother and grandmother, the disease fully manifesting in both at approximately 50 – 55 years of age.

The findings of the thorough clinical examination conducted at first presentation were as follows:

Marked swelling in both hands with more pronounced swelling in individual finger joints, particularly in the metacarpophalangeal (MCP) joints. Severe pain in these joints on pressure, e.g. when shaking hands (VAS 9–10) and on movement (VAS 6–8); full extension of fingers not possible or only with pain. Flexion restricted, complete closure of the fist not possible due to pain and swelling. Early deformation of the DIP joint of the left index finger. Blood circulation, motor skills, sensitivity without findings, no numbness or paraesthesia of the hands. The patient was unable to wear her wedding ring at first presentation.

Due to the history and identical symptoms of her mother and grandmother, the patient declined to have an X-ray examination or MRI scan for further clarification. However, the clinical signs and massive discomfort provided and provide clear evidence of familial polyarticular arthritis. The patient had been previously treated with just various NSAIDs, novamin-sulfone drops, paracetamol, vitamin D, hot

and cold hand baths, squeeze balls and rest. Under this treatment, the patient was never without pain and the fingers were always swollen. She usually needed to spend about 10 minutes every morning exercising her fingers to improve mobility and be able to start work.

Normally at this point, options for further treatment would primarily include a period of unloaded rest, cortisone (topical and oral), physiotherapy, further intake of high dose NSAIDs and, where applicable, even treatment with methotrexate. However, as the previous treatment had been unsuccessful in all respects, in close consultation with the patient we opted for radial extracorporeal shockwave therapy (rESWT), which was then combined in the further course with high-energy laser treatment. We know of many cases of patients with polyarticular arthritis where ESWT had very often rapidly alleviated pain even when the polyarthrititis had previously been refractory to treatment. Unfortunately, however, there are to date no conclusive scientific studies on the successful effect of radial shockwave therapy in polyarticular arthritis of the hands. Similarly, there are no scientific studies on combination therapy with high-energy laser $\lambda = 905 \text{ nm}$ and ESWT.

The rESWT was performed using a Swiss Dolor-Clast device (Electro Medical Systems; Nyon, Switzerland) and the EVO Blue handpiece (36 mm applicator). The laser is a high-energy pulsed laser with a wavelength of $\lambda = 905 \text{ nm}$ and 300 W maximum output. At the start of treatment in February 2019 approx. 5000 rESWs (radial extracorporeal shock waves) were applied per hand at 0.3 bar (36 mm applicator) around the MCP joints, then the fingers, followed by the palms and the carpometacarpal joint of the thumb. The rESWs were always applied at 20 Hz, i.e. 20 rESWs per second, and always at the end also as a form of deep lymphatic drainage massage, moving the handpiece always from distal to proximal over the



Patient receiving high energy laser treatment ($\lambda = 905 \text{ nm}$)

Typical rESWT for polyarticular arthritis (different female patient)

carpal tunnel. Treatment was initially performed weekly. From the third treatment session onwards, we were able to increase the working pressure to 0.6 bar, and the patient reported a distinct improvement in pain and swelling, and after the fifth session was even able to wear her wedding ring again. However, in the more severely affected left hand the working pressure could not be increased beyond 1.2 bar and in the less affected right hand beyond 1.6 bar. The patient was then fully without pain for approx. 3 weeks before the swelling and pain returned.

At the start of July 2020, we had the opportunity to attempt combination therapy with high-energy laser ($\lambda = 905 \text{ nm}$) and rESWT. After a 3-minute anti-inflammatory laser programme (applied using a flexible arm) applied to the 2–3 main pain areas in the more severely affected left hand, we were immediately able to increase working pressure up to 2.0 bar after a five-minute break and continued to apply rESWT at the usual 1.5–1.6 bar in the less affected right hand. The effect on the left hand was immediately felt to be greater according to the patient and the pain relief induced by rESWT even markedly better than before.

At follow-up after 5 weeks the otherwise worse left hand was still very good, whilst the patient was once again already experiencing pain in the right hand.

At the next treatment session, a break of 1 hour

was observed between the laser and rESWT treatments, which enhanced the effect even more! We were able to apply rESWT this time at 2.5 bar in the left hand and at 2.4 bar in the right hand (this time also preceded by laser treatment). The follow-up this time after 8 weeks (05.10.2020) was reason to celebrate, as the patient even after this length of time was still without pain and the hands were no longer swollen and were freely movable.

Conclusion

Radial shockwave therapy is a very successful and reliable treatment option for polyarticular arthritis and has proved itself countless times in our practices. The combination of high-energy laser at $\lambda = 905 \text{ nm}$ and subsequent rESWT can markedly further enhance the positive effect. This is due to the pain-alleviating effect of the laser, which would be comparable to that of topical ibuprofen. As a result, subsequent rESWT can be performed at a markedly higher working pressure and thus a stronger and markedly longer lasting effect can be achieved. The two treatment modalities should ideally be applied 1 hour apart, but the effect can be already observed, albeit weaker, after a break of 5 minutes. This combination treatment allows, for example, chronic symptoms of polyarticular arthritis to be treated significantly even more effectively and longer lasting than before.



Peter Stiller is a Consultant in General Medicine and Emergency Medicine at Allgemeinmedizin Lechhausen & MedWorks – private Sportsmedicine, Augsburg. He was formerly team doctor of for the FC Augsburg 1907 professional football club.

Professional football player following ATFL and CFL tears

Combination therapy with high-energy laser and rESWT

Alexander Ablaß,
Körperwerkstatt Augsburg

History and MRI findings: during a league match, the football player received a kick on the medial malleolus of the right ankle, resulting in a supination injury. On MRI, both the anterior talofibular and calcaneofibular ligaments were no longer constantly defined and there was a marked high-signal swelling of the surrounding soft tissue. Mild joint effusion in the tibiotalar joint. Hyperintense bone marrow oedema in the medial talus and dorsomedial and dorsolateral tibial epiphysis.

Treatment

The player received initial treatment on the pitch using the RICE method. As acute treatment he also received 600mg oral ibuprofen as required, forearm crutches to relieve the right leg from weight and provide pain relief and cold compresses to reduce swelling.

From day 2 after the initial injury, the patient wore an ankle brace with a compression component, lateral stabilisation and straps to reduce anterior translation of the talus.

Combination therapy with high-energy pulsed laser ($\lambda = 905 \text{ nm}$ and 300 W maximum output) was also initiated at this time to provide local pain relief in preparation for the radial shockwave therapy to allow application at a markedly higher energy intensity using a Swiss Dolor-Clast machine (Electro Medical Systems; Nyon, Switzerland) and the EVO Blue handpiece. The treatment regimen was as follows: laser

programmes for pain relief and absorption of oedema and shockwave application using a 36 mm applicator, frequency 20Hz, 5000 impulses per session, 2 bars of pressure, applied over the lateral and medial malleolus areas to approximately the distal third of the lower leg and the anterior ankle area with the aim of pain relief and oedema absorption.

The patient was already without free of pain following the first combination therapy session in conjunction with the cold applications mentioned above. At the same time, upper body and trunk training was also initiated to maintain physical fitness.

The above combination therapy was performed daily, followed by cold compression using a therapy machine and bandages, until day 5 after the initial injury. After the third therapy session with laser and rESWT, there was no longer any swelling in the ankle joint and full weight-bearing without support was possible.

Between day 6 and day 18, therapy was continued 3 times a week as follows:

- laser programme for pain relief in preparation for rESWT
- applied with a 15 mm applicator, frequency 20 Hz, 4500 impulses per session applied to the tears. The pressure was increased in the further course from 2.0 bar to 3.0 bar. Treatment was followed by 2 x 3-minute cold therapy with Cryolight.
- applied with a 36 mm applicator, frequency 20 Hz, 4500 impulses per session, applied over the surrounding lateral malleolus area. The pressure was increased in this area in the further course from 2.5 bar to 3.2 bar.



Laser and rESWT for oedema absorption and pain relief

rESWT on the torn ligaments

From day 6 after the initial injury, it was already possible to initiate relaxed cycling, i.e. low linear weight-bearing for collagen alignment, and from day 10 simple ankle stabilisation exercises. From day 12 post trauma, the player had his first running sessions with carefully managed jumping exercises and full taping around the ankle, depending on the RTA (return to activity) phase attained at the time.

Twenty days after injury, the player passed his RTS (return to sports) test and was permitted to carry out ball work, sprint training and lateral movement sequences with taping applied.

Laser and rESWT therapy over the injury site were continued in parallel as follows: pain relief programme with laser and rESWT, applied with a 15 mm applicator, frequency 20 Hz, 4000 impulses per session applied to the tear sites, 3.5 bar.

As part of the gradual increase in weight-bearing, the athlete was reintroduced to all aspects of team training before the end of week 4 post trauma, with taping applied. Having passed the RTC (return to competition) test on day 27 post trauma, the player was permitted to fully participate in team training without restriction, but with full taping applied. He played his first league match 34 days after his initial injury.

He received further treatment for 2 weeks as follows:

laser (pain relief programme) to prepare the tissue and rESWT applied with a 36 mm applicator, frequency 20 Hz, 4500 impulses per session, over the surrounding lateral malleolus area, 4bar, with the aim of supporting full

healing, the stability of the ligament complex and the absorption of the bone marrow oedema as secondary prophylaxis.

Conclusion:

High-energy laser and rESWT in combination are an outstanding method of providing effective and above all long-lasting treatment of injuries to the lateral ligament complex of the ankle. The major advantage of this method is the pain relief provided by the laser, which, unlike other medication, has no adverse impact on the effect of rESWT, but allows the energy intensity to be increased, thereby further enhancing its effect. This combination therapy can be equally used in a wide variety of indications, such as insertion tendinopathy, muscle injuries, fractures and many others.



Alexander Ablaß is a registered German naturopath for physiotherapy, physiotherapist, manual therapist and sports physiotherapist from Augsburg, who has worked with the FC Augsburg football club (football academy) for six years. In July 2019, together with his business partner Ferdinand Merckx, he opened the physiotherapy centre "Die Körperwerkstatt in Augsburg" specialising in sports physiotherapy. They also work with Augsburger Panther (1st league ice hockey).

Acute and stress metatarsal fractures in sport

Jonathan Häußler, Juliane Wieber, PD Dr. Catalá-Lehnen

LANS Medicum Hamburg, Center of Sports and Regenerative Medicine

Foot injuries make up a not insignificant proportion of sports injuries, but the kind of frequency varies depending on the sport. According to the 2018 Sports Report of the Verwaltungs-Berufsgenossenschaft (VBG), basketball accounted for 7.4% of foot injuries, ice hockey for 5.6%, football for 10.3% and handball for 4.3% [20]. Metatarsal fractures are the most common entity [3]. The first metatarsal is the least

commonly fractured, accounting for approximately 5% of metatarsal fractures, and the fifth metatarsal the most commonly fractured, accounting for approximately 56%. Fractures are evenly spread among the other metatarsals [6]. Stress fractures may occur as well as traumatic fractures. They account for 38% of stress fractures of the lower extremity. Stress fractures mostly involve the second and third metatarsals [6]. Irrespective of whether an acute or stress fracture is present, it is essential to identify as soon as the cause and contributory risk factors as quickly as possible factors. Subsequent treatment should take these into account.



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Causes	
Extrinsic factors	Intrinsic factors
<ul style="list-style-type: none"> footwear loading surface changes in training changes in technique 	<ul style="list-style-type: none"> bone metabolism underlying disease hormone metabolism
Diagnosis	
Equipment-based diagnosis	Laboratory tests
<ul style="list-style-type: none"> imaging (ultrasound, X-ray, MRI analysis) foot and leg statics gait analysis 	<ul style="list-style-type: none"> full blood count without differential creatinine, gamma GT, CRP, 25-OH vitamin D, parathormone, collagen crosslinks, bone AP
Treatment	
Immobilisation/unloading	Optimisation of bone healing
<ul style="list-style-type: none"> short walker custom-made carbon sole 	<ul style="list-style-type: none"> vitamin D, vitamin K₂, boron, enzymes shock wave therapy, PEMF, ultrasound avoidance of NSAIDs

Fig. 1 Diagnosis and conservative treatment of metatarsal fractures

Symptoms

Whereas in acute fractures sudden onset of pain is typically a cardinal symptom, in metatarsal stress fractures it generally develops gradually. Reduced loading capacity is associated with fractures irrespective of aetiology. Adequate early diagnosis and identification of risk factors are particularly detaining important in competitive sports to avoid long periods without training or competition.

Risk factors

It is crucial to identify any predisposing factors. For example, stress fractures are more common in ballet dancers due to repeated maximum plantar flexion [36, 27]. Athletes in sports with high running or jumping loads are also at risk. As retiring from the sport is not an option for competitive athletes, it is essential to identify other possible causes. These may include changes in loading, such as increased training volumes,

changes in surface, new shoes, special shoe inserts or biomechanical compensation mechanisms following prior injury [7, 21]. Systemic causes should also be considered. These include changes in hormone balance, eating disorders and malabsorption syndrome [1, 2]. The female athlete triad is a common example [33, 1]. It is therefore important to check intake of protein, calcium and vitamins D and K₂, as well as use of alcohol, opioids and tobacco [28, 10]. Non-steroidal anti-inflammatory drugs (NSAIDs) in particular can have a negative impact on fracture healing. Use of NSAIDs has caused a significant decrease in trabecular bone mass in ectopic ossification areas due to the decreased number and activity of osteoblasts. This is caused by interference with the bone morphogenetic protein-7 (BMP-7) signalling pathway. Although trauma is the direct cause in acute fractures, the other above factors can predispose to fracture and should therefore also be considered even if the immediate cause is apparent. [32]

Diet

Diet can have both a positive and negative effect on fracture healing. First, it is essential to avoid any toxins. Smoking and heavy drinking are associated with loss of bone mass (osteopenia) and increased risk of fracture [28]. The available data on moderate drinking is still inconclusive [38]. In general, a fully nutritious diet is essential in any injury to ensure an adequate supply of energy and protein. In this case, 2–2.5 g protein/kg body weight are recommended. It is especially important to prevent micronutrient deficiencies. Vitamins D and K₂, magnesium and boron are particularly important in promoting bone healing.

Vitamin D deficiency

Vitamin D plays an important role in calcium and phosphate homeostasis. Particularly in combination with calcium it helps maintain a balanced bone metabolism [18, 19]. It is therefore essential to rule out vitamin D deficiency (< 25 nmol/L) [9] and any possibility of resulting secondary hyperparathyroidism (sHPT). Prolonged sHPT is associated with impaired bone turnover [23, 17] and can also lead to loss of mineral salts [26, 17]. Guidelines recommend measurement of 25-hydroxy vitamin D serum levels in all patients with sHPT [22].



Fig. 2 20-year-old patient, 2nd Handball Bundesliga, recurrent fracture sustained during the game, fifth metatarsal: (a) initial MRI with visible fracture gap and marginal fluid collection, laboratory tests showed no vitamin D deficiency, decision made for conservative treatment with physiotherapy, shock wave therapy (ESWT) and carbon inserts; (b) follow-up X-ray after 9 weeks, clear callus formation with surrounding oedema, plantar cortical gap still present; (c) X-ray on completion of conservative treatment after 13 weeks, clear callus formation in the fracture area with some small areas of still unconsolidated cortex.

Osteopenia

Osteopenia can occur alone or as a result of vitamin D deficiency [17]. Diagnosis mostly involves dual-energy X-ray absorptiometry (DXA). A new procedure will allow bone density to be determined without the need for exposure to radiation based on calcium homeostasis in the skeleton [9].

Biomechanical compensation mechanisms

If the above mentioned risk factors have been ruled out or recurrent metatarsal injuries occur, structural compensation mechanisms should also be considered [8]. These mechanisms can result in an imbalance in the loading and unloading of bones and soft tissue structures, resulting in fracture [21]. From a biomechanical perspective, changes in movement vectors and the resulting force vectors lead to incorrect loading e.g. overloading [31]. A picture of the movement pattern and the resulting loading vectors can be gained using gait/running analysis, which allows the kinematics and kinetics of the lower extremity to be observed [5]. Use can also be made of dynamic procedures such as foot pressure measurement and gait analysis [7, 5, 11]. These allow observation of, for example, running and foot roll behaviour.



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Based on the findings, it is possible to counteract incorrect biomechanical and compensation loading with the choice of individual shoe inserts and foot muscle training

Diagnosis

Following medical history and physical examination, it is advisable to perform diagnostic ultrasound of the foot to gain a more better understanding of the fracture. In the hands of an experienced investigator, diagnostic ultrasound is just as sensitive and specific as diagnostic X-ray [4]. However, if a fracture is suspected, this should be followed by diagnostic X-ray of the foot in three planes [3]. In fractures of the base of metatarsals 1–4, computer tomography should also be performed, as such fractures may be associated with Lisfranc dislocation fractures. In the case of stress fractures, MRI is the gold standard, as X-ray images are often falsely negative [36].

Treatment

Conservative or surgical treatment

Shaft fractures of metatarsals 2–5 with no or slight dislocation can be treated conservatively. Dislocations of up to 3 mm and plantar malalignment up to 10° are amenable to conservative treatment [3]. In such cases, immobilisa-

tion in a short walker with full weight bearing adjusted according to pain level is sufficient. This treatment when combined with a change of shoe to one with a rigid sole after 4–6 weeks has the advantage of a better functional outcome compared with immobilisation in a lower leg plaster cast [4]. Provision with a carbon sole is also a primary consideration. Fractures of the first metatarsal with dislocation should be surgically stabilised, as this bone plays a central role in carrying body weight and in the foot arch [4]. Fractures of more than one metatarsal, even with slight dislocation, require surgery [3]. In subcapital and metatarsal head fractures, axial deviations up to 10° are similarly amenable to conservative treatment.

Conservative treatment consists of unloading the forefoot by means of a rigid sole with full weight bearing adjusted according to the pain level. For fractures with greater dislocation and extra-articular fractures, intramedullary wires are the fracture-fixation procedure of choice [3]. Surgery should also be indicated for shortened metatarsals or rotation defects of the toes [12].

Special features of stress fractures

Stress fractures commonly involve the neck of the second and third metatarsal and the shaft of the fifth metatarsal. A very pronounced foot arch increases the risk of stress fractures of the fifth metatarsal due to increased loading [12]. It can take 3–6 months for the fracture to heal. As with traumatic fractures, treatment consists



Fig. 3 20-year-old patient, 2nd Handball Bundesliga with recurrent fracture of the fifth metatarsal four months after the initial injury: MRI after repeat injury shows (a) bone marrow oedema in the fifth metatarsal and

(b) proximal fracture gap. Follow-up X-ray 2 months after (c) recurrent fracture following conservative treatment with physiotherapy, shock wave therapy and provision with carbon inserts, and (d) consolidation of the fracture.

of initial unloading with gradual restoration of weight bearing as the bone heals [15]. Stress fractures of the fourth and fifth metatarsal in particular are more prone to non-union [36]. In a case series, 11 athletes with stress fractures of the base of the fourth metatarsal were therefore treated with plate fixation and autologous bone grafting from the calcaneus. On average, all athletes were able to return to sports after 12 weeks [30].

Procedures to promote bone healing

Non-union may occur with both acute and stress fractures. There are various treatment procedures that may be used before surgical revision needs to be considered. It is essential not to delay their use until it is too late but to initiate application as early as possible in the healing process.

Shock wave therapy

Shock waves ensure increased production of growth factors, nitrogen oxides and free radicals, which trigger the healing process. This can be exploited to treat stress fractures [15]. Shock wave therapy induces angiogenesis, and mesenchymal stem cells differentiate to osteoblasts. The periosteum is also stimulated, which plays a major role in callus formation [15]. There are a number of case series that report positive outcomes for stress fractures. These involved the use of focused medium to high energy shock waves.

In most cases the same doses were used as for non-union. The best outcomes were achieved with 2000 impulses at 0.2 mJ/mm² in 2 sessions. For non-union, there are individual randomised, controlled studies as well as case series. The healing rates with shock wave therapy do not differ from those following surgery. In the studies 4000 impulses were applied at an energy flow density of 0.09–0.7 mJ/mm² in each of generally 3 or 4 sessions.

Pulsating electromagnetic field therapy (PEMF)

PEMF is another procedure being advocated for non-union and delayed healing. Studies have demonstrated good healing of Jones fractures with non-union, particularly when the devices have been used for more than 9 hours a

day [24]. Fracture healing was more quickly achieved following surgery in the treatment group than in the group receiving placebo magnetic field therapy [34]. The evidence of the results, however, is problematic because a control group was part of the study design in only one of the studies.

Ultrasound

Studies point to improved healing in non-union, but in some there was no control group [35, 14]. Good healing rates were achieved, and individual studies indicate greater cost effectiveness compared with surgical revision [14].

Platelet rich plasma (PRP)

Animal studies have shown positive effects of PRP on fracture healing [13]. In view of these results a beneficial effect is also conceivable in humans. Clinical experience shows that additional treatment with PRP does lead to a positive course in a protracted course of fracture healing. Overall, the evidence for PRP promoting fracture healing is scarce [29]. On the other hand, injection of PRP has been successful in alleviating pain and in associated biomechanical compensation mechanisms as well as protective guarding and movement avoidance [25, 37]. However, further evidence-based studies are required for a more evidence-based and conclusive assessment [16].

Summary

The first important step in the treatment of metatarsal stress fractures is to figure out the cause and identify any risk factors. It can help prevent secondary injury. This should be followed by multimodal treatment comprising modified weight bearing and optimised bone healing. The pain experienced by the patient plays a central role particularly with regard to modifying weight bearing. However, due to their negative effect on fracture healing, administration of NSAIDs should be avoided. Pain can be reduced, and bone healing promoted by diet, shock wave therapy and, when applicable, supplementary electromagnetic field therapy.

The bibliography can be requested from info@thesportgroup.de.

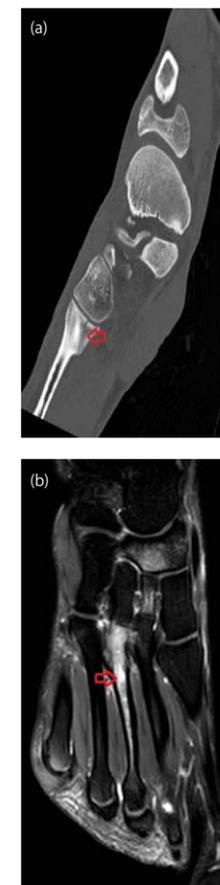


Fig. 4 23-year-old patient, 2nd Handball Bundesliga with proximal fracture of the third metatarsal: (a) CT shows proximal fracture of the third metatarsal with joint involvement; (b) also evidence of bone marrow oedema throughout the third metatarsal on MRI.

Cartilage/bone lesions

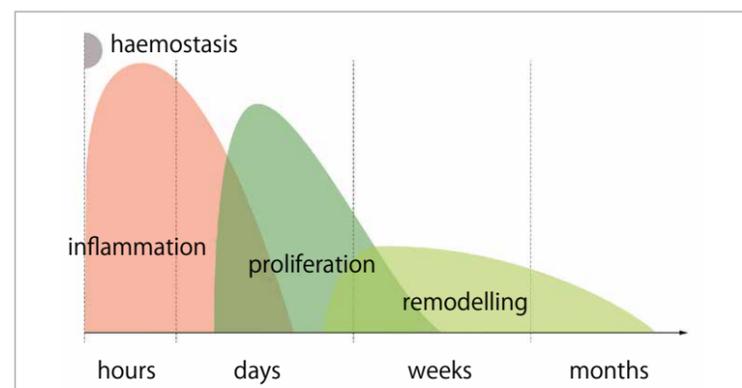
Biologic treatment methods for the ankle joint

Dr. Tomas Buchhorn,
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With roughly 27 million ankle injuries worldwide each year, and roughly 1.7 million associated osteochondral lesions of the talus (Baumhauer et al. *Am J Sports Med.* 1995; 23 (5): 564–570), potentially with consequential damage, the orthopedic and trauma surgery community has some considerable interest in improving post-op results over the long term.

On the one hand, ankle trauma can cause changes in the sense of bone marrow edema (bone bruise) due to the mechanical aspect of the mode of injury; on the other hand, injuries to the cartilage of the talus (chondral lesions) or combined bone-cartilage injuries (osteochondral lesions) can also occur as a result of the trauma. Osteochondral lesions of the talus can be accompanied by subchondral cysts. Patients affected complain of ankle pain, some of which is unrelated to pressure being applied, of restricted ankle movement, some of swelling and locking-up, as well as instances of functional instability [4]. In addition to the symptoms described above, clinical examination of the patient may reveal unstable syndesmoses, problems in the area of the medial and lateral capsular ligament apparatus, and axial deviations in the hindfoot, requiring further treatment [5].

Fig. 1 Tissue regeneration and timeline



Treatment options up till now have involved conservative and surgical measures. Conservative measures include relief using forearm crutches, taking NSAIDs, physiotherapy exercise, providing ankle orthoses and shoe insoles, and perhaps intra-articular corticosteroid injections. Surgical treatment options are roughly divided into bone marrow stimulation, cartilage repair and cartilage regeneration measures. In recent years, injections with hyaluronic acid preparations and platelet rich plasma (PRP) preparations have been attracting more and more attention in the treatment of osteochondral lesions of the talus. Various studies have demonstrated improved joint mobility and reduced post-op pain where growth factors and bioactive components, contained in the PRP, were injected intraoperatively during ankle operations. Interestingly, these studies have shown that the improvement in the above factors is independent of the surgical technique [3]. Below, we discuss some new techniques for treating bone marrow edema, and chondral and osteochondral defects of the talus.

Biological basis

As already described above, use of PRP for this type of injury has become more prominent in the last ten years due to the positive outcomes achieved. To better understand the effect of PRP, it is necessary to look more closely at the physiology of tissue regeneration. The healing mechanism generally applies in equal measure to all tissue types and following haemostasis is in three phases:

Inflammatory response

Platelets and leukocytes in the blood clot release growth factors and numerous other cytokines, which trigger the inflammatory response. Endothelial cells also present then guide the inflammatory processes to the injury site [7]. Complex metabolic cycles involving neutrophils

and macrophages, amongst others, ensue [8]. The latter, activated by messenger substances from leukocytes, then initiate the release of healing factors such as TGF- β , bFGF, PDGF and VEGF [9].

Proliferation

Released VEGF stimulates plasma proteins to lay down a provisional matrix, into which stromal progenitor cells, guided by cytokines released by the immune cells, then grow. The progenitor cells differentiate depending on the growth factors and cytokines present, developing into the predominant tissue-specific cell type (approx. 3–5 days after injury). Stimulated by PDGF, IGF and TGF β , these cells also produce collagen, proteoglycans and other components of the extracellular matrix [10].

Remodelling

Collagen deposition peaks approx. 2–3 weeks after injury and the transition to the remodelling phase begins. A balance develops between synthesis, accumulation and degradation. Small capillaries join to form larger vessels. Water content, cell density and metabolic activity fall. The type, quantity and organisation of collagen change significantly, resulting in increased firmness. The initially deposited collagen III becomes collagen I, and the physiological ratio of 4:1 (collagen 1 to 3) is restored [11]. If this physiological healing cascade is disturbed at some point by intrinsic or extrinsic factors, various pathologies result depending on severity and tissue type.

Platelet-Rich Plasma – PRP

PRP, usually produced from whole blood by centrifugation, features a greater concentration of platelets and so also greater concentration of the growth factors it contains. When PRP is injected into the affected region, the greater concentration of growth factor has a positive effect on cell proliferation, differentiation, chemotaxis, and angiogenesis [11]. Impaired healing processes start up again and affected tissue is stimulated into recovery.

Use in Bone Regeneration

Like in other tissues, PRP has positive effects on cell proliferation, differentiation, chemotaxis, and angiogenesis in bone healing. With platelets having a lifespan of 7–10 days, it is assumed that PRP supports early bone healing rather than influencing late bone formation [12]. There is increasing evidence that platelet-induced inflammation response plays a major role in the early stages of recovery, and that effective regeneration cannot occur without it [12]. Excessive inflammation, however, can have a negative effect on recovery. Here, PRP has a positive effect on both the extent and duration of the inflammation, through the growth factors TGF- β 1, IL-4, HGF and TNF- α [12], such that recovery is channelled in the right direction at an early stage.

Use with Cartilage Damage

Cartilage has only very limited self-healing capacity when damaged, due to its inherent avascularity, which therefore leads to cartilage damage and osteoarthritis. However, numerous growth factors play a central role in the development and homeostasis of cartilage, suggesting the use of PRP in cartilage regeneration. Anabolic factors, such as TGF- β 1 or IGF-I, stimulate chondrocytes into synthesizing proteoglycans, aggrecan and collagen II. They induce proliferation of synoviocytes and mesenchymal stem cells. At the same time, the catabolic effects of, for example, Interleukin 1 (IL-1) or matrix metalloproteinases (MMPs) are reduced [13].

Bone Marrow Edema of the Talus

Bone marrow edema is a pathological increase in interstitial fluid in the bone, and can be detected early using an MRI scan, if there is vague joint pain (Fig. 2). There are various causes of bone marrow edema. Persistent joint pain is called bone marrow edema syndrome (BMES), which is defined as lasting from 3 to 18 months [14–16]. It is worth mentioning that distinguishing it from osteonecrosis of the talus can be difficult. As a rule, however, osteonecrosis follows a fulminant disease progres-

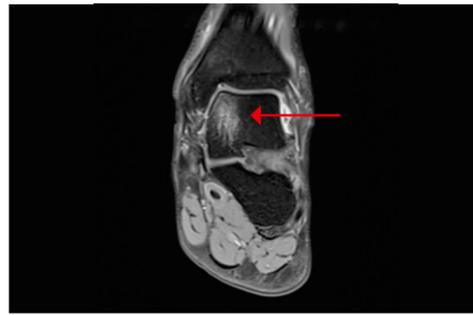


Fig. 2 Bone Marrow Edema of the Talus

sion. Bone marrow edema can roughly be classified as vascular ischemic, mechanical or traumatic, and reactive bone marrow edema. Bone marrow edema of the talus is often visible on an MRI scan following trauma. How and why bone marrow edema syndrome develops from bone marrow edema remains unclear [17].

Clinical Symptoms

Clinical symptoms manifest themselves as acute pain and significant impairment of function, and swelling in or on the ankle. There are normally no signs of local inflammation.

Imaging Procedures

Diffuse osteopenia can sometimes be seen in the affected area on unenhanced x-rays. Bone scans with detectable tracer accumulation in bone marrow edema are an indication of increased bone regeneration activity. If it is uniform, the surrounding soft tissues are not affected. Sensitivity is around 60% [18]. Magnetic resonance imaging is the method of choice for confirming the diagnosis. MRI scans have 100% sensitivity. In order to differentiate osteonecrosis from bone marrow edema, using a gadolinium-based contrast agent is recommended [19].

Therapy

Basically, a conservative management approach is preferable. Treating the symptoms, taking pressure off the side affected, and taking anti-inflammatory drugs, as well as manual therapy and physiotherapy should be tried first. Recent studies show that IV administration of iloprost or bisphosphonates (such as ibandronate) can lead to a significant improvement in symptoms. Administration of the drugs mentioned above is intended to improve blood circulation (ilo-



Fig. 3 Preparing the biologic substances

prost) or to inhibit osteoclasts (bisphosphonates) [20–23]. It is vital to pay attention to the adverse drug reactions which can occur with IV administration of iloprost and bisphosphonates. In particular, localized osteonecrosis of the jaw and atypical femoral fractures should be mentioned, especially when bisphosphonates are being administered [26].

During surgical procedures, the affected bone area is drilled (core decompression) [24, 25]. Symptoms can be improved through the reduction in pressure that results from drilling, as the pain is reduced. It is furthermore assumed that drilling can lead to increased blood flow or even revascularization. The effect of PRP on bone healing has already been described in the biological basis. This also applies to bone marrow oedema. Like in other tissues, PRP has positive effects on cell proliferation, differentiation, chemotaxis, and angiogenesis in bone healing. These connections lead us to a new therapeutic approach. In addition to the pressure relief from surgery described above, by drilling into the bone, platelet-rich fibrin (PRF) made from PRP and autologous thrombin solution is also infused into the affected bone areas. Only material from the patient themselves is used to produce the PRF.

Producing the biologic substances (see Fig. 3): PRP (ACP Autologous Conditioned Plasma). 15 ml ACP can be produced from 45 ml of venous blood, using 3 ACP double syringes (Arthrex GmbH). Autologous thrombin solution: The Thrombinator System (Arthrex GmbH) is used to produce the thrombin solution. The Thrombinator process uses the blood-clotting cascade mechanism to produce an autologous thrombin serum, avoiding the use of aggressive

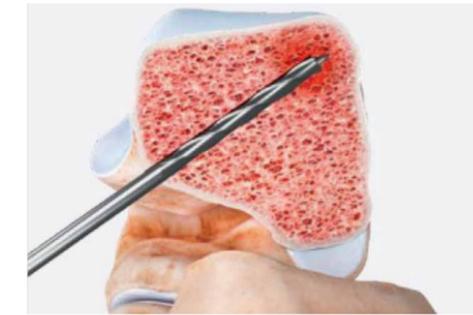


Fig. 4 + 5 Retrograde drilling

chemical reagents such as ethanol. The design of the Thrombinator eliminates the need for prolonged incubation times and heating. The autologous thrombin solution is produced from PRP in roughly 15 minutes directly at the point of use.

Application of Biologic Substances in Bone Marrow Edema

This can be performed as a minimally invasive surgical procedure (arthroscopic). With the retrograde drilling, placing a targeting tool intra-articularly over the affected cartilage-bone areas is recommended, in order to allow drilling in a targeted manner. If necessary, intra-operative X-rays can be used for checking. First, retrograde drilling using the targeting tool (GPS system, Arthrex GmbH) (Fig. 4 + 5). Platelet-rich fibrin is then infused into the hole using a tapered inserter. The taper prevents the PRF from flowing back before gelling when pressed gently into the hole. Finally, the blind hole is sealed up using bone filler (INNOTERE Paste-CPC, Arthrex GmbH). Platelet-rich fibrin is prepared by mixing PRP and autologous thrombin solution, simulating the final



step in the coagulation cascade, in which a stable amount of fibrin is produced from fibrinogen (contained in PRP) and thrombin. Patients use walkers and forearm crutches to relieve pressure post-op until the wound has healed. Full weight bearing is usually possible immediately once the wound has healed, provided there has been no surgery on associated injuries. In one observational study, patients showed pain reduction using the visual analogue scale, from an average of VAS 9 to VAS 1, 14 days after the combined surgical procedure of drilling the bone and infusing PRF intraosseously.

Chondral Lesions and Osteochondral Lesions of the Talus

Chondral or osteochondral lesions of the talus occur particularly in young patients as a result of trauma, in most cases sprain trauma. Flick and Gould's studies of 500 recorded cartilage-bone injuries to the talus show a distribution of 98% lateral talar dome lesions and 70% medial talar dome lesions. The authors were able



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Fig. 6 Shaver blade with GraftNet adapter



Fig. 7 Harvesting cartilage using a shaver blade



Fig. 8 Applying the cartilage paste



Fig. 9 Sealed with PRF (Platelet-rich fibrin)



Fig. 10 Chondral lesion following preparation



Fig. 11 Chondral lesion after filling with AutoCart



Fig. 12 Osteochondral lesion following spongiosaplasty



Fig. 13 Osteochondral lesion after filling with AutoCart

to demonstrate that the causes can be acute trauma as well as repetitive microtraumas affecting talar cartilage.

Clinical Symptoms

The focus is again on ankle pain, which shows no improvement even after prolonged immobilization or physical therapy measures. The pain indication is localized either medially or laterally, some patients reporting feelings of locking-up, and there may be clinically significant swelling and effusion in the ankle joint. The medical history almost always reveals an accident that occurred only recently.

Imaging Procedures

Imaging procedures include unenhanced X-rays in 3 planes under load (AP mortise view) [27]. If there are specific uncertainties concerning assessment of the hindfoot, a Salzman image may be needed as well. CT scans are particularly important where bony structures are involved, and help to determine the depth of the lesion [28, 29]. For some time now, digital volume tomography has been used to obtain three-dimensional images of the ankle with pressure applied. These images with pressure applied have the advantage that treatment planning is more precise, since the bone position changes in situations with pressure applied. Standard procedures include MRI scans, which can map articular cartilage using cartilage-sensitive pulse sequences. It is possible to see changes in cartilage in the MRI scan, as well as changes in subchondral bone, which cannot be detected in normal X-rays. The sensitivity and specificity for cartilage changes in the talus is given as 96% [30]. dGEMRIC sequences allow us to measure directly the concentration of GAG (glycosaminoglycan). However, this procedure requires intravenous injection of gadolinium-based contrast agents. In recent years, the so-called SPECT procedure has gained popularity [31]. SPECT stands for Single Photon Emission Computed Tomography, and is a special type of CT scan used to differentiate between active lesions of the cartilage bone complex on the talus, and inactive cartilage bone lesions on the talus.

Treatment

Treating the chondral lesion on the talus depends on the size of the cartilage damage. Car-

tilage damage smaller than 1 cm² and less than 5 mm thick is usually treated with microfracture or nanofracture (bone marrow stimulation) [27]. Cartilage damage larger than 1.5 cm is usually treated using autogenous bone graft techniques or, if possible, autologous chondrocyte implantation [5]. Refixation can be carried out for intact, chondral fragments at least 3 mm thick. Refixation is carried out in such cases using biodegradable compression screws, darts or pins [27]. Treatment of osteochondral lesions usually involves both building up the damaged bone area and treating the affected cartilage area. Cartilage has only very limited self-healing capacity when damaged, due to its inherent avascularity, which can therefore lead to osteoarthritis. Here, too, the thinking is to combine the surgical procedure with PRP and thrombin.

Surgical Procedure

With chondral lesions, care should be taken to ensure that the cartilage defect is debrided and prepared appropriately. Look out for clean, healthy cartilage edges.

AutoCart™ Procedure (Fig. 6–9)

Chondral fragments are harvested from the cartilage margin using a 3 mm shaver (Sabre 3 mm, Arthrex GmbH). Alternatively, cartilage chips can also be removed from non-load-bearing areas on the knee as required. Fragments are harvested in a GraftNet tissue collector (Arthrex GmbH) and then transferred to a 1 ml syringe with a Luer lock connection. The chondral fragments are then mixed with PRP in a ratio of 3:1 using a female to female adapter. On the one hand, this creates a homogeneous paste-like mass, and on the other hand, the ACP contains the fibrinogen needed for clotting. The 1 ml syringe is connected to the application cannula and the fragments transferred into the cannula. The fragments are then carefully pushed to the cannula

tip using the cannula trocar, until they appear in the opening. The arthroscopic fluid should then be drained from the ankle joint and the lesion dried as much as possible. The fragments mixture is now carefully pushed forward with the trocar and applied into the defect. The fragment paste is then carefully covered drop by drop with the prepared thrombin serum. The Thrombinator method relies on the blood clotting cascade mechanism. The combination of the fibrinogen contained in the paste and the thrombin applied creates a stable clot that holds the mixture in place in the lesion. For the seal, mix the PRP with thrombin in the ratio 1:1. After mixing, apply the mixture quickly to the lesion drop by drop. Then wait about 2 minutes. The joint should be carefully moved under visual control, to check the congruence of the joint components.

Figures 10 and 11 show intra-operative images of a chondral lesion being treated using AutoCart. When treating osteochondral lesions, the stable clot mentioned earlier, consisting of fragmented cartilage and PRF, is placed and fixed onto the spongiosaplasty after surgical reconstruction (Fig. 12+13). Here, too, the joint should also be carefully moved under visual control following infusion, to check the congruence of the joint components. The patient uses a walker with 20 kg partial weight load for six weeks post-op. A splint with a 20-0-20 dorsiflexion/plantar flexion range of motion is recommended. Lymphatic drainage and, if necessary, analgesia should be prescribed. NSAIDs should be avoided due to their fibrocyt-inhibiting effect. From the 7th week, depending on the clinical picture, more pressure can start to be applied. In an observational study, both procedures (arthroscopic as well as open with spongiosaplasty) proved to be safe, at least in the short term, and easy to carry out. Long-term results will show how tissue regeneration is progressing.

The Innovative Concept in Modern Sport Medicine BMS Matrix therapy

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Cardiac strain analysis

Speckle tracking echocardiography – a useful new tool for sports cardiologists

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Dr. Jonas Zacher,
German Sport University Cologne

The potential effects of (competitive) sports on cardiac morphology and function are many and varied and have been well researched. The myocardial adaptations induced by physical training were already of interest to sports medicine as far back as the late 19th century. Around 1890 the Swede Dr. Henschen documented markedly enlarged athletes' hearts in cross-country skiers and around 1900 the American Dr. White recorded sinus bradycardia in participants in the Boston marathon. Incidentally, Dr. Henschen used auscultation and percussion to ascertain the size of the heart. It was not until the mid-20th century that the diagnostic options of X-ray, ECG and, last but not least, echocardiography were introduced. [1].

Sports cardiology diagnostics is a well-established cornerstone in the care of high-performance athletes. It is used, for example, in the diagnosis of acute illness or reduced performance in athletes as well as in the regular and mandatory medical competitive exercise eligibility examinations of the various associations. One basic component of the diagnostic process is echocardiography, which nowadays allows an experienced investigator to perform both a visual high-definition and software-assisted assessment of the function of cardiac structures and function.

The ejection fraction (EF) has long been the most important parameter in the assessment of myocardial function. It involves tracing the endocardium in diastole and systole in 2D echocardiography in a two- and four-chamber view and calculating cardiac output using Simpson's method (see Fig. 1).

In recent years the relatively new imaging technique of speckle tracking, specifically speckle tracking echocardiography (STE), has markedly increased the diagnostic options regarding the assessment of myocardial function. It involves tracking individual or several speckles in the visualised myocardium during the cardiac cycle using the echocardiography

software. This allows conclusions regarding contractility at levels that cannot be followed by the naked eye (unlike the ejection fraction). It allows, for example, calculation of longitudinal strain (shortening of the distance between the apex and the base of the heart) and of radial strain (thickening of the myocardium) (see Figs. 2 and 3, respectively). The calculation is performed for different myocardial segments, ultimately allowing global values for

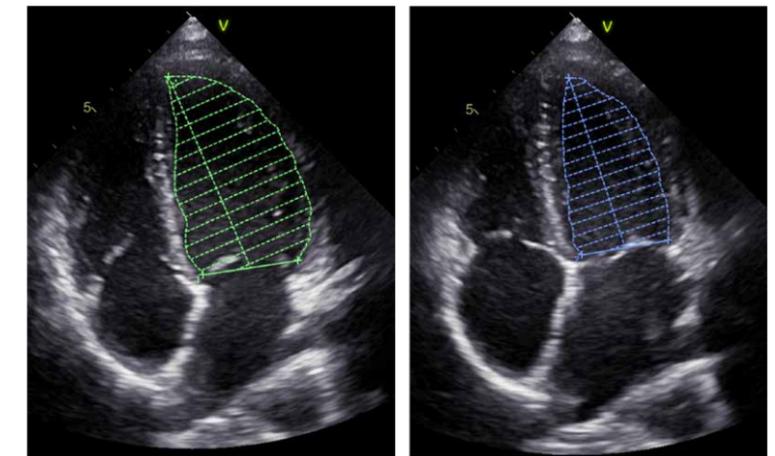


Fig. 1 Determining cardiac performance in terms of ejection fraction using Simpson's method. Monoplane measurement of the LV area in a 4-chamber view in diastole (left) and systole (right).

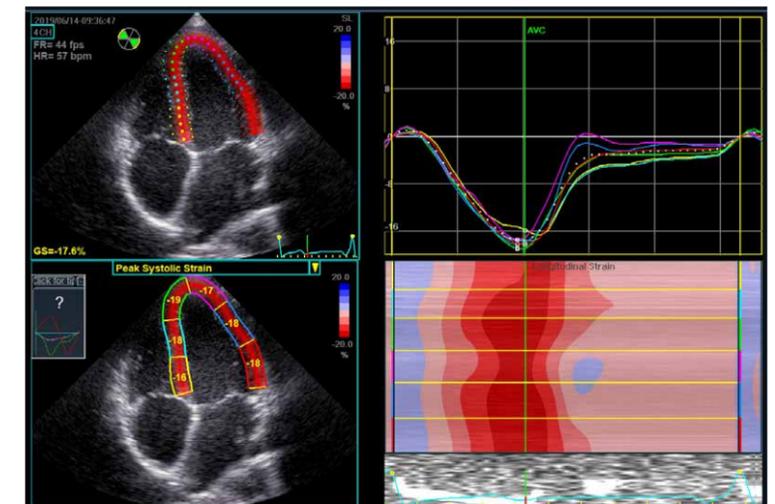


Fig. 2 Measurement of left ventricular longitudinal strain in a 4-chamber view. Visualisation of 6 segments of the left ventricle (bottom, left), and of maximum strain over the course of the left ventricular contraction cycle, in the form of a line diagram (top, right) and colour-coded (bottom, right).



Dr. Jonas Zacher, studied sports sciences at the German Sport University Cologne until 2006 and then studied medicine at the University of Cologne until 2013. From then and until 2018, he worked in the Department of Cardiology, Electrophysiology and Rhythmology of the Porz am Rhein Hospital. Since 2018, he is Deputy Head of the sportsmedical clinic of the Institute of Cardiovascular Research and Sports Medicine of the German Sport University Cologne, as well as an associate at the Cologne Cardiac Centre (Kardiozentrum). His research focuses on the effects of training therapy on cardiac disease and the training-induced adaptation of diseased and healthy hearts.

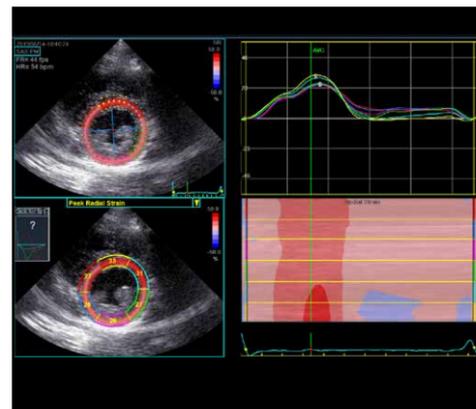


Fig. 3 Measurement of left ventricular radial strain in the parasternal short axis at the level of the papillary muscles. Visualisation of 6 segments of the left ventricle (bottom, left), and of maximum strain over the course of the left ventricular contraction cycle, in the form of a line diagram (top, right) and colour-coded (bottom, right).

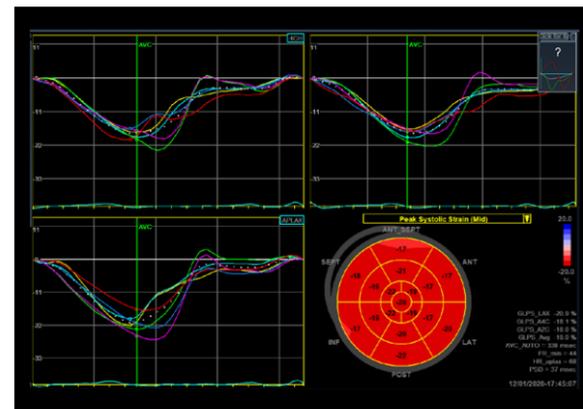


Fig. 4 Construction of the bull's eye, which shows the mean of all regional peak longitudinal strain values from the three apical planes, with the centre of the bull's eye representing the left ventricular apex and the periphery the base.

the three-dimensional left ventricle to be calculated from different 2D echocardiography settings (the same applies, to a lesser extent, to the atria and the right ventricle). Peak strain values are thus calculated for each myocardial segment from a two-, three- and four-chamber view and combined into a simplified view, the bull's eye. A separate mean is calculated for the left ventricle, giving the global longitudinal strain (GLS) (see Fig. 4).

The calculation of myocardial strain is now common practice in cardiology; GLS is used as a predictor for cardiovascular mortality in healthy individuals, as a parameter in the diagnosis of cardiac amyloidosis, to assess the cardiotoxic effects of chemotherapy and to detect myocardial inflammation and pathological myocardial hypertrophy [2]. The latter two applications in particular are now part of clinical routine in sports cardiology. Ambitious athletes often neglect the necessary rest that should be observed during and after an infection, which in the further course repeatedly leads to the possibility of myocarditis. With respect to this – often complex – issue, strain analysis is a new and useful tool for sports cardiologists/sports medicine physicians. Local reduction in longitudinal strain, detectable in the bull's eye or in

segment visualisation, may indicate a local inflammatory process [2]. In high-performance athletes, myocardial hypertrophy is considerably more common than inflammatory processes. In most cases, marked thickening of the ventricular septum is clearly detectable and understandable as a sports adaptation consistent with physiologic eccentric hypertrophy (see Fig. 5). In some cases, however, other factors may suggest pathological mechanisms as a possible cause of septal hypertrophy. These include concomitant arterial hypertension, elements of concentric hypertrophy or indications of possible hypertrophic cardiomyopathy (e.g. apical hypertrophy, familial clustering or very pronounced hypertrophy). Whereas, based on current knowledge, physiological adaptation as in an athlete's heart has no effect on cardiac strain values; various pathological mechanisms reduce these values – sometimes markedly [2, 3]. Strain analysis with speckle tracking echocardiography therefore provides sports cardiologists and sports medicine physicians with an effective new tool in daily routine diagnostics. Further research regarding the effects of sports activity on the different cardiac strain parameters is required, e.g. to study differences in the various sports disciplines or between the genders – a task that we



Fig. 5 Left - hypertrophied left ventricle of a female athlete, septum 11 mm, ventricular diameter 56 mm.



Right – normal ventricle of a female non-athlete, septum 6 mm, ventricular diameter 44 mm.

have also set ourselves at the German Sport University in the Institute for Cardiovascular Research and Sports Medicine.

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Vitamin D

A key element for immune defense, regeneration and performance – What is the evidence for supplementation?

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A healthy immune system forms the base for general health and a good immune defense. Naturally, this is desirable by the general population, but even more for top performers such as athletes. Peak performance is possible once the body has built up a strong immune system. Individual habits, nutrition and the environment have been proven to influence our health. [1]. In particular, a balanced and healthy diet is the key factor for the body's performance. Unbalanced nutrition can have serious consequences for the immune system and thus increase the risk of chronic diseases. [1]

Vitamin D can be produced in a physiological way. Sunlight is essential for this endogenous synthesis. The endogenous synthesis takes place primarily in the skin, where 7-dehydrocholesterol is converted into cholecalciferol (Vitamin D3) by UVB solar radiation. To reach its biologically active form, cholecalciferol undergoes further conversion steps in the liver (calcidiol) and kidney (calcitriol). The latter is the biologically active form of Vitamin D and acts as a transcription factor. After binding to the Vitamin D receptor, calcitriol regulates the expression of various proteins in the cell. The physiological mode of action of calcitriol is therefore similar to that of a hormone and not that of a vitamin. Vitamin D, as a precursor of calcitriol, should be considered more as a prohormone (Fig. 1). [2, 3] The connection between Vitamin D and the parathyroid hormone (PTH) was recognized shortly after its discovery.

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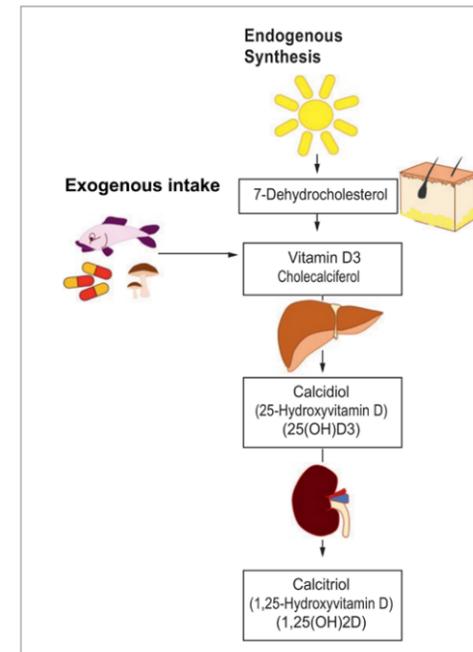


Fig. 1 Diagram for endogenous synthesis and exogenous intake of vitamin D3

The regulatory effect of Vitamin D in the body's mineral balance and in particular the regulation of calcium and phosphate levels was emphasized. [4-6] In addition, it was discovered very early on that Vitamin D plays an important role in mineralization and bone formation. As a result, many studies have focused on the impact that Vitamin D has on skeletal health and the treatment of conditions such as osteoporosis. Some studies increasingly showed the sustainable positive effect of Vitamin D on the immune system and thus on general body health. Meanwhile several studies prove that Vitamin D has a preventive effect with chronic illnesses such as diabetes mellitus, hypertonia as well as cardiovascular illnesses. [7]

In addition, studies report its potential anti-inflammatory and antiviral effects. [8] In this context, it has been shown that supplementing Vitamin D to school children has reduced the incidence rate of influenza virus infection. [9] Since endogenous Vitamin D synthesis is limited by the rather short exposure time to sunlight in most countries, the need for exogenous supply is becoming increasingly important. However, the intake of Vitamin D by food in

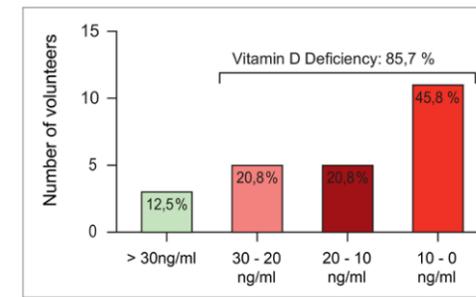


Fig. 2 Distribution of vitamin D levels according to a pilot study conducted by the Clinic for Oral and Maxillofacial Plastic Surgery at Goethe University Frankfurt am Main.

the population seems to be insufficient, which has led to a pandemic of Vitamin D deficiency worldwide. [10] This pandemic has already been documented in many studies by different countries. [11] Moreover, a pilot study has examined the Vitamin D levels of medical staff in the Clinic for Oral and Maxillofacial Plastic Surgery at the Goethe University in Frankfurt am Main. Of 24 participants, 85.7% had a Vitamin D deficiency with a value of less than 30 ng/ml, and 45.8% had less than 10 ng/ml (Fig. 2). Literature shows, that a Vitamin D level of under 30 ng/ml is considered a deficiency (Hypovitaminosis). [11, 16, 19, 20] It is important to emphasize that a healthy Vitamin D value should be in the range of 40 to 60 ng/ml. However, there are still no standardized recommendations.

Booster of the immune system

Increasing interest was given to the study of the immune system supporting mechanisms of Vitamin D. Interestingly, the majority of body cells express Vitamin D receptors on their surfaces, which brings out the multimodal action of Vitamin D. Due to its regulatory effect, the active form of Vitamin D as a hormone can intervene in the synthesis of different cytokines and regulate them. [12] It has been shown that Vitamin D inhibits the production of pro-inflammatory cytokines while it upregulates the synthesis of anti-inflammatory signal molecules. [3] Thus, it unfolds its immunomodula-



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tory effect and supports the differentiation of lymphocytes into Th2-cells and regulatory T-cells. [12] This might explain its potential preventive influence in chronic and infectious diseases.

The correlation between Vitamin D levels and the prevalence of various chronic diseases has been shown in several clinical studies. A meta-analysis of 25 prospective cohort studies has shown that low Vitamin D levels increase the risk of cardiovascular disease. In about 10,000 patients, the risk of cardiovascular disease was about 44 % higher than in people with healthy Vitamin D levels. [13] Another study highlighted a correlation between Vitamin D levels and the development of hypertension. It examined 8,155 patients suffering from high blood pressure and Vitamin D deficiency. After the Vitamin D deficiency was eliminated, 71 % of the patients no longer had symptoms or measurable high blood pressure. [14]

Furthermore, the potential of an anti-infective or antiviral effect of Vitamin D has been increasingly investigated in recent years. As a result, Vitamin D gained an expanding status as a preventive or adjuvant therapy. [9, 15] In addition, studies have shown that supplementation of Vitamin D reduces the prevalence of influenza infections during flu outbreaks. [17] Another meta-analysis showed that certain Vitamin D receptor polymorphisms used to pro-

cess Vitamin D are associated with an increased risk of enveloped virus infection. Based on the Vitamin D-mediated increase in immune defense and its potential role as an antiviral agent, its importance in the prevention of viral diseases was discussed. Especially in the current COVID-19 pandemic, Vitamin D supplementation can play an important role in preventing and defeating infection. [18]

Current guidelines and recommended doses of the authors for healthy adults

Vitamin D concentration can be expressed by two units: microgram (μg) and international units (IU). One microgram is equivalent to 40 IU. Since in most cases the food intake does not cover the body's needs, supplementation with dietary supplements is absolutely necessary. The current recommendations of the doses to be administered are largely inconsistent in the literature and are mainly based on the estimated bone health needs. The recommendations range from 400 to 4,000 IU per day. The Institute of Medicine (IOM) recommends a daily dose of 600 IU/day for adults under 70 years of age and a dose of 800 IU/day for people over 70 years of age. [21] The American Society of Endocrinology recommends a daily dose of 1,000 – 4,000 IU/day. [22] The European Food Safety Authority classifies a daily dose

of 10,000 IU/day as safe, but recommends not to exceed the 4,000 IU/day. [18] When supplementing Vitamin D3 over a longer period of time, it is important to combine the supplementation with Vitamin K2/mk7 since Vitamin D3 requires Vitamin K2 in order to prevent potential hypercalcemia in the blood. [22] In general, Vitamin K2 is responsible for transporting the minerals absorbed by Vitamin D3 in the intestine and reabsorbed in the renal tubules from the blood to the bones. The ratio of Vitamin D3 to K2/mk7 should be 10,000 IU Vitamin D3 to 100 μg K2/mk7.

It is clear, that a healthy immune system is necessary for everyone and not only for top athletes. Current studies, with increasing evidence show, that a relatively high daily dose is necessary to reach the targeted values. Based on the data investigated, we recommend a daily dose adapted to the patient's or athlete's needs. In the case of Vitamin D deficiency (less than 40 ng/ml), a daily dose of 10,000 IU/day should be administered for three months to compensate for the deficiency. As a maintenance dose for a Vitamin D level in the range of 40 to 80 ng/ml, a daily dose of 5,000 IU is suitable. If this range is exceeded (> 80 ng/ml), it is advisable to reduce the dose to 1,000 IU/day. The Vitamin D level should be checked every three months to adjust the dose to the individual needs (Fig. 3). When supplementing Vitamin D, it is equally important to consider the patient's medical history and, in the case of impaired organ function or metabolic diseases, to individualize the dose accordingly.

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Dr. Sarah Al-Maawi holds a doctor in dentistry from the Johann Wolfgang Goethe University, Frankfurt, and is continuing to study for her doctorate in medicine. From 2016 to 2017 she was a research assistant in the FORM-Lab which focuses on Oral and Maxillofacial Surgery. Since 2018 she holds a position as assistant dentist in the Oral and Maxillofacial Surgery department of the Johann Wolfgang Goethe University, Frankfurt.

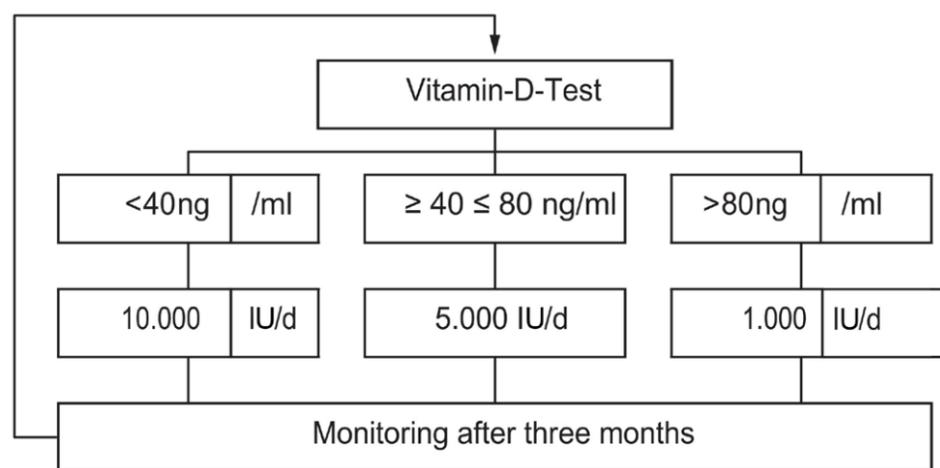


Fig. 3 Dose recommendation of the authors for healthy adults after vitamin D test

Inhibiting inflammation and optimising regeneration

Usefulness and labelling of dietary supplements – need for standardised measurements, e.g. of anthocyanin content, to achieve objective comparability

Dr. Klaus Pöttgen,
team doctor of the German Triathlon Union,
doctor at the SV Darmstadt 98 youth
training centre

Anti-inflammatory drugs such as NSAIDs (diclofenac and ibuprofen) should no longer be routinely administered due to their many adverse effects, which include inhibition of tendon cell migration and tendon healing, negative effect on collagen synthesis, increased rate of fibrosis in muscle injuries, decreased stability of cruciate ligament transplants, reduced cross-linking of tendon rigidity, delayed fracture healing, increased risk of cardiac arrest and suppression of testosterone activity.

It has long been shown that other, natural substances have an effective anti-inflammatory impact. The performance-enhancing properties of natural substances, such as those found in beetroot or caffeine, have also been long known and are mentioned in the IOC consensus paper 2018 and the International Association of Athletics Federation (IAAF) consensus paper 2019. To achieve an effective anti-inflammatory effect and enhance performance capacity, specific processes are required to supply these substances at sufficient concentrations and to offer them in a practical oral form that can be

taken during the normal course of the day. Protein products with a high amino-acid content or capsules with a high omega-3 fatty acid content are well-known examples of this, as otherwise it is often not feasible to take equivalent quantities of fish, meat and vegetables. Other ingredients are often desirable in the nutrition plan for health and calorie reasons. Plant-based concentrates are now also available to bundle the increased effect of phytochemicals, making it unnecessary to eat hundreds of berries or cherries. This also reduces high fructose intake, which leads to fatty liver and an increase in uric acid via the body's own metabolism. However, not only plant-based substances but also substances of animal origin, such as collagen, classified as type I-III, have an anti-inflammatory effect. Type II collagen is primarily found in joint cartilage and is available in oral form as collagen II (denatured or hydrolysed collagen type II protein) or as non-denatured (or native) type II collagen for the alleviation of osteoarthritis (OA) symptoms. Dietary supplements are therefore available in an adequate oral form for individual management in preventing and treating disorders and inflammatory processes, which is often not possible with only conventional food in a professional or sports environment and which can additionally be improved in terms of absorption using various methods.



Polyphenols

Polyphenols are an important constituent of a healthy diet. They are phytochemicals that are naturally present in fruit and vegetables, particularly those with a red or purple colour. They include anthocyanins, which have high antioxidant and anti-inflammatory properties. Sour cherries, particularly Montmorency cherries, have been shown to have a high anthocyanin content (Kirakosyan et al. 2009). Anthocyanins are also found in berries (bilberries and black currants) and are used for dietary supplementation. The antioxidant and anti-inflammatory properties of anthocyanins in sour cherries have also been demonstrated in cell experiments. The effects were found to be comparable to known anti-inflammatory substances, such as prostaglandins (Wang et al. 1999). Scientific studies have shown that consumption can reduce oxidative stress and muscle damage under sports loading and that positive effects can be achieved in terms of sports performance capacity and regeneration. However, due to differences in composition and the different extraction processes used, the polyphenol content may differ in individual products. The content and exact composition should therefore be identified for the consumer, ideally using standardised measurement methods, as is the case with medicinal products. Oxidative stress molecules, reactive oxygen species (ROS), are produced in muscle tissue by metabolic processes under sports loading. This is a completely normal and natural physiological process to meet exercise demands. However, under highly intensive interval loads, very high amounts of these oxygen radicals may be released and may adversely affect the muscle cells. Regeneration following loading may then

take longer and the performance capacity, especially under high loads, may be reduced (Reid 2016). Polyphenols can be further subdivided into flavonoids and non-flavonoids (see table).

Effects of polyphenols on sports performance capacity

It has been demonstrated, for example, that Montmorency cherry juice can improve muscle regeneration following strenuous sports sessions involving muscle loading (Bowtell et al. 2011). This was confirmed in a further study with semi-professional football players who drank Montmorency cherry juice before and after intensive training. The players recovered more rapidly and experienced less muscle soreness (Bell et al. 2016). It has also been shown that the intake of sour cherry juice for one week can significantly reduce muscle pain in healthy endurance runners following a long-distance run (Kuehl et al. 2010). The intake of Montmorency cherry powder for one week had a positive effect on the endurance of professional cyclists, who improved their speed over a distance of 15 kilometres as a result (Morgan et al. 2019). Dietary supplementation with Montmorency cherries would, however, seem to improve performance capacity (e.g. maximum strength) not only over long distances but also in sprints, as was demonstrated in trained cyclists in 2018 (Keane et al. 2018). In a further study, endurance runners who received a sour cherry supplement before and after a half-marathon had lower inflammatory markers in the blood, resulting in a reduction in secondary muscle damage (Levers et al. 2016). Similar results were also found in a previous study on strength training, with Montmorency cherry powder intake resulting in

Polyphenols

	Flavonoids	Non-flavonoids
Sources	Found esp. in the peel and skin of red, blue and purple fruit.	Strawberries, bilberries, citrus fruits, apricots, cherries, cinnamon
Possible health benefits	Anti-oxidant; anti-thrombotic; anti-hypertensive; anti-inflammatory and antibiotic	Anti-inflammatory; anti-oxidant; neuroprotective; cardioprotective
Examples	Anthocyanins and flavonols	Ellagic acid, stilbene (e.g. resveratrol), turmeric, coumarin

less muscle soreness, less muscle degradation and increased strength in the recovery phase (Levers et al. 2015). In most of these studies, reduced inflammatory processes, a reduction in oxidative stress and improved oxygen saturation in muscle tissue seemed to have had a positive effect on sports performance capacity. Furthermore, polyphenol uptake provides the body with more nitrous oxide (NO), as polyphenols can activate endothelial NO synthase (eNOS), an NO-forming enzyme. There was a marked reduction in uric acid due to Montmorency cherries (Bell et al. 2014; Jacob et al. 2003), and the inhibition of xanthine oxidase with a 26% reduction in uric acid was demonstrated as the mechanism of action (Kirakosyan et al. 2018).

Blueberries also demonstrate anti-oxidant and anti-inflammatory properties and more rapid recovery following eccentric muscle loading (McLeay et al. 2012), in a similar way to black currants (Hutchison et al. 2016). Furthermore, there is an increase in ORAC (oxygen radical absorbance capacity) levels. Anthocyanins in bilberries demonstrated a greater effect in inflammatory bowel disease compared to 5-ASA (mesalazine) (Pereira et al. 2017). Subclinical inflammation is often identified in chronic diseases such as diabetes, cardiovascular disease (CVD) and obesity. There is increasing epidemiological evidence that diets rich in fruit and vegetables can considerably reduce the risk of chronic disease partially as a result of anti-oxidant and anti-inflammatory activity. The protective effect of anthocyanin on diabetes closely correlates with the prevention of dyslipidaemia, lower systemic oxidative damage and increased insulin sensitivity (Li et al. 2015). Cherries also reduced haemoglobin A1C (HbA1C), very low-density lipoprotein (VLDL) and triglycerides/high-density lipoprotein (TG/HDL) in diabetic women and VLDL and TG/HDL in overweight subjects. An improved cholesterol profile with an increase in HDL and a fall in LDL was also demonstrated, for example, with an intake of 320 mg bilberries and black currants (Qin et al. 2009).



Analytical characterisation of ingredients

To date, there is a lack of standardised information on the value-adding ingredients in products that would allow direct product comparison. The information is often limited to stating the botanical species. Furthermore, different methods of analysis are used to characterise the ingredients and there are no prescribed standards allowing objective comparison, as in the case of medicinal products. However, the polyphenol content of different products can vary significantly. These differences may be due to various factors, including different extraction processes, drying processes or the use of different parts of the cherry (e.g. skin or pulp). By way of example, two different commercially available products containing Montmorency cherry have been characterised below.

One of the products is an enzyme preparation that contains bromelain, vitamins, turmeric and boswellia (incense) as well as Montmorency cherry extract. The cherry content in the combination product is 60%. The monoprod-uct, which was also tested, contains only Montmorency cherry extract powder (100%). Both products were characterised and compared with respect to their polyphenol content, anthocyanin content and antioxidant properties. The following methods were used:

- creation of an anthocyanin fingerprint profile using high-performance liquid chromatography (HPLC) and quantification of the cyanidin equivalent content
- determination of the total polyphenol content (Folin assay)
- determination of the ORAC value (ORAC test)

The HPLC-determined anthocyanin profile of the two products confirms that Montmorency cherries primarily contain the anthocyanidins cyanidin-3-glucosyl rutinoside and cyanidin-3-glucoside identified in the literature (Kirakosyan et al., 2009). However, the total content and ratio to one another vary significantly between the combination product and the monoprod-uct. Anthocyanins are naturally present in more than 600 different compounds, pri-

marily in glycosylated form. The samples for analysis are usually hydrolysed to allow quantification, i.e. the different residual sugars are separated off and the molecules transferred to one of the six basic anthocyanidine structures (pelargonidin, cyanidin, peonidin, delphinidin, petunidin, malvidin). Due to the predominance of the cyanidin form in the Montmorency cherry products, the content was determined as a cyanidin equivalent. In the combination product, the cyanidin equivalent content per capsule was 0.14 mg (equivalent to 17.25 mg per 100 g). In the monoprod-uct, the content was significantly lower, at 0.02 mg (equivalent to 3.33 mg per 100 g). Despite its higher cherry content compared to the combination product, the lower anthocyanin content of the monoprod-uct may possibly be ascribed to different extraction or drying processes. Using the Folin assay, a photometric method of measuring the quantity of all phenol compounds in relation to an equivalent standard (catechin), 70.08 mg polyphenol (equivalent to 8.760 mg per 100 g) were measured in one capsule of the combination product, whilst the monoprod-uct contained 4.38 mg polyphenols (equivalent to 730 mg per 100 g).

The ORAC value

The ORAC value allows both the comparison of the antioxidant capacity of different extracts and the detection of changes, for example due to storage conditions or different harvests. 69.395 $\mu\text{mol TE}/100\text{ g}$ were measured for the combination product and 14.337 $\mu\text{mol TE}/100\text{ g}$ for the monoprod-uct (Fig.).

Other ORAC values in berries/fruit in $\mu\text{mol TE}/100\text{ g}$ (according to the Agricultural Research Service (ARS) of the US Department of Agriculture USDA, 2010):

- wild bilberries/forest bilberries: 9.600
- elderberry: 14.697
- cranberry/lingonberry: 9.090
- black currants: 7.957
- pomegranate seeds: 4.479

The ORAC value of different plants does not, however, allow direct conclusions to be drawn about whether they have better or worse anti-

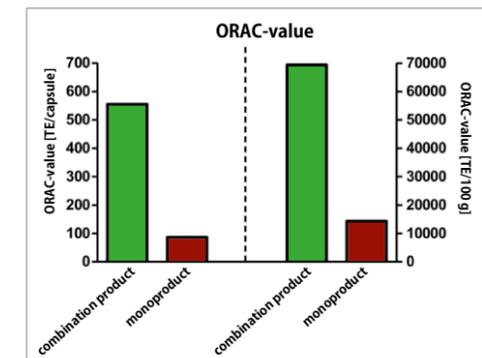


Fig. ORAC value of the combination product (green) and the monoprod-uct (red). (TE= trolox equivalent)

oxidant properties in the body. The ingredients bromelain, vitamins C and B, turmeric extract and boswellia contained in the combination product can affect the test results in addition to the Montmorency cherry extract, particularly the total phenol content and the ORAC value, but have no effect on the anthocyanin content, which is determined by the sour cherry content alone. Turmeric is a polyphenol with anti-oxidant and anti-inflammatory properties. Boswellia (incense) is similarly known for its high polyphenol content. Although the enzyme bromelain is not a polyphenol, it also has an anti-inflammatory effect and impacts positively on the cardiovascular system (Pavan et al. 2012). The combination product investigated here is also more beneficial than the monoprod-uct due to its many sources of polyphenol. As regards anthocyanins, the content of which was investigated here as specific constituents of sour cherries, the content is even higher in the combination product than in the monoprod-uct. Despite the differences in the composition of the products compared here (combination product vs. monoprod-uct), the specific test procedures used show that there are great differences in the test results and the ingredients (particularly as regards the anthocyanin content in this case). It would therefore be desirable for more detailed product information regarding the ingredients, e.g. the anthocyanin content, to be provided, allowing better characterisation of the available products. This would make it easier for consumers to compare the products they want to buy. Unfortunately, due to the lack of any prescribed measurement standards, an objective assessment continues to be difficult.

Resting the mind

Mental recovery –
An important part of regeneration in sports



Fabian Loch,
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When looking at the public sports coverage, there is a multitude of statements such as “We need a break, physically as well as mentally”. Moreover, the aspect of mental recovery comes up regularly in sport psychological consultancy and supervision. But which possibilities to mentally recover can athletes choose from?

The field of work psychology has already concluded that the relevance and impact of mental recovery breaks are a central issue and the benefits of such for the work context have been examined extensively [1]. In contrast, sports science has only started to pay attention to mental recovery and sports practice is increasingly giv-

ing more weight to the mental recovery aspect. The latest developments in high-performance sports underline that physical as well as mental demands have increased [2]. A holistic perspective emphasizes that athletes are exposed to multifactorial stress factors which are composed of global (e.g., sleep behaviour, insufficient recovery breaks, performance pressure), sport-specific (e.g., training and competition planning, competition travelling), and additional influencing factors (e.g., demands of sports and education). A sport-specific perspective additionally emphasizes that the stress pattern of sports like swimming, competitive shooting, or modern pentathlon which require the athlete to maintain a high cognitive as well as physical level over a prolonged time period (e.g., multiple competitions in one day) increases the risk of mental fatigue [3]. This clarifies that the individual resources for com-

ensation of sport-specific and external training and competition load will not be sufficient in case the individual capacity of coping with such is exceeded. The result could be a state of mental fatigue. The sport-practical necessity of focusing on mental recovery measures can be derived from this, as this can counteract an acute mental fatigue state.

Mental fatigue and mental recovery as central terms

Essentially, mental fatigue is understood as a biopsychological state which develops due to prolonged cognitive and mental demands and can have a negative effect on athletic performance [4]. The effects of a mental fatigue state can be visible on three different levels, the psy-

chological-subjective level, the behavioural level, and the physiological level [5]. Current research shows that mental fatigue is mainly perceived as an emotionally subjective state and effects are visible on the first two areas. Indicators for the first level comprise an increased feeling of fatigue, lack of activation, and decreased motivation and attention [5]. Central indicator is the increased perception of exertion which negatively affects the sport-specific performance. Key aspect on the behavioural level is the decrease of cognitive performance, which is shown in limited ability to concentrate, a plummeting accuracy of execution and a delay of reaction. A survey study with the aim to understand mental fatigue adds to these findings, as aspects like mental disengagement, limited guidance of attention, and lower discipline and enthusiasm are described as typical [6,3].

“For me personally, mental fatigue is a lack of ability to concentrate, lack of motivation or personal drive to train or take part in a competition. I was having a hard time focusing on technical elements and the actual competition when I was mentally tired.”

(former high-performance swimmer and two-time Olympian)

The concept of mental recovery comprises the recovery process of cognitive abilities (e. g., the ability to concentrate) and the restoration of mental resources by reducing mental demands during a sufficient recovery break [7]. According to this, mental recovery includes cognitive as well as emotional processes. The aim of a short-range mental recovery is securing the willingness to perform in the following stress phases as well as the restoration of the needed resources by means of suitable recovery measures. With regard to this, the recovery break plays a crucial role in enabling the athlete to recover mentally [8]. Moreover, mental detachment seems to be especially relevant for regaining a mental balance by alternating between stress and recovery.

Mental recovery strategies in sports

It can be assumed that the different levels are mutually dependent. However, it seems sensible to apply mental recovery strategies on the subjective-psychological as well as behavioural level. Typical strategies to react to mental and physical outcomes would be psychological recovery strategies such as self-regulation techniques, resource activation strategies, and relaxation measures [9]. Loch et al. have summarized the current scientific knowledge to gain more precise insights into mental recovery in high-performance sports. Their focus hereby is on mental recovery strategies for competition breaks* [10]. Based on this, one can differentiate between psychologically oriented strategies (e. g., breathing regulation techniques, training of mental imagery, power nap measures, mental detachment) and complementary psychological measures (e. g., music; see Tab.1). These strategies can support reducing a stress reaction, regulating the arousal level, increas-

ing the mental well-being, and promoting concentration, motivation, and alertness of athletes during their break to subsequently reach the individual performance optimum [3].

Recommendations for sports practice

So far, recovery measures have been separated from a physical and comprehensive-psychological consideration. Prospectively, there should be a focus on mental recovery as a distinct work field. The mediation and learning of self-regulation skills – consisting of self-awareness, self-regulation, and self-control – seem to be beneficial for the mental recovery process [11]. Especially in the light of athletes being able to realize how to prepare mentally for a stress phase (“switch on”), but at the same time not being able to use an effective mental recovery measure during their break (“switch off”) it appears necessary to summarize a first guidance for the concept of mental recovery in sports [3].

- Mental recovery is a highly individual process. Therefore, mental recovery strategies should be applied according to the individual needs.
- Athletes should learn to assess their own mental state to recognize an acute imbalance of recovery and stress.
- A regular monitoring (e. g., with psychometric instruments) of mental fatigue and recovery enables the planning and implementation of deliberate mental recovery phases.
- Chosen and pro-actively used recovery measures can enable the athlete to react in the best possible way to acute mental fatigue states and increase the recovery gain.
- The development of a specific recovery routine (e. g., combination of physical and mental recovery strategies) for recovery breaks is helpful for optimizing the recovery state.

Mental recovery	psychologically-orientated strategies	breathing techniques
		mental imagery
		powernaps
		debriefing
		mental detachment
	additional strategies	restorative environments
		music
		nutritional supplements (e.g. caffeine)

Tab. 1 Overview of potential mental recovery strategies in sport (adapted from Loch et al., 2019, p. 59).



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subclinical brain damage. In terms of clinical signs, the disease is characterised by behavioural and psychiatric symptoms including even suicidal ideation, cognitive changes including concentration and attention disorders, speech disorders and limitations in motor function, such as dysarthria and gait disorders, and tremor. Furthermore, there is evidence that head injury could also be a risk factor for the development of Alzheimer's disease. Overall, it is suspected that repetitive brain injury has neurodegenerative consequences [3]. To date, however, systematic analyses, particularly longitudinal studies allowing epidemiological statements to be made, are not currently available.

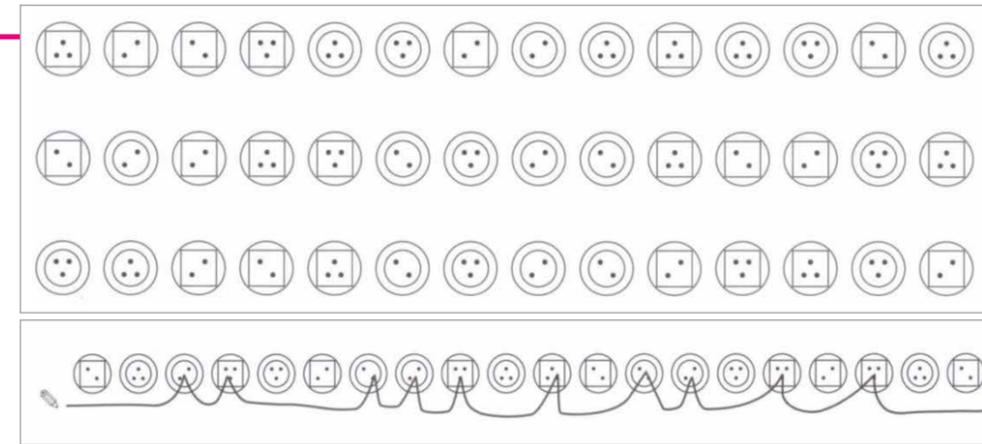
Although this development is generally to be viewed as positive, it does not make the diagnosis, treatment, rehabilitation and management of cases of head injury any less of a major challenge due to their complexity and their partly continuing trivialisation. For example, an evaluation of athletes' time off play and training in the few cases of head injury reported to the VBG [Administrative Employers' Liability Insurance Association] shows that many athletes return to training much earlier than the six days at the earliest recommended by international consensus [1]. To have a comparative yardstick available at the onset of a head injury, both the VBG and the German Football League have recommended since 2019 that a basic neurological and neurophysiological test be conducted before the start of the season. The values recorded can then serve as reference values and can be used in cases of acute head injury and when new measurements are taken in order to provide valuable information for further treatment or, regarding a possible chronicity, to identify reduced cognitive performance and to develop a player-specific plan for return to competition (RTC). Following a head injury, treatment primarily comprises initial rest, based on the motto "rest as needed and as tolerated", and later, in the absence of symptoms, a return to routine training after approx. 5–6 days. It is only after this that return to play/competition should be considered. The treatment strategy typically comprises 6 rehabilitation stages, from 1 (no activity) to 2 (gentle aerobic exercise), 3 (sports-specific exercise), 4 (training without physical contact), 5 (training

with physical contact with medical permission) and 6 (return to play with medical permission).

Proposed solution

Prior to the 2019 season, the authors jointly developed and implemented an assessment that considers the time factor as well as objectivity, reliability and validity. This basic test comprises taking a medical history of injuries, particularly head injuries, determining the neurological status focussing particularly on the cranial nerves, balance and coordination, and a neuropsychological attention and concentration test, specifically the Frankfurt Attention Inventory, FAIR 2. The neuropsychological test is a paper-and-pencil test to determine attention and the ability to concentrate in terms of performance, quality and continuity, which takes approx. six minutes to complete. The FAIR can be given as an individual or group test. There are many different and well published options for recording inter-individual differences in attention performance and the ability to concentrate for the age range 9 to 72 in all areas of psychological practice as well as in sports psychology. The advantages of the test are its outstanding reliability and validity, its suitability for groups, its simplicity and its suitability as a follow-up check. Unlike other similar tests, the FAIR test is fairer and does not allow cheating. A further advantage is that the test items are readily understandable visual signs consisting of squares and circles and are therefore non-specific to culture and language [4]. According to the authors, the following postulates were important in selecting this test: a time limit, stimuli readily understandable and commonly known, stimuli containing two dimensions, stimuli distributed according to probability theory principles, simultaneous viewing of stimulus dimensions, recording how the test was carried out, keeping to and monitoring the predetermined order, assessing performance achieved only with concentration, recording the quality, quantity and overall concentration level.

Test design: The benefit of the overall assessment described is based on the following con-



The FAIR measures the attention given as the ability to distinguish between visually similar signs in a concentrated (i.e. accurate and rapid) manner, while ignoring irrelevant information. It works with two target items, a carefully controlled distribution of items and a full marking system. Within 3 minutes, all elements should be marked that, for example, show a square with 3 dots and a circle with two dots. A line should be drawn through them. The items to be marked are given a tick.

siderations: prevention by raising awareness in athletes, trainers, therapists, the possible identification of a predisposition; registering cognitive parameters in performance diagnostics, whereby the individual comparative values allow a better assessment of limitations following injury, management following a head injury can be carried out more easily or further treatment can be individually adjusted; the comparative values provide important information when deciding whether the athlete is fit to return to training or competition. In addition, the assessment does not take much time to complete (max. 30 min per player). What may happen if the injury is not appropriately managed in time: in the short term, match-deciding errors may arise due to reduced cognitive function, the general probability of injury is increased, there is a 4-6-fold increased risk of further head injury, cognitive, physical and psychological symptoms persist longer than necessary, and the risk of second impact syndrome increases: "It's better to miss one game than the whole season!"

Conclusion

Head (brain) injuries, particularly after mild trauma, e.g. exposure to repetitive heading, remain an underestimated issue in professional football, especially as late sequelae such as neurodegenerative and neuropsychiatric disease

may still manifest even after the end of a player's career. Prevention, diagnostics, documentation of the course and specific individualised treatment should be given high priority and follow an interdisciplinary, multi-modal and standardised strategy. Clubs should honour their duty of care towards the usually very young players. The standard involvement of neurological and neuropsychological expertise is urgently recommended, preferably in the form of specialised concussion centres.

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Editorial addition

According to Scottish researchers at the University of Glasgow and the Hampden Sports Clinic, who compared a total of 7,676 former Scottish professional football players (1900–1976) with 23,028 non-athletes, former professional players die three and a half times more frequently from the effects of neurodegenerative disease. When Alzheimer's disease is at least a contributory cause of death, the risk is even five times greater.

(source: <http://www.thefa.com/news/2019/oct/21/field-research-study-findings-211019>)



PD Dr. habil.
Kai Wohlfahrt

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Thrower's shoulder

Clinical picture, diagnostics and therapy

Prof. Dr. Dennis Liem,
sporthopaedicum Berlin

The treatment of shoulder pathologies associated with throwing and overhead sports continues to present a major challenge. The throwing or overhead motion is a complex and, furthermore, sport-specific movement, which subjects the shoulder joint to a high degree of repetitive stress.

Additionally, in the case of competitive athletes, long years of stress have led to adaptation processes in the shoulder, which can further exacerbate sport-related shoulder problems. In these athletes, one-off injuries due to macro-trauma are not usually the cause of the symptoms. They are more likely to be due to stress-related damage caused by repetitive microtrauma. Initial treatment is usually conservative, once structural shoulder damage has been excluded by means of clinical examination and medical imaging. The conservative treatment is complex, can be protracted, and presents a major challenge for both athletes and therapists. Surgical treatment can be necessary in the presence of structural damage to the labrum, biceps tendon anchor, rotator cuff or joint capsule.

The throwing or overhead motion (e.g. as performed in racquet sports) is a sport-specific motion, which functions in a complex kinetic chain. The key positions here are occupied by the glenohumeral joint and the often forgotten scapula as force transmitters with their muscular connection to the trunk. In the wind-up phase, the arm is brought into approximately 90° of abduction and maximum external rotation, in order to generate a maximum throwing speed. In the subsequent acceleration phase, there is particular activation of the anterior shoulder muscles, such as the subscapular muscle and pectoral muscle. There is a rapid glenohumeral internal rotation. In the deceleration phase of the throwing or overhead motion, there is very high force transmission onto the glenohumeral joint.

Long-term practice of the throwing/overhead sport, perhaps while still growing, activates anatomical adaptation processes. Increased glenohumeral external rotation allows a higher throwing speed. This is achieved by enlargement of the anterior joint structures (capsules and ligaments). By contrast, contracture and thickening of the dorsal capsule/ligament structures is common and verifiable in ultrasound examination or magnetic resonance imaging (MRI). These adaptation processes can facilitate the development of structural damage, so that early clinical detection is crucially important in preventing such damage.



Image: © imago images / Hartmut Bösener

The increased external rotation ability leads to pathological contact between the dorsal regions of the supraspinatus tendon and the superior glenoid and the Superior Labrum Anterior to Posterior (SLAP) complex. This mechanism is a frequent form of internal impingement and is known as posterosuperior impingement.

Clinical examination

In mobility testing, typical glenohumeral differences are already apparent when comparing the contralateral side. Glenohumeral Internal Rotation Deficit (GIRD) with additionally increased external rotation in the throwing shoulder is the most significant clinical sign. Measurement of the external and internal rotation is performed with the arm hanging down or abducted to 90°, always in comparison to the contralateral side. Another finding on examination, due to the frequent presence of narrowing of the dorsal glenohumeral capsule, is Posterior Shoulder Tightness (PST). With the patient supine (ensuring stabilisation of the scapula), a reduced adduction ability is evident compared with the contralateral side. For both pathologies, typical treatment methods in the form of stretching exercises have been defined and investigated in the scientific literature. For patients with GIRD, sleeper stretches are described, whereas a relatively simple cross-body stretch is reported for PST. The latter, in particular, has impressively good outcomes in the literature. In contrast to contracture of the



Fig. 1 Relocation test

dorsal capsular structures, the anterior capsular/ligamentous structures are frequently overextended and clinically painful tests indicate anterior microinstability (e.g. relocation test, Fig. 1, painful anterior apprehension test, sulcus sign).

The scapula plays a crucial role in every shoulder joint movement and any malfunction of its complex three-dimensional motion can be both the cause and the result of shoulder pain (Table 1). When making a diagnosis, thorough examination with the patient undressed to the waist while comparing both sides is important (Fig. 2). If the symptoms can be reduced by manual stabilisation of the affected scapula, this is highly likely to indicate a relevant scapular dyskinesis. The treatment of such scapular dyskinesis is often both protracted and difficult and requires optimal communication and cooperation between physician and physiotherapist.

Important: Exclusion of relevant structural damage

If there is clinical suspicion of structural damage to the glenohumeral joint, medical imaging should be performed to exclude this. In our own clinical practice, this is initially ultrasound examination, which allows especially good visualisation of the rotator cuff, biceps tendon and posterior capsule. Particularly if labral and/or SLAP lesions are suspected, we consider this to constitute one of the rare indications for an MRI arthrogram using intra-



Fig. 2 Example of right-sided scapular dyskinesis

ticular contrast agent, as this is markedly more informative in these specific pathologies than a plain MRI scan.

Surgical treatment of structural damage

Anterior joint capsule/labrum

The importance of surgery to reduce joint capsule volume, such as the capsular shift procedures as originally described by Jobe, has declined in this specific patient population, as it is associated with a limitation in the ability to rotate the shoulder externally. This is not always compatible with a return to a high level of throwing performance. Labral lesions, on the other hand, should be treated by means of arthroscopic refixation.

Biceps lesions (including SLAP/pulley lesions)

Whereas refixation of the SLAP complex to the origin of the long biceps tendon became popular in the last decade, according to current knowledge, there is now considerable reluctance if a SLAP repair is indicated. The reasons for this are once again limited postoperative mobility and hence doubts about the patient's ability to return to sport at the same level. As a rule, in the case of SLAP lesions, tenodesis of the long biceps tendon is currently recommended, as with partial lesions of the biceps tendon itself.

Rotator cuff lesions

Due to posterosuperior impingement, which, as described, arises from increased external rotation in overhead throwing athletes, even young athletes can develop significant partial lesions on the joint side of the supraspinatus tendon (Fig. 3). In this case, the indication for surgical repair must be very carefully reviewed, as experience has shown that a return to top-level competitive sport is very difficult after rotator cuff reconstruction.

Follow-up treatment

As with almost all reconstructive shoulder procedures, follow-up treatment always entails

Table 1 Causes of scapular dyskinesis

Osseous causes	Thoracic kyphosis
	Sequelae of scapular/clavicle fracture
Articular causes	Acromioclavicular (AC) joint pathologies (dislocation/osteoarthritis)
	Glenohumeral (GH) joint pathologies (micro-/macro-instability, limited mobility, GIRD)
Neurological causes	Cervical radiculopathy
	Peripheral nerve damage (accessory nerve/long thoracic nerve)
Muscular causes	Muscle shortening (major/minor pectoral muscle)
	Periscapular muscle pathologies (trapezius muscle/serratus anterior muscle/rhomboid muscles)

an immobilisation period of four to six weeks, during which passive mobility is permitted with a prescribed amount of movement. Usually, a return to full sporting activity is not possible until after six months.

Summary

Thrower's shoulder is not a clearly defined clinical picture, but rather a combination of various diagnoses, which can be present to varying degrees in overhead throwing athletes. Structural damage should be clinically and radiologically excluded. Initial treatment is usually conservative. The surgical procedures, which are rarely required, are normally performed arthroscopically and entail protracted follow-up treatment.



Fig. 3 Partial lesion of the supraspinatus tendon in an overhead athlete



Prof. Dennis Liem has directed the Shoulder Surgery and Sports Orthopaedics Department at the Münster University Medical Centre since 2008. His activities focus on the entire range of shoulder surgery including (revision) arthroplasty and arthroscopic surgery of the knee, elbow and hip joints. He is an active member of the German (DVSE), European (SECEC) and American (ASES) Societies for Shoulder and Elbow Surgery and has appeared in the Focus list as a shoulder specialist for many years. Since 2019 he is member of the sportorthopaedicum Berlin.

Back strain

Finite element study shows one book in the backpack weighs 7 books to the spine

Dr. Kenneth K. Hansraj,
Vassar Brothers Medical Center in the
Hudson Valley, NY, USA

A Global Problem – As we consider a return to school, we must start to think of the impact of the backpack. A finite element assessment study showed that a one-pound book in a backpack weighs seven books to the spine. When the student leans forward 20 degrees, then the one-pound book in a backpack exerts 12 books to the spine.

Backpacks are standard load carriers for people of all ages, especially school children and the military. This study describes the effect of forces exerted by specific backpack weights on a model of the spine. It is essential for understanding the load that the spine experiences.

Results (Tab. 1)

People everywhere have struggled to assess the impact of objects in a backpack to the body in general, and the spine in particular. Backpack use is associated with back pain, intervertebral

disc compression, neck pain, altered posture, altered walking mechanics and plantar foot pressure.

Recommendation of the literature (Tab. 2)

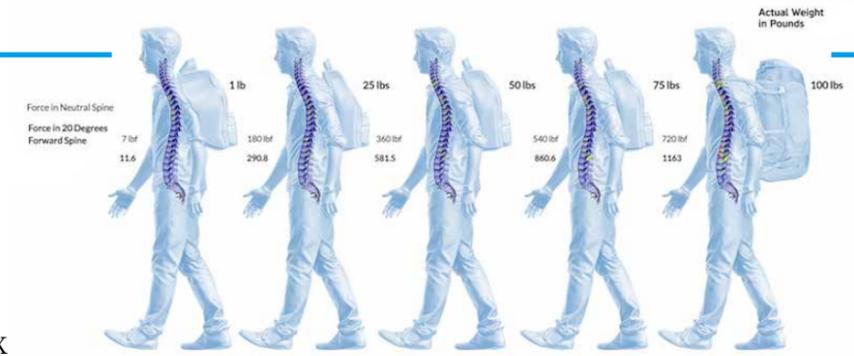
Previous studies have suggested a safe load of 10% body weight in children and adolescents, 13% and 15% in young adults, and 15–20% in college-aged adults. This study focuses on the force generated to the spine.

Risk

The first affected are the ligaments. When the ligaments are stressed and are inflamed, then there is a loss of side-by-side range of motion and stiffness. The muscles are also stressed and inflamed. Stressing a muscle makes it stronger. However, persistent eccentric loading leads to intractable pain. The disc spaces are also eccentrically loaded, seeing undue stresses. With constant eccentric loading, the process of wear, tear, and degeneration proceeds. Surgery may be needed.

Weight		Neutral Spine			20 Degrees Forward		
		Induced Stress (N/m ²) (MPa)	Added reaction force		Induced Stress (N/m ²) (MPa)	Added reaction force	
(lb.)	kg		(N)	(lbf)		(N)	(lbf)
1	0.45	2.42E+4 (0.0242)	32.18	7.23	6.44E+5 (0.644)	51.73	11.63
25	11.34	6.05E+5 (0.605)	804.40	180.83	1.61E+7 (16.1)	1293.3	290.75
50	22.68	1.21E+6 (1.21)	1608.8	361.664	3.22E+7 (32.2)	2586.6	581.5
75	34.02	1.79E+6 (1.79)	2380.96	535.28	4.77E+7 (47.7)	3828.2	860.62
100	45.36	2.42E+6 (2.42)	3217.6	723.36	6.44E+7 (64.4)	5173.5	1163

Tab. 1



Prevention

One Book = 7 Books to the Spine

When the force magnifiers are identified at 7X in neutral spine, and 12X in 20 degrees of forward posture, people should be careful with their contents in a backpack.

Thinking About Your Packing

Pack only what is necessary. People tend to overpack and bring every possible option available in their backpacks. A person with a hoarding disorder experiences distress at the thought of getting rid of items. Now each item is shown to have consequences to the spine.

Embrace digital textbooks

Digital textbooks are easier to read, access pages and do not transmit forces on the spine.

Embrace Neutral Alignment = Proper Posture

- Proper posture is the position of
- “Ears above the shoulder,
 - Angel Wings back”, = chest open

This position is the most efficient. This proper posture includes your chin being level with the floor, your scapula retracted, and your abdomen firm. Our study shows that in neutral alignment, which is good posture, the forces on the spine are 7.2X the weight. With just 20 degrees of forward posture = poor posture, the force is magnified to 11.6X the weight. This results in a 60% increase in forces.

Tab. 2

	Weight of Person Lbs. (kg.)	Conventional Recommendation	Conventional Actual Weight Allowed Lbs.(kg.)	New Study Force that the spine sees in neutral (lbf.)	New Study Force that the spine sees in 20° Forward Flexion (lbf.)
Estimated 6 years old	50 (13)	10% bodyweight	5 (2)	36	58
Estimated adolescent 15 years old	124 (56)	10% bodyweight	12 (6)	110	143
Estimated young adult 18 years old	150 (68)	15% bodyweight	23 (10)	162	261
Estimated young adult 18 years old	200 (91)	15% bodyweight	30 (14)	216	348
Estimated college aged adult	150 (68)	20% bodyweight	30 (14)	216	348
Estimated college aged adult	200 (91)	20% bodyweight	40 (18)	288	464

Back Pack Forces on the Spine Pounds of force (LBF)

Wear Both straps

The forces on the spine are the same with one strap or two straps. Both straps allow for a division of the forces that the spine sees. Similarly, with one strap, one side sees twice the amount of forces.

Keep the Backpack Closest to the Body

Closest to the body is the most efficient position for diminishing spine forces.

Develop a strong core and legs

The body provides certain inherent muscle shock absorbers. Building the core muscles with planking for example helps to strengthen the body’s force dampeners. Strong thigh muscles help.

New Technology Diminishes Spine Forces Seen in Backpacks

Patented technologies (US Patent 9,700,080 B1) address the postural, ergonomic reinforcement of backpacks to diminish the forces seen by the spine with 40–70% efficiency.

Literature
Hansraj KK; Hansraj J.A.; Griffin-Hansraj, M.D.; Kiernan, J.; Subesan, N., Firtat, B.; Elsis, A.: Backpack Forces on the Spine. *Surgical Technology Int.* 2018 Nov; 33:361–365



Dr. Kenneth K. Hansraj, is a spinal and orthopedic surgeon specializing in cervical, thoracic and lumbar procedures for example laminectomies and spinal fusions. He believes in tailoring the operation to the patient using the latest spine technologies. Dr. Ken is a spinal surgeon at Nuvance Health based at The Vassar Brothers Medical Center in the Hudson Valley, NY, USA and has extensive experience with national outlets such as CNN, HLN, CBS, FOX, NBC, ABC, NPR and has been featured globally.

New Sports-medical Rehabilitation Center in Beijing's Best Location

Despite the pandemic, the Swiss Sorehsa AG Group, Basel opened a new branch of CityReha in the most attractive area of Beijing.



CityReha Shouhou opened its doors on October 1st 2020. The new center is located in a 5-star senior care facility close to Chaoyang Park and surrounded by many western embassies and international schools. Our sino-international team is welcoming and treating athletes and patients from all over the world. Whether athletes want to return to sports after injury or seniors want to improve their quality of life our experienced international Physiotherapists (PT) and Medical Training Therapy (MTT) professionals are providing the full range of services in PT and MTT from the early acute phase after injury/surgery and chronic problems to primary and secondary prevention. We're guiding the recovery process from injury, surgery, disease or chronic symptom to the best possible outcome.

Cooperation with the Chinese Basketball Association (CBA)

Recently, CityReha has concluded a cooperation with the CBA and China-Life-Insurance. As part of this cooperation, CityReha completes an initial isokinetic assessment with the majority of the professional CBA athletes in order to ascertain the functional status and condition of the players and to identify possible neuromuscular deficits and to create better conditions for the prevention of further injuries by means of appropriate instructions or a training plan.

Sophisticated Equipment from Germany & USA

City Reha Shouhou is equipped with the latest and most sophisticated devices in China and probably even worldwide. From a health risk assessment (Cardioscan), through assessments of endurance and balance capabilities to comprehensive isokinetic multi-joint (Biodex System 4), spine & trunk assessments by tergumed, the facility has all relevant options to identify all physical deficits and accordingly design tailor-made training measures for each patient individually.

With AlterG and vacumed CityReha also offers high class treatment & training with NASA technologies. AlterG provides an individual gait therapy for orthopedic & neurologic patients as well as a cardiovascular performance training for athletes. Vacumed offers a vascular training, regeneration, and stimulation of blood circulation. For further regeneration, CityReha offers cardioscan Airzone. With Airzone, one breathes in alternating oxygen-reduced and ambient air. Having less oxygen available, the body reacts with adaptation and self-healing processes. Among other things, the powerful mitochondria multiply, which leads to an improved energy supply and slowing down the aging process.

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Membership program for Milon Micro Center

CityReha Shouhou complements its services with attractive prevention and memberships programs. For special target groups a completely new training area is designed:

Our NEW MILON MICRO CENTER is also high-level equipped with Cardioscan, Milon Circuit Training, Sensopro and Wonderwall. Here, our members receive an individual but targeted and very efficient training plan tailored to their personal needs based on the Milonizer BodyScan and a Milonizer Fitness check-up. This combines strength training including an endurance part with a coordination and mobility training.

Sorehsa AG continues to follow its vision to grow

Sorehsa AG is still following its vision and reacted counter-cyclically by investing into the future with the opening of CityReha Shouhou in Beijing. Antoni Mora, CEO of Sorehsa Ag Group, stated with regards to this project: "The planning and implementation of this project in uncertain times was a demanding for the project team which is – due to the pandemic – partly located in Switzerland. Now we are looking forward to a successful future."

Patella fracture

Conservative treatment – a challenge during the crisis

Simon Roth¹ and Dr. Stephan Hub²

¹ MYOact Mainz,
² Trauma Surgery and Orthopaedics,
Ingelheim Hospital and Trauma/Surgical
Joint Practice, Am Brand, Mainz

In times such as those we are currently experiencing, it is essential that certain key posts in our society continue to function. The staff in these posts must carry on with their duties. But what if this can no longer be guaranteed? An accident or similar can quickly result in the disturbance or cancellation of smooth processes.

But how can these processes be quickly restored if an operation is either not indicated or is not a priority in an emergency situation? All doctors and therapists providing conservative treatment need to be creative in finding solutions. Social distancing has its limits, and especially when a visit to the doctor is called for. Who is willing these days to sit for hours in a crowded doctor's surgery to then have a few questions answered and be given a referral to a radiologist or physiotherapist?

Modern technology – an opportunity

This is where modern technology comes in. Using telemedicine, the doctor can directly contact the patient at home via video chat. Questions can be answered and referrals given. But what if a specific clinical examination is required? There are after all also cases where a particular manual diagnostic technique is required for adequate assessment of a structure. If the patient is in any case receiving treatment from a well-trained therapist, then the therapist can act as an extension to the doctor's arm*. Interdisciplinary collaboration and transparency included. The therapist performs whatever examination the doctor requests via video. If the physiotherapist has the appropriate training and equipment, then they can even perform MSK ultrasound in place of the doctor. This illustrates only too well the increasing need in the future for innovative training and continuous training in this sector. Using portable ultrasound equipment, physiotherapists can learn how to provide diagnostic support under the instruction of doctors via telemedi-



Fig. 1 Extrazell® BMS medical device to prepare for pain-adjusted control of the quadriceps muscles.



Abb. 3 a + b X-ray of the knee in two planes + patella skyline views

cine, and thus unnecessary visits to crowded practices can be avoided. Therapeutic interventions should focus on the absolutely essential. As much as necessary, as little as possible, such as manual therapy as well as physical treatment measures (Fig. 1). Exercises can also be instructed and monitored via video chat (Fig. 2). Patient fears are allayed with simple explanations. It is especially in the acute phase following injury or surgery that many patients feel inhibited in loading various structures adequately. Scientific studies have shown that anxiety disorders can also have a negative impact on wound healing [1]. It is not uncommon that following a ligament injury in the foot patients are also hesitant to load the hip or knee. The consequences of such compensation in the long term are known. Instruction from the therapist in this regard can prevent any relevant resulting injury.

Case study: patella fracture following a fall, male patient, 59 years old

Imaging

- X-ray of the knee in two planes + patella skyline views (Fig. 3 a + b)
- MRI to differentiate between bipartite patella and fresh bone injury

Treatment

- surgery not indicated (provided there is no dislocation and/or joint involvement)
- conservative physiotherapy (manual therapy, EMG-aided training)
- orthosis
- MBST

Procedure

Following the necessary initial presentation at a trauma surgery/orthopaedic practice or hospital, a CT or MRI scan is also required in this case in addition to the performed X-rays to record any possible structural damage. With the appropriate referral and MRI, the patient

presented at the physiotherapist. By this time, the patient had already been provided with an orthosis and conservative treatment had already been initiated. To further stimulate fracture healing, MBST therapy (9 sessions – magnetic resonance) had already been initiated at the outset. The first session had been conducted via video chat without any problems. Initial instruction on how to behave in the acute injury phase had been given and any questions had been answered. To support these measures, it is essential in this case that the patient is provided with an orthosis (in this example, limiting flexion to 20° initially and then to 40° after approx. 3 weeks). If the clinical picture is less severe, a functional bandage, for example, may also be beneficial, not so much in terms of mechanical stability or similar as of raising conscious awareness of the injured area. It makes the patient feel more secure and at the same time warns against complacency. Patients need something tangible to feel that they are receiving treatment [2]. Thereafter, a visit to a physiotherapist was essential. Targeted techniques to mobilise various contracted or hypomobile structures were necessary to prevent a dysbalance. Instruction in exercises on dysfunctional structures (e.g. hypomobile joints) may lead to a non-physiological neuromuscular pattern and result in secondary injury [3].

Example of a possible chain of cause and effect

Limited flexion of the knee due to the fracture necessarily results in a non-physiological gait pattern. The patient will develop an individual strategy for moving from the terminal stance phase via the intermediate to the terminal swing phase [4]. In most cases this predominantly involves pelvic compensation. Elevation of the ilium on the swinging leg side continually results in one-sided lateral flexion in the lumbar spine. Neuromuscularly, this means increased unilateral activity of, for example, the quadratus lumborum and the spinal erector muscles. An acquired sacroiliac joint affection may result but is only one of many possible courses. This acquired pattern must be quickly resolved as soon as flexion in the knee can be



Abb. 2 Telemedical follow-up appointment with Dr. Stephan Hub and Simon Roth.

**Note from the editor: see also <https://www.fifamedicalnetwork.com/can-we-examine-a-players-hip-via-telehealth/>. Original study: Owusu-Akyaw KA, Hutyrá CA, Evanson RJ, et al Concurrent validity of a patient self-administered examination and a clinical examination for femoroacetabular impingement syndrome BMJ Open Sport & Exercise Medicine 2019;5:e000574. doi: 10.1136/bmj-sem-2019-000574*

increased again. It is not uncommon for residual compensation to remain long after the pathology has been resolved. This can often be detected by the practised eye. Sometimes specialist technology is required to gain a more accurate picture (e.g. EMG) (Fig. 4). A known example is the dysbalance between the vastus lateralis and medialis muscles. Targeted training of adjacent joints and compensation-affected muscles is possible with acute fractures as well. It is important also not to overlook the often overloaded contralateral side. The abrupt unloading of the one leg may result in the development of

tendinopathy in the other. Patella tendonitis often acquired following patella fracture can also be diagnosed early and prophylactically (e.g. ultrasound) and treated in a targeted manner. An essential part of the treatment is activation of the gluteus medius muscle. This can be trained in different positions regardless of the fracture. It can be trained via extension/abduction and external rotation in the hip with the knee extended and, where applicable, with the orthosis. But it can also be trained with the patient either prone or standing upright and both in the swinging and standing leg. To pre-

vent excessive activation of the quadriceps muscle that may also be counterproductive for the fracture, use may be made of EMG via biofeedback (Fig. 5). For optimal prevention, instruction in various manual therapeutic techniques and in the mobilisation of specific segments can be given in one session and filmed on the patient's mobile. This allows the creation of an individual database of exercises and manual techniques to support regeneration. Stay at home. Rehab at home.

Contact with the patient remains close. Feedback via email or mobile messenger is important. Video chat sessions are held at regular intervals to ensure progression in loading and exercises. The doctor can be consulted regarding recommendations for improving regeneration by means of diet or dietary supplements. Instruction in specific breathing techniques (diaphragmatic breathing) ensures improved metabolism and lymphatic flow and supports trunk stability [4]. With these and similar measures, it is possible to ensure patients receive basic rehabilitation treatment without unnecessary time and effort and exposure to the risks of infection. Further measures can be implemented on an individual basis, always following the motto, "as much as necessary, as little as possible". Ideally in these times, the patient will only need to sit one more time in a waiting room.



Simon Roth studied media technology at the Rhine-Main University of Applied Sciences before deciding to become a physiotherapist. On graduation, he immediately specialised both in manual therapy and the use of EMG in a clinical setting. He has been using EMG in everyday clinical practice for more than six years and has taken over 10,000 readings. With the founding of MYOact, he focussed on competitive sport amongst others and works together with teams from the first Bundesliga and the premier league but also devotes time to analysing recreational athletes and "ordinary" patients.

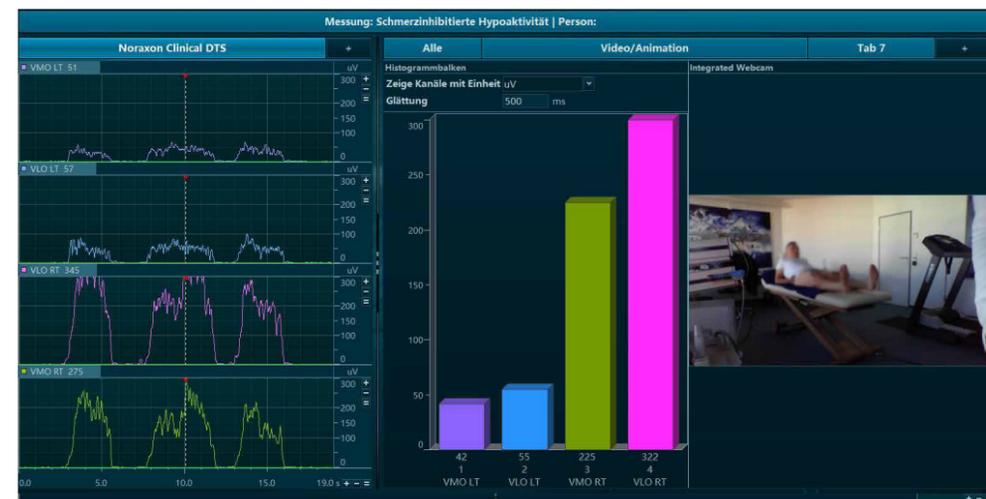


Fig. 4 EMG: pain-related inhibition of the vastus medialis and lateralis muscles on the affected side

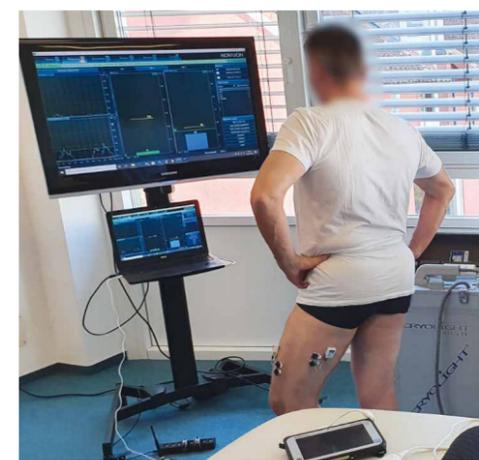
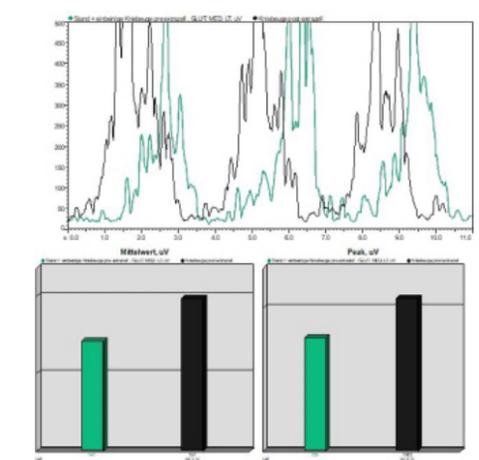
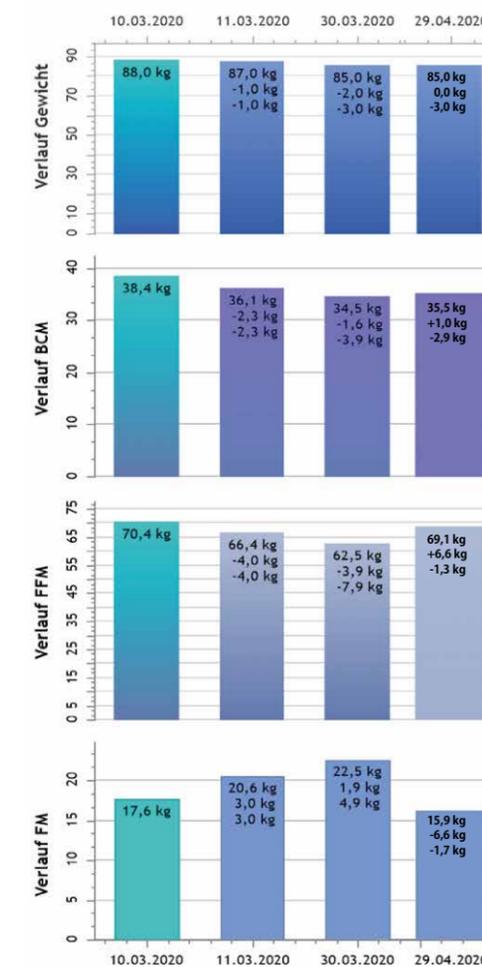


Fig. 5 EMG biofeedback training to activate the biceps femoris muscle without involving the quadriceps femoris



Activity of the gluteus medius muscle in flexion of one knee before and after local treatment with the Extrazell® BMS medical device. Activity improved by just under 30% after 3 minutes of treatment.

IMPORTANT: The patient must be prevented from making unrestrained use of the pool of exercises touted by influencers in the social media and possibly causing themselves more harm than good!



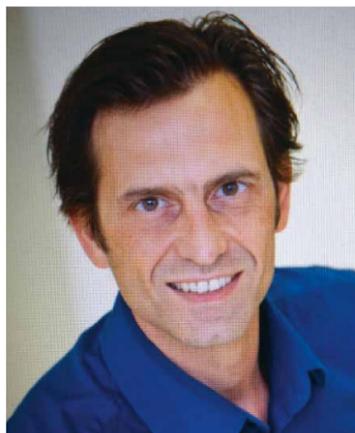
BIA reading before and after fracture: changes in weight, BCM (body cell mass), FFM (fat-free mass) and FM (fat mass)

Conclusion

What we need in the future is now being implemented more rapidly. Big brother is watching you. But only if this is what patients want. Monitoring as a possible tool to check on rehabilitation measures conducted by the patients themselves. It should never be forgotten, however, that interpersonal contact and touch are an important element in any form of healing. Technology should never be a substitute for the work of the doctor or therapist in the long term. It serves rather as digital support, and not just in the present times.

Literature

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- [3] Daniel Wagner, Michael Liebensteiner 2017: Die degenerative Erkrankung des Patellofemoralgelenks: Diagnose und stadiengerechte Therapie AGAKomitee-Knie-Patellofemoral. Pathogenese, Diagnosestellung und Klassifikation der Degeneration des Patellofemoralgelenks
- [4] Kinesiology of the musculoskeletal system by Donald A. Neumann



Dr. Stephan Hub is an Orthopaedic and Trauma Surgery Consultant. He is the Medical Director of the Department of Orthopaedics and Trauma Surgery at the Ingelheim Hospital and is a member of the medical team at the Trauma/Surgical Joint Practice, Am Brand in Mainz (Janocha/Özay/Hub). His specialisms are orthopaedic joint surgery and endoprosthetics, injuries of the musculoskeletal system and outpatient and inpatient surgery.

Expert meeting on arthritis management and the sports nutrition day

What effect do weight reduction and an anti-inflammatory diet have on arthritis as a metabolic disorder? What are the potential benefits of using dietary supplements and UC-II® (undenatured collagen type II) as an innovative monoproduct? These and other questions ensured a productive exchange of information among the experts present.

Organised by thesportgroup GmbH/ sportärztezeitung and featuring UC-II® a novel ingredient from Lonza, 14 renowned sports physicians and nutritionists met at the Bad Nauheim Sports Clinic (German Institute for Sports Nutrition e.V.) on 29 June 2019 for an expert meeting of a special kind. The aim of the event, following the launch and holding of a sports nutrition day in February, was to further organise, structure and categorise the subject of sports nutrition. For example, it was already decided at the Mallorca seminar in June to include the subject of arthritis management, which has now been implemented in an expert meeting on all matters relating to arthritis and inflammation management.

Arthritis is the most common of all joint disorders. This is also indicated by the current S2k guideline on arthritis of the knee 2018. Alongside aspects of medical, conservative and surgical treatment, the subject of nutrition is also beginning to feature in the form of weight management. Despite the fact that weight reduction is recommended as one of the most important preventive measures for patients (100% consensus), there is no readily available information as to what form such weight and nutri-

tion management (inflammation management) should take.

Robert Erbeltinger, editor of the sportärztezeitung, opened the meeting with a presentation on the (sports) nutrition day, which was already launched at the Mallorca seminar in June 2019 and at the Opel Arena in Mainz in February 2019 and which will be held regularly in future (details to follow). Internationally, the subject of sports nutrition has also received more attention at a scientific level, as is shown by publications such as the IOC Consensus Statement: dietary supplements and the high-performance athlete (British Journal of Sports Medicine 2018) and the International Association of Athletics Federations Consensus Statement 2019: Nutrition for Athletics (International Journal of Sport Nutrition and Exercise Metabolism 2019).

The purpose of this continuing education series, which first started with the concept of eat for regeneration developed by Robert Erbeltinger and which has now also gained substance with the sports nutrition day, is to create order and clarity regarding the subject on a national basis and to demarcate it as a scientific and sports medical subject separate from current trends and the fitness market. The following subject

areas will be clearly categorised, integrated and developed: (sports) nutrition/arthritis and inflammation management/weight and nutrition management/(sports)cardiology & internal medicine / nutrition psychology/monitoring/doping/legal matters & anti-corruption.

Dipl. oec. Günter Wagner (German Institute for Sports Nutrition e.V.) added in his talk that while doctors are aware of the value of a healthy diet, just mentioning it to patients is not enough. Long-term treatment success requires adequate explanation and education. Implementing a nutrition-based treatment and getting the patient or athlete on board take time. Old habits must be broken and new habits acquired. Orthopaedics is a good example of this. It is a specialism where time is an issue for the doctor, but where there is a lack of awareness for keeping to a healthy diet and thus for sustained and effective treatment. Dirk Danneberg MD (private orthopaedics and sports medicine practice in Darmstadt), who has for many years already included nutrition and monitoring as a diagnostic aid and a documentation of the disease course when treating arthritis in his practice, explained the status quo of arthritis management. He explains to his patients that losing 5 kg is like taking off a 20 kg rucksack. This comparison makes his patients sit up and take note and prompts them to start thinking about the health benefits of losing weight. The explanation and education include a bioimpedance analysis. As one possible treatment, he recommends meal replacement therapy as an alternative to dietary support. He also reported on processes in the joints that are attributed to inflammatory fat and enhance arthritis, on the use of orthoses to stabilise and uniformly distribute the load on the joints, and on the use of hyaluronic acid (e.g. single-shot vs. multi-shot) and the combined use of PRP and HA as hybrid therapy. This prompted an unscheduled but lively and animated discussion among the participants, which showed us just how topical this issue is. For this reason, we would like at this point to present to you a practice-based review article by our scientific advisor and participant at the expert meeting, Cornelius Müller-Rensmann MD, the first part of which provides a summary on hyaluronic acid.

Hyaluronic acid... old hat?



Dr. Cornelius Müller-Rensmann, orthopaedic practice, Münster

Patients presenting with cartilage damage of one sort or another are a common everyday occurrence at the practices of sports medicine physicians. As far back as 1760, the Scottish anatomist William Hunter observed that “hyaline cartilage does not heal”. This insight is still true today and shapes the treatment routine of all orthopaedists and sports medicine physicians and of many patients. Due to the high, multi-directional loads placed on joints and repetitive trauma, athletes often begin to suffer from arthritis in important weight-bearing joints at a comparatively early age. Since no cartilage-healing substance has yet been found, hyaluronic acid, in use for many decades, is still highly valued in the treatment of cartilage lesions. This explains why hyaluronic acid also suddenly became a topic of discussion at the expert meeting in Bad Nauheim when the subject of arthritis and inflammation management was being discussed (see above). The different ways in which it is applied were interesting and were the reason for this small digression about hyaluronic acid. Is a single injection better than multiple injections? Do you combine hyaluronic acid with a local anaesthetic or a corticosteroid? These questions led to animated discussion among experienced users.

What is hyaluronic acid?

Hyaluronic acid is a polysaccharide occurring naturally in connective tissue. A special characteristic of hyaluronic acid is its capacity to bind large amounts of water. In joints, it is a principle constituent of synovial fluid and acts as a lubricant, specifically by adjusting its viscosity to the forces acting on it mechanically. It adheres to the joint cartilage in a chemical interaction and is not squeezed out of the joint space under loading, as is often assumed. It also plays a role in regenerative processes in that it widens the intercellular space and thus improves the migration of cells. This is very useful as a chemical property, for example postoperatively in microfracturing.

Hyaluronic acid? – It doesn't matter which kind of hyaluronic acid you use; it all comes from the same source!

The opinion frequently held by doctors that the hyaluronic acid supplied by different providers is all produced by only one manufacturer (comes from the same source) is incorrect. There are approx.

From left to right above: PD Dr. Matthias Brem, PD Dr. Felix Post, Dr. Cornelius Müller-Rensmann, Dominik Mattern, Robert Erbeltinger, Dr. Patrick Behr, Dr. Henning Ott, Dr. Dirk Danneberg, Dr. Ralf Schauer, Stephane Vouche, Prof. Dr. Peter-Wolfgang Billigmann, below: Dr. Klaus Pöttgen, Dr. Thomas Ambacher, Dr. Nico Becker, Dr. Paul Klein, further: Dipl. oec. Günter Wagner, Dr. Christoph Merkelbach



10 manufacturers globally that produce the raw material. The products do, however, vary in quality, especially in terms of stability. This means that some hyaluronic acid products lose their viscosity after prolonged storage. It is assumed that this has something to do with a barely measurable impurity in the raw material. This is not something the individual doctor can readily check. It is therefore advisable not to store hyaluronic acid products for too long and, if possible, to choose products where the raw material has not been produced in Asia, as these products are likely to be the most unstable.

Does hyaluronic acid really work?

Intra-articular and peritendinous administration of hyaluronic acid is effective. Its efficacy has been demonstrated both for the indication arthritis (e.g. B. Miltner et al. 2012, Petrella et al. 2006) and meniscopathy (e.g. Dernek et al. 2017) and not least for tendinopathy as well (N.Lynen 2012, 40 mg hyaluronic acid and 10 mg mannitol ((Ostenil Tendon)), Gorelick et al. 2015). There are differences particularly regarding its duration of effect. It has been statistically shown that hyaluronic injections can significantly delay the time until endoprosthetic treatment of the knee becomes necessary (Altmann et al. 2015). Proof of efficacy consequently resulted in the inclusion of intra-articular hyaluronic acid therapy in the AWMF [Association of the Scientific Medical Societies in Germany] guideline on arthritis of the knee.

(Pain reduction after 3 months for the following treatments/comparator treatments)

What hyaluronic acid should you use?

Opinions differ sharply on this issue. The differences in quality mentioned above are hard for

a treating physician to check. It is equally hard to decide whether to opt for a linear or cross-linked hyaluronic acid or a hyaluronic acid with a high or low molecular weight. There are studies on this issue, but they are often initiated and funded by the manufacturers. It is difficult to find clear answers. A study on a rat model showed that linear hyaluronic acid with an intermediate molecular weight increased cartilage elasticity the most (Gaumet, Badout, Ammann Genf 2018). However, relatively good elasticity values were also achieved in the same study with high-molecular weight cross-linked hyaluronic acid. An important issue to consider is the frequency of injection. With a single administration, the risk of infection from the injection is naturally lower than with an administration given 3 – 5 times. A study by Bannuru et al. in 2015 showed no significant difference in the efficacy or duration of effect between the 5-times administration of hyaluronic acid and the single administration of two products from the same manufacturer. The duration of effect of both products was approx. 6 months. This is also consistent with users' current clinical experience.

Should you combine hyaluronic acid with other substances?

This subject was also a matter of very intense debate at the expert meeting in Bad Nauheim. Some users administer local anaesthetics and/or corticosteroids in combination with hyaluronic acid products. A number of studies (Bulstra et al. 1994, Gulihar A. et al. 2013, Farkas B. et al. 2010) have shown that both local anaesthetics, e.g. lidocaine, and corticosteroids, e.g. betamethasone, lead to the death of cartilage cells. In view of the study data, use of local anaesthetics should be very selective. Use of intra-

articular corticosteroids should also be considered carefully based on the risk profile. Routine administration in combination with hyaluronic acid is certainly not appropriate. However, there is agreement that hyaluronic acid should not be used to treat an inflamed knee with synovialitis and effusion. In such cases, single administration of corticosteroids is useful. There is high consensus on this procedure in the AWMF guideline on arthritis of the knee under item 4.1.2. At the same time, mention is also made that high-dose corticosteroids can inhibit cartilage cell metabolism and thus damage the cartilage (Hirsch et al. 2013).

Is hyaluronic acid still the gold standard?

Intra-articular hyaluronic acid products have been available for many years and, based on the current study data, are still one of the most important options for the symptomatic treatment of arthritis. A significant effect cannot, of course, be achieved in every patient. And not every patient will experience a lasting effect. However, in routine clinical practice it is important to have a useful option available for symptomatic relief in patients with arthritis that does not yet require surgery. Professional athletes with meniscopathy, for example, can also be helped in this way, as it allows surgical repair of the meniscus to be postponed until the end of the season. Due to the different mechanisms of action, the combined use of hyaluronic acid and platelet-rich plasma is also an increasingly popular option. There is still a lack of valid studies on this. From what was generally said at the expert meeting on arthritis and inflammation management in Bad Nauheim, the combined use of intra-articular hyaluronic acid and oral UC-II®, i.e. a combination of improved cartilage nutrition and an immunological approach, may be of prospective interest.

Interim conclusion

The administration of intra-articular hyaluronic acid has been and still is an important pillar of the medicinal treatment of arthritis. Our per-

sonal experience over the last 20 years tends to favour the 3-5-times administration in a weekly rhythm. The impression of a somewhat higher sustained effect compared to single administration commends multiple administration. However, in elderly and immunosuppressed patients single administration with strict indication is the better option. The variety of the individual hyaluronic products in terms of molecular weight and cross-linking makes comparison difficult. The data available is sometimes inadequate. The user must have confidence in the manufacturers when selecting which product to use. Reputable manufacturers will always be transparent about where the product was produced and filled.

Following the extensive discussion of hyaluronic acid, Dominik Mattern from Lonza presented an innovative mono-product for the treatment of arthritis, providing a further treatment option and alternative to NSAIDs. UC-II® is undenatured type II collagen, produced from cartilage using a patented, non-enzymatic, low-temperature process. This preserves the undenatured/natural structure of the collagen. It stimulates natural repair mechanisms and helps new cartilage to form. It can therefore improve mobility and thus the well-being of the patient. Prof. Thomas Hügle MD also referred to the positive study-based outcomes of supplementation with UC-II® in his chapter Diet, dietary supplements and medication in arthritis (S. Nehrer, V. Valderrabano, M. Engelhardt: Cartilage and arthritis in sport. 5th GOTS [German Society of Orthopaedics and Traumatic Sports Medicine] expert meeting).

Vergleichs-therapie	Paracetamol	IA Placebo	Celecoxib	Naproxen	Ibuprofen	Diclofenac	IA Corticosteroids	IA Hyaluronic acid
Oral Placebo	0,18 (0,04–0,33)*	0,29 (0,04–0,54)*	0,33 (0,25–0,42)*	0,38 (0,27–0,49)*	0,44 (0,25–0,63)*	0,52 (0,34–0,69)*	0,61 (0,32–0,89)*	0,63 (0,39–0,88)*
Paracetamol	—	0,11 (–0,17–0,38)	0,15 (0,00–0,30)	0,20 (0,03–0,37)*	0,26 (0,05–0,47)*	0,33 (0,12–0,54)*	0,42 (0,12–0,73)*	0,45 (0,18–0,72)*
IA Placebo	—	—	0,04 (–0,21–0,30)	0,09 (–0,15–0,34)	0,15 (–0,13–0,44)	0,23 (–0,03–0,49)	0,32 (0,16–0,47)*	0,34 (0,26–0,42)*
Celecoxib	—	—	—	0,05 (–0,08–0,17)	0,11 (–0,10–0,31)	0,18 (–0,01–0,37)	0,27 (–0,02–0,56)	0,30 (0,04–0,55)*
Naproxen	—	—	—	—	0,06 (–0,15–0,27)	0,13 (–0,07–0,33)	0,22 (–0,06–0,51)	0,25 (0,01–0,49)*
Ibuprofen	—	—	—	—	—	0,07 (–0,17–0,32)	0,16 (–0,15–0,48)	0,19 (–0,09–0,47)
Diclofenac	—	—	—	—	—	—	0,09 (–0,20–0,38)	0,11 (–0,14–0,37)
IA Corticosteroids	—	—	—	—	—	—	—	0,02 (–0,12–0,17)

* signifikant überlegen

Dr. Müller-Rensmann Part II

What is UC-II®?

UC-II® is the abbreviation for undenatured type II collagen. This collagen was harvested by a chemist from chicken sternum. What is special here is that the collagen is not harvested by heating or hydrolysis, which would result in the collagen being denatured and losing its efficacy. This substance is now harvested by a Swiss company (production site in the USA) using a special patented process and is marketed in different oral pharmaceutical forms. Its mechanism of action is interesting as it does not involve high concentrations of a substance that is a structural component of cartilage being present in the joints on oral intake. The effect is thought to arise through the development of oral tolerance due to an interaction between UC-II® and the immune cells in Peyer's patches in the small intestine. The regulator T-cells formed during this interaction can produce anti-inflammatory cytokines in the joints. These in turn can have a symptom-modulating and repair effect on the joints. A number of studies (Lugo, Saiyed, Lane, Nutrition journal ((2016)), Bagi, Berryman, Lane Osteoarthritis and Cartilage ((2017)) corroborate this propagated effect on rat models and in placebo-controlled trials*. As with hyaluronic acid, which was used at an early stage in veterinary medicine, e.g. in equestrian sport, UC-II® has already been adopted in today's veterinary practice. It can be considered as a new approach that offers us support in helping our athletes, who often suffer from arthritic changes in their joints early on in their lives. Even if the currently available data for the relatively new substance UC-II® is still limited, the studies have been promising and we will follow and monitor further developments with interest.

**a placebo-controlled, randomised, double-blind study in humans in 2016 showed that UC-II® undenatured type II collagen can improve the well-being, mobility and flexibility of the joints of individuals with OA. It was statistically far more effective than a combination of 1.5 g glucosamine and 1.2 g chondroitin, according to the WOMAC index (Western Ontario and McMaster Universities Osteoarthritis Index).*

Insertion: Alternatives to NSAIDs

Although alternatives to NSAIDs have already been available for some time, it is also regrettable, especially from a cardiologist's point of view, that these alternatives are not being used. In addition to the known adverse effects in the gastrointestinal tract, the adverse effects on renal function are blatant. What is often forgotten in daily routine, although it is nothing new, is the considerable hypertensive effect of NSAIDs in everyday life. Moreover, cardiac mortality and myocardial infarction rates are significantly higher under NSAIDs, as sometimes becomes apparent even after just a few weeks of use. Particularly enzyme therapy with proteolytic bromelain and papain can be regarded here as a useful alternative. Studies have shown positive effects on postoperative oedema, and bromelain was significantly superior to standard treatment. The amount of analgesics used, particularly NSAIDs, was also significantly lower. Fortunately, there has now been a marked increase in the use of enzyme therapy. New combination products with added turmeric and Montmorency cherry further enhance these effects. As regards UC-II®, I would like to refer to the following study: Undenatured type II collagen (UC-II®) for joint support: a randomized, double-blind, placebo-controlled study in healthy volunteers. J Int Soc Sports Nutr. 2013 Oct 24;10(1):48. doi: 10.1186/1550-2783-10-48.

This study on healthy subjects who followed a loading protocol using a step-mill showed that supplementation with UC-II® led to significantly less knee pain, better knee mobility and a longer period of pain-free training.

PD Dr. Felix Post



Discussion

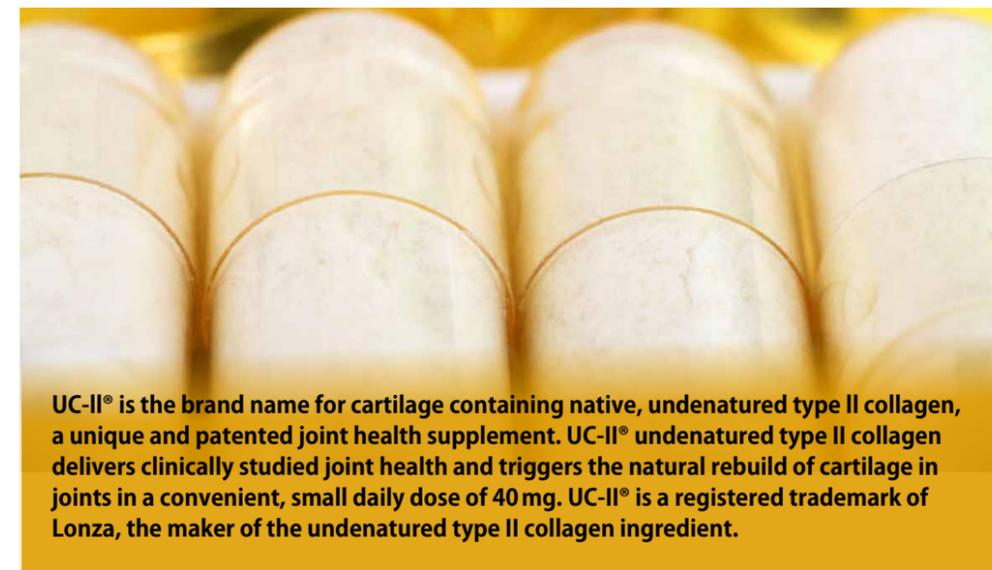
There is a growing awareness in the medical profession for the sustained treatment success of a healthy diet for patients and athletes. Of particular note here is its benefit in arthritis and inflammation management and the resulting pain reduction. It is now sufficiently known that the use of NSAIDs beyond the post-traumatic phase of 2 to 4 days (see the article, Alternatives to NSAIDs/analgesics by Klaus Pöttgen MD and Private lecturer Thilo Hotfiel MD in: sportärztezeitung 03/18, pp. 84–89) is to be viewed critically. But NSAIDs are still one of the most frequently used methods of treatment. As before, there is a lack of explanation and education about alternatives, a fact the expert team is in total agreement with. Henning Ott MD sees a healthy diet and the use of UC-II® as a potential for finding a possible valuable alternative to analgesics, for reducing inflammation and swelling and moreover even for promoting homecare, i.e. guiding and instructing patients. Paul Klein MD supports this statement and describes UC-II® as not so much a dietary supplement as a completely new approach which helps the body help itself as a mediator by increasing the secretion of interleukin 10 stimulated by the immune system in the gut. Ho-

wever, both Private lecturer Felix Post MD and Paul Klein MD point out that there is a general lack of in-depth knowledge on the subject and that diet and dietary supplements are still only a topic of discussion among experts or have got a bad name due to the fitness sector.

Outlook

As there are proven recommendations regarding high-performance sport but fewer or hardly any for popular and recreational sport or sports therapy, we are now keen to take the next steps and build on the work done so far. In our sports nutrition work group, we will provide options and recommendations as to how athletes and patients, in consultation with experts, should make effective use of the potentials of a healthy diet and useful dietary supplements. We would like to organise the subject, both quantitatively and qualitatively, and raise awareness in physicians, patients and athletes. To this end, thesportgroup GmbH/sportärztezeitung are also forming a committee of physicians and partners to draw up and develop key opinions and make recommendations.

Patrick Göller



UC-II® is the brand name for cartilage containing native, undenatured type II collagen, a unique and patented joint health supplement. UC-II® undenatured type II collagen delivers clinically studied joint health and triggers the natural rebuild of cartilage in joints in a convenient, small daily dose of 40 mg. UC-II® is a registered trademark of Lonza, the maker of the undenatured type II collagen ingredient.

Anterior knee pain

Causes, pathogenesis and treatment

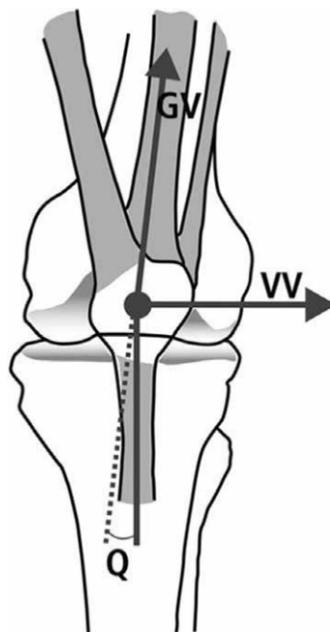


Fig. 1 Diagram of the Q angle (GV = overall vector of the quadriceps muscle, VV = valgus vector/resulting force vector)

Prof. Dr. Christoph Becher,
International Centre for Orthopaedics,
ATOS Clinic Heidelberg

The term “anterior knee pain” basically refers to any pain in the anterior area of the knee, particularly in the patellofemoral compartment. It covers a wide range of structural and functional impairments and changes, which can only be clearly identified and differentiated from one another based on a proper medical history and using clinical and imaging diagnostics.

Anatomical and biomechanical causes

The patellofemoral joint demonstrates a specific interaction between static elements (ligament and bone) and dynamic factors (neuromuscular) that play a role in the high load-bearing capacity of the joint. Anterior knee pain may be triggered by intra-articular pathologies, extra-articular soft tissue disorders, malalignment of the joint components or symptoms radiating from the abdominal or pelvic area. The main cause of the symptoms is malalignment of the patella in the patellofemoral groove [1]. Decentralisation results, on the one hand, in incorrect loading of the soft tissue stabilising the patella and, on the other, in chondral softening and fissures with subsequent load-bearing pain due to uneven retropatellar loading of the cartilage. A predisposition to dislocation, possibly resulting in complete dislocation, is a particular diagnostic and therapeutic challenge due to the wide range of causes.

Between maximum and approx. 30° knee flexion, the patella is engaged in the patellar sulcus (trochlear groove of the femur) and is protected against lateral and medial instability. The further the knee is extended below 30°, the more

important the role played by the passive soft tissue and active restraints becomes. A possible malformation of the trochlear groove is known as trochlear dysplasia and is, as it were, the worst precondition for stable patellar tracking. The otherwise physiologically present tracking of the patella in the groove as it moves from extension to flexion is present to a lesser extent from a knee flexion of approx. 20° or is even negatively affected by an elevation in the trochlear groove (commonly known as a trochlear bump). This means that the patella is tracked by soft tissue restraints over a considerably greater range of flexion. In many cases, this leads to increasingly painful overloading of these structures. There is also a risk of permanent destabilisation of the patella. The medial patellofemoral ligament (MPFL) is the most important passive soft tissue structure acting against lateral translation of the patella. Biomechanical studies have shown that the MPFL, with up to 90% of the medial structures, plays the most important role in resisting lateral displacement of the patella with a knee flexion of between 0–30° [2].

Active factors are understood to include particularly the quadriceps muscles, especially the vastus medialis muscle, which helps prevent lateral displacement. Anatomically, the patella is predisposed to lateral instability. The Q-angle (quadriceps angle) describes the vector of pull exerted on the patella on contraction of the quadriceps [3]. This vector produces a laterally directed force or valgus vector that is formed from the overall vector of the quadriceps muscle with that of the patella tendon in the frontal plane. The significance of the Q angle is disputed. On the one hand, the angle changes depending on the position of the patient, the flexed position of the knee and the contraction of the quadriceps muscle; on the other hand, the angle varies greatly between individuals. Nonetheless, a basic understanding of the consequences of an increase or decrease in the Q

angle and its effect on the resulting force vector is important. Any malalignment that results in an increased Q angle leads to increased lateral displacement of the patella, which ultimately causes increased compressive loading of the lateral retropatellar joint surface or lateral destabilisation of the patella (see Fig. 1).

A change in the mechanical leg axes leads to changes in the tracking of the patella. With increased antetorsion of the femoral neck, for example, the distal femur is internally rotated relative to the tibia. Increased external torsion of the tibial head relative to the distal tibia can result in an externally rotated tibial tubercle relative to the femur. Both ultimately increase the Q angle and hence the load on the lateral portion of the patellofemoral joint [4]. Furthermore, the lateralised course of the patella, particularly in extension, can lead to a predisposition to dislocation.

Development of pain

Several neurohistological investigations have established a connection between the distribution of substance P nerve fibres in the soft tissue of the knee and anterior knee pain [5]. As opposed to non-innervated cartilage tissue, particularly the peripatellar synovial capsule tissue including Hoffa’s fat pad is histomorphologically the most important of the pain-afferent structures and is most likely to be the trigger of pain in the patellofemoral joint. Although the retropatellar cartilage is not the cause of the pain itself, damage to the cartilage due to overloading of the subchondral bone and inflammatory changes in the adjacent synovia with its rich supply of nerve fibres can result in pain. The subchondral bone changes induced by increased retropatellar surface pressure are then often seen as intraosseous oedema on MRI. It should also be noted that in chronic patellofemoral pain syndrome psychological factors also play a role. The considerable functional impairment may not always be attributable only to the pain itself but also to the psychological disturbance caused by pain expectation [6].

Treatment

Treatment of anterior knee pain is generally based on the cause of the symptoms. Imaging complements a precise clinical examination and plays an important role in accurately determining the pathological cause. In addition, the pathology can then be further classified and quantified. It further helps in making the final treatment decision, particularly in avoiding or when precisely planning surgical interventions.

Conservative treatment plays a prominent role, particularly when no clear intra-articular pathology is present as the cause of the symptoms. Each patient generally requires an individual treatment programme to treat the specific symptoms appropriately according to the stage and based on their individual needs. Scientifically based online video exercise programmes (e.g. MAWENDO) can be very helpful in ensuring the correct performance of exercises, controlling loading and increasing motivation. The use of inserts, orthoses, bandages and tapes may also be useful. Treatment with inserts can correct a large portion of forefoot and hindfoot deformities. Patellofemoral pain syndrome has to date been primarily associated with forefoot varus and flatfoot (pes planovalgus). The purpose of external stabilisers, such as orthoses, bandages and tape dressings, is to stabilise the movement of the patella and minimise retropatellar pressure. There is also cutaneous stimulation of the soft tissue structures that lie beneath. With the resulting reduction in symptoms and the greater feeling of security, patients gain more confidence in their knee and can increase its functional capacity again.

Most surgical techniques involve reconstructive procedures with the aim of recentring the joint components (see Fig. 2) and treating the sequelae of the pre-existing instability (e.g. cartilage treatment). Due to the frequent complexity and wide range of pathologies, the use of a treatment algorithm is recommended when treating anterior knee pain. For a step-by-step analysis, it would be advisable, for example, to use the algorithm developed by Ostermeier and



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Fig. 2 15-year-old female tennis player (state tennis team) with anterior right knee pain secondary to miserable malalignment (combination of increased femoral antetorsion, external tibial rotation and thus increased Q angle with the patella internally rotated when standing with the feet parallel) (picture on the left). She experienced purely load-dependent pain when engaged in sport. Following osteotomy of the femur and tibia, the now 17-year-old tennis player is symptom-free (picture on the right).

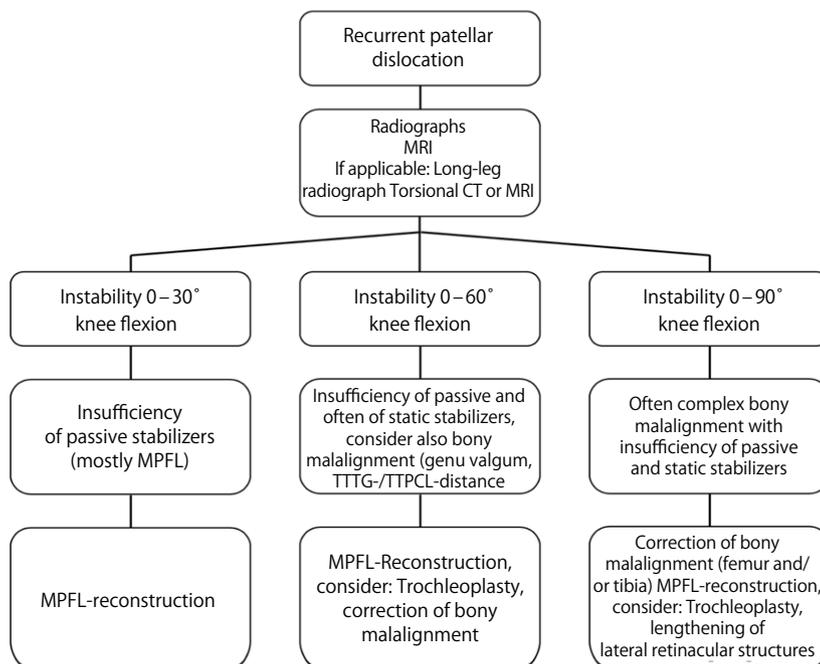


Fig. 3 Algorithm for the procedure for chronic patellar instability with recurrent dislocation. The algorithm was developed by the patellofemoral committee of the AGA [Society for Arthroscopy and Joint Surgery – German-speaking work group for arthroscopy] [8].

Becher [7] that presents treatment measures graduated according to the clinical and imaging findings. In cases of chronic patellofemoral instability, the algorithm of the patellofemoral committee of the AGA (Society for Arthroscopy and Joint Surgery) is recommended as a guideline [8].

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