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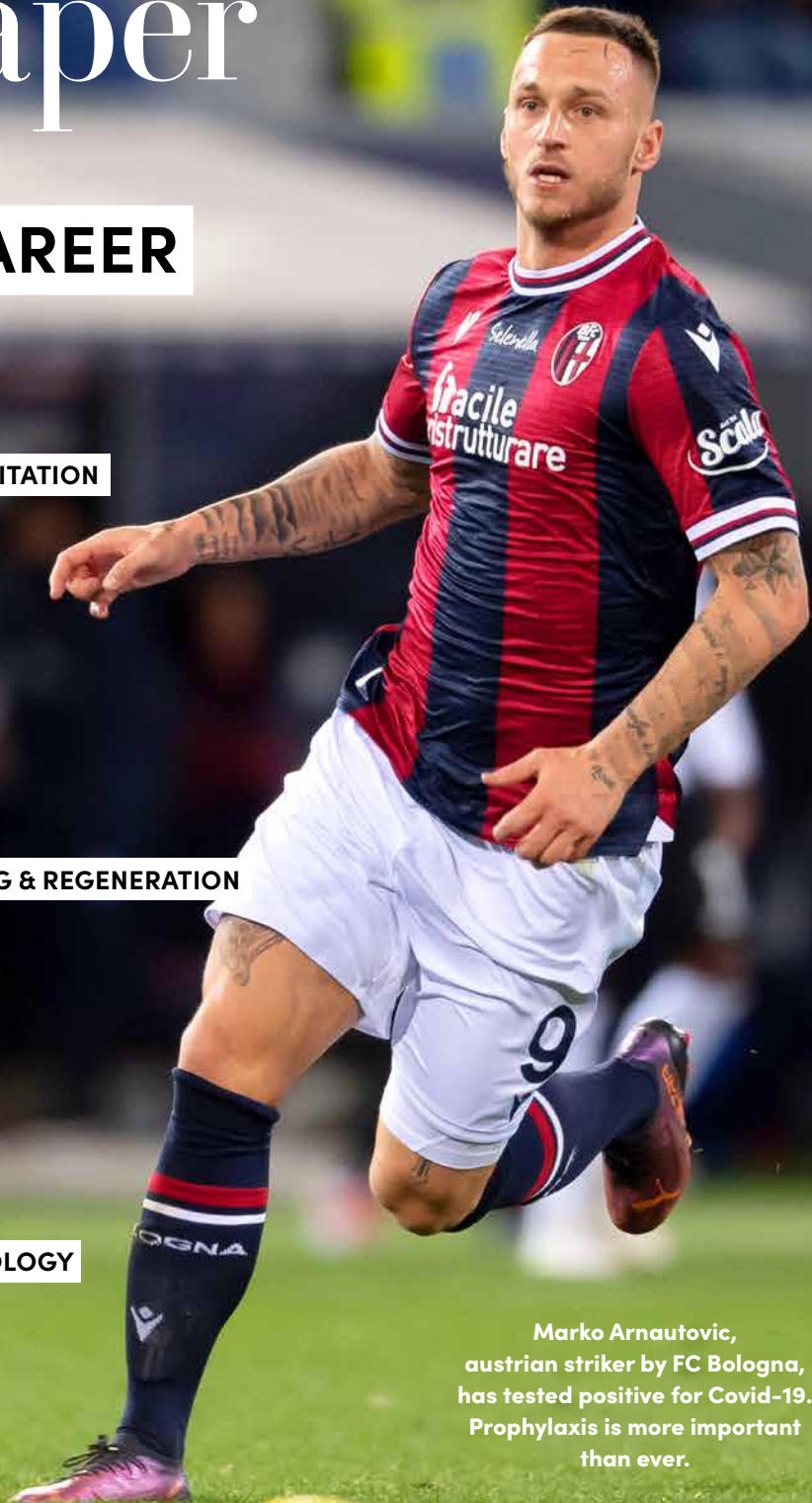
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Best regards yours thesportgroup-Team



sportärztezeitung

PLATELET-RICH PLASMA & HYALURONAN

A potential therapy synergism regarding cartilage repair?

**JULIANE WIEBER AND PHILIP CATALÁ-LEHNEN, MD /
LANS MEDICUM HAMBURG**

Hyaluronan (HA) has been used successfully in osteoarthritis treatment for over 30 years. Since a few years Platelet-rich Plasma (PRP) is applied in modified preparations and various indications e.g. in the treatment of gonarthrosis and progressive cartilage damage. Pain and loss of function are the main clinical symptoms that lead to treatment [13].

HA as well as PRP therapeutic applications show a positive effect regarding effectiveness, pain reduction and improvement of mobility over a period of up to 12 months, whereas HA levels off to a steady state of its positive effects after the first 6 months [12]. Although knee-replacement surgery provides an effective solution for severe knee osteoarthritis (OA), for younger and middle-aged patients with earlier stages of Arthritis, conservative nonsurgical interventions have been proposed [6, 24, 9]. Thus, the International Osteoarthritis Society recommends non-surgical treatment as a first line therapy [33]. Conservative interventions include analgesics, non-steroid and steroid anti-inflammatory drugs, corticosteroid and HA injections. More recently PRP, as a biological therapy, has become an intriguing treatment option to improve the status of the joint [5, 11, 10, 28, 29]. This raises the question whether the effects of HA and PRP is potentiated when a combination therapie of both is used and therefore leads to a possible therapy synergism.

BENEFITS OF HYALURONAN

Currently, there is no evidence regarding the intraarticular therapy with PRP or HA, which advises one injection regimen superior to the other. The American Association of Orthopaedic Surgeons (AAOS) does not yet recommend HA in their guidelines for osteoarthritis, but current studies seem to update this recommendation [18, 23]. The Society of Orthopaedics and Orthopaedic Surgery (DGOOC) states in their updated S2k guideline of September 2020, “Intra-articular hyaluronic acid injection may be used in patients in whom the use of NSAIDs is contraindicated or in whom NSAIDs are not sufficiently effective” [27]. HA has viscoelastic as well as anti-inflammatory and cytoprotective properties, in addition to stimulating endogenous HA synthesis [26, 1, 14, 3, 4]. The rheological and mucoadhesive properties are particularly important for artificial joint fluids, as this elastic matter is able to successfully absorb mechanical energy and protect cartilage from damage, tear or abrasion [2]. These properties gain importance especially at high loads such as in competitive sports. The therapeutic effect

and possible side effects of HA depend directly on the molecular weight of the biopolymer, its cross-linking, the dosage and its preparation [1, 26, 23, 17, 19] HA has its peak effect at about 2 months and lasts a total of about 6 months [10, 21]. (For further information please see *sportärztezeitung* 01/21 and Figure 1).

BENEFITS OF PRP

The last few years, PRP has been used in various indications, including osteoarthritis and cartilage damage. PRP, as an autologous therapy, releases local growth factors, which in turn stimulate chondrocyte production. This endogenous effect stimulates the extracellular matrix and could promote cartilage repair [11, 2]. Moreover, PRP has anti-inflammatory effects by increasing anti-inflammatory mediators, decreasing proinflammatory mediators and the expression of pro-inflammatory enzymes [22]. Further, PRP improves patient reported outcomes in terms of pain, functionality and stiffness, over a period of 6–12 months [10, 11, 30, 25, 16, 8, 12]. In some cases, the outcome after additional PRP injection is better than single HA injection therapy [10, 12, 29]. Especially in long-term outcome, PRP seems to be superior to HA solution [11, 15, 32]. Compared to saline, where significant functional impairment occurs after approximately 6 months, the improvement with PRP is consistently maintained over a 12-month period. This indicates that the improved outcome with PRP is not based on a placebo effect [10]. It was demonstrated in vitro that chondrocytes cultured with



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growth factors, which are also present in PRP, had higher proliferation rates than the control culture without growth factors [7]. Another topic that remains unclear is whether leukocyte-rich or leukocyte-poor PRP shows more benefits regarding functional and pain outcome parameters. However, based on current knowledge, it appears that leukocyte-rich PRP is more effective [5].

COMBINATION THERAPY – POTENTIAL FOR A THERAPY SYNERGISMS?

In case of a combination therapy, it can be differentiated between a direct combination therapy and an injection therapy with time intervals of e.g. 48 h to 7 days between HA and PRP injection. With both therapy regimes a synergism would be conceivable. This synergism could be due to the anti-inflammatory and visco-elastic properties of action of HA and the additional chondrocyte stimulating and anti-inflammatory effect of PRP [33]. This synergistic effect has been partially demonstrated in experimental in-vitro cell and in-vivo animal experiments [30]. Increased chon-

drocyte proliferation and increased glycosaminoglycan concentration, decreased apoptosis and therefore less cartilage damage were observed [20]. Furthermore, it has been shown that synovial fibroblasts and tendon cells exhibited improved cell mobility in a PRP plus HA solution than in a PRP-only solution [33]. A current meta-analysis by Zhang et al. (2020) showed that a combined therapy of PRP and HA leads to significantly higher improvements in terms of pain perception and functionality compared to PRP or HA alone (after 6 months). Additionally, the PRP-HA group achieved greater improvement in WOMAC function score, WOMAC total score and Lequesne score at 12 months [32]. Gilat et al. (2021) concluded that combination therapy was superior to HA alone in terms of functionality and pain after 6 and 12 months [15]. However, long-term studies (>12 months) are still lacking. Moreover, combination therapy only referred to the simultaneous administration of PRP and HA in one injection session. There is currently no evidence regarding a therapy success in

terms of an injection regimen with a 48 h to 7 days interval between injections [33, 16]. The combination therapy of PRP and HA is not to be expected leading to an increased risk, compared to therapy with PRP or HA alone and shows comparable side effects [33]. No significantly increased rate of adverse events was demonstrated in either group [29, 28]. As described before, the properties of PRP would conceivably reduce joint inflammation and stimulate chondrogenesis [5]. Yet only Xu et al. have included examination (Doppler Imaging for Synovium and Cartilage, Synovial fluid for Inflammatory parameters) regarding these parameters [30]. A comprehensive pathophysiological concept does not yet exist, but a common therapeutic effect via the extracellular matrix is conceivable. This is activated by both the hydrophilic properties of HA and platelet growth factors. Future studies should investigate possible effects on various synovial parameters and the extent of cartilage damage on MRI, because evidence is lacking regarding objective parameters.

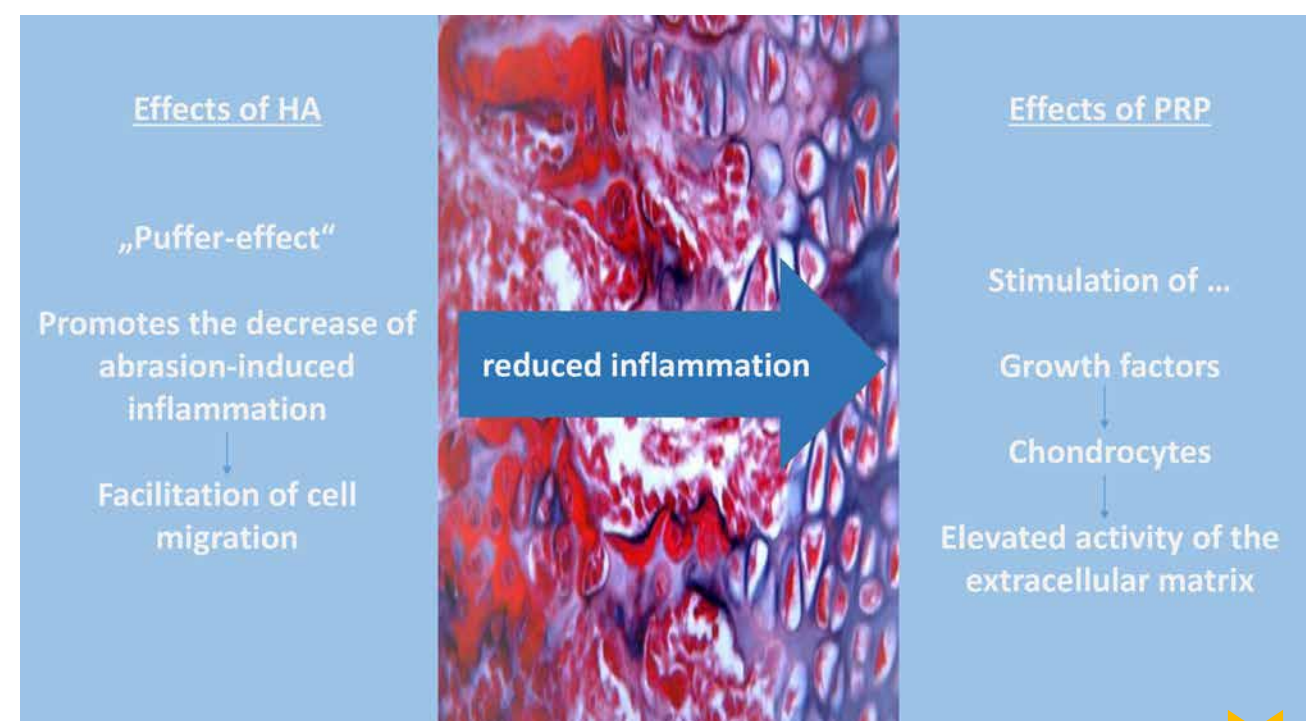


FIG. 1 Potential Therapy Synergism of Hyaluronan and Platelets Rich Plasma (PRP)

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LIMITATIONS

One of the most frequently mentioned limitations is the heterogeneity in the preparation and injection of PRP, but also in the kind of injection of HA [11, 10, 5, 12, 8]. Too short follow-ups and lacking study designs were also criticized [33, 10, 25, 22]. Additionally, there were concerns about patient selection and heterogeneity among patients. The inclusion and exclusion criteria were not evaluated in detail and patients who had knee pain but no knee osteoarthritis were enrolled [8, 10, 33]. Some authors also missed post-injection radiographic or MRI data collected at follow-up [22, 5, 21].

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CONCLUSION

The current study designs appear to be very heterogeneous. Standardized designs with more homogenous groups will be needed in order to develop evidence-based therapy [12, 31, 10, 5, 20]. Based on the literature PRP seems to be superior to HA alone in terms of pain and functionality in mid- and long-term follow-up [12, 31, 22, 5, 21]. However, recent studies show that the combination therapy of HA and PRP shows promising results (VAS, WOMAC function and total, Lequesne Index) after 12 months than PRP alone [33]. It can be concluded that, at the present time, further high quality RCTs using a stand-

ardized method of preparation and injection are needed to establish an evidence-based therapy. As mentioned above, additional examinations of the synovia, as well as cartilage imaging should be included in the study design in order to make solid statements about the influence on inflammation and cartilage repair to refer to more objective parameters. Additionally this would lead to a more valid statement about the influence of the injection therapy on inflammation and cartilage repair.

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ANTERIOR CRUCIATE LIGAMENT RUPTURES

The problem of re-ruptures in professional sport

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The British Journal of Sports Medicine (BJSM) recently published a study by the Football Research Group under the supervision of Jan Ekstrand from Sweden in collaboration with the Isokinetic Medical Group from Bologna under the leadership of Francesco Della Villa. The aim of the study was to present the re-rupture rate for anterior cruciate ligament ruptures in professional football and their scientific evaluation.

The study is based on the globally largest data collection of injuries in professional football, the UEFA Injury Study, which has involved the collection of injury data from clubs in the UEFA Champions League and others for more than the past 20 years. The conclusion of this study is that in one of five cases among professional football players out of the 118 study participants with an anterior cruciate ligament rupture a second ACL rupture appeared. Players who had suffered an isolated or non-contact injury in the primary rupture were particularly prone to a re-rupture. There was also some indication that the risk of re-rupture was reduced when the return to training after injury was more delayed.

BJSM study, Della Villa F et al 2021:
<https://bjsm.bmj.com/content/55/23/1379>

INTERPRETATION OF THE STUDY

Taking into account both, the given limitations of such a study project with all the various surgical techniques used in ACL reconstruction of the study participants in Europe in the last 20 years, and the purely epidemiological reporting by team doctors rather than by the surgeons performing the ACL reconstruction, the data are nevertheless unique and from highest interest for surgeons, physicians and teams. The study population, which is quite large for this type of study, certainly represents for the worldwide professional sport the group, where the time pressure and sporting and financial pressure on the players and clubs is enormously high, so that the influence on the timing of surgery, the rehabilitation phase and/or the return to competition is accordingly high. The trend towards a **longer rehabilitation phase being required before players can return to team training** seems to be still an important factor for reducing the pressure on the player. The time period until return to sports/training/match are only indirect indicators and cannot be generalised. In each individual case, it is therefore recommended to provide an individualised regular functional testing battery during rehabilitation after ACL recon-

struction. Especially for professional athletes are repeated functional testing recommended after surgery, once before the general return to sports, the return to team training and the return to competition, respectively. It can also be reasonable to perform follow-up testing also after the formerly ACL injured player has successfully returned on field. These follow up examination can provide important information about the fitness and functional capacities of the player and represent one option to control and accompany the consistent and injury free football playing.

The fact that re-ruptures are more common in **non-contact injuries** of the anterior cruciate ligament may indicate an individual neuromotor weakness, overuse of the musculoskeletal system or an anatomical anomaly in the injured player. This aspect represents highest importance and supports the strategy that injury analysis (video, risk factors, etc.) must be started directly after an ACL rupture in each professional football player occurred and has the clear goal to prevent further injuries after the return-to-competition. Such an analysis of possible risk factors in the case of an ACL rupture is currently rarely or not at all practised even in professional

player, but should be practised in the case of each non-contact rupture and also in other injury mechanism, which are difficult to explain.

The fact that **isolated ACL ruptures** in particular are supposed to be a trigger for re-ruptures seems to be a certain contradiction, because concomitant injuries to other structures of the knee joint, such as ligaments or menisci, usually tend to lead to subsequent problems and remaining instabilities, recurrent complaints or imbalances. However, this topic could be an important message especially for knee surgeons. The critical evaluation of such a risk factor leads to the suspicion that the reported “isolated” ACL ruptures may represent a more complex knee injury type, with principally overlooked concomitant lesions of other knee structures. Accompanying meniscus or cartilage injuries can easily identified and treated by MRI and also during the arthroscopic surgery of the ACL injury and represent therefore not the classic potential for an overlooked concomitant lesion. Rather, it must be discussed if concomitant partial ruptures of the medial or lateral collateral ligaments are not adequately detected or addressed in the primary examination in this context. In particular, if the radiological findings speak for an isolated ACL rupture and without a notice for collateral ligament injuries, the actual clinical stability of the collateral ligament structures and their integrity must be controlled and verified in a clinical examination of the knee. Imaging diagnosis may overlook anteromedial or -lateral as well as posteromedial or -lateral instabilities of the knee, which are frequent concomitant problems in case of an ACL injury. The answer to such a critical evaluation of these results cannot be completely demonstrated with the data set of the UEFA Injury Study, but could be a plausible explanation, which also corresponds to the practical routine in knee surgery.

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DATA OF THE ANTERIOR CRUCIATE LIGAMENT REGISTRY IN GERMAN NATIONAL SPORT

The data of the UEFA Injury Study show how important a detailed epidemiological and sport-specific analysis of injury data is. Many national ACL registries in Europe have the potential for similar analysis and should perform such investigations to their sports and football populations. The ACL Registry of German Sports with their ACL injury data from professional and amateur football, handball, basketball and ice hockey collects such data since the year 2014 and provides results for more than 1.700 ACL injuries. This registry registered almost 18 % of re-ruptures in football player, where professional football player had indeed significantly fewer re-ruptures than amateur footballers, but they returned to football after ACL injury in the mean 140 days earlier than amateurs. The comparison of the different playing level seems to be a direct consequence to the different medical setting, but also indicates that a rate of

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ACL-re-rupture in professional football player cannot necessarily be the result of a too early return to play. Additionally, is the mean return-to-competition time after ACL injury of about 251 days longer than often expected by the football community or the players themselves.

FOOTBALL-SPECIFIC CONCLUSION

It is of great importance that separate and sport-specific analyses should be conducted for amateur and professional sports. The data of the UEFA Injury Study or the ACL Registry in German Sports are essential for appropriate conclusion for the own clinical practice routine. It is a matter of players, clubs and physicians conducting an own analysis of each individual occurred ACL injury. It is important to identify the actual influencing factors for the occurred ACL rupture with the goal to prevent any re-rupture. The (possibly undiscovered) same influencing factors that led to the primary ACL rupture may also increase the risk of re-rupture after return to play.

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NATURAL TREATMENT & CONSERVATIVE TREATMENT FIRST

Current thoughts on the guidelines for osteoarthritis of the knee by Robert Erbelinger, Gerd Rauch, MD and Prof. Götz Welsch, MD

The S2k guidelines on osteoarthritis of the knee (lead author: Prof. J. Stöve MD) have an important and significant role in routine orthopaedic and sports medical practice and are intended to provide key recommendations for doctors [1]. We already discussed this with Prof. J. Stöve, Dr Flechtenmacher, Dr Ellermann and Prof. Herbolt shortly after the guidelines were published in 2018 (sportärztezeitung 04/18, Expert talk on the guidelines for osteoarthritis of the knee [2]).

The guidelines, which are still valid until 29/11/2022, will be updated in the autumn. This topic area is a matter of special significance to us, particularly due to the many discussions we have had with our scientific advisors and other experts at our numerous continuing education sessions, at which users repeatedly came up with requests, providing us with new stimuli, starting points and tips, which we wish to pass on and share, thus offering support.

It is sufficiently well known that the potential of sports medicine has in no way been fully exploited. This applies equally to doing sport and targeted physical activity exercises in prevention/prophylaxis and therapy and to sports medical nutrition based on scientific principles. Dr Patrick Müller, researcher at the German Centre for Neurodegenerative Diseases, Madgeburg, makes the point in the German Magazine for Sports Medicine, for example, that “the fundamentally positive effects of physical activity and sport in the prevention and treatment of numerous chronic diseases have been scientifically proved. In this context, physical activity should be classified as a medicine with the highest level of evidence”. He also says that the potential of physical activity is still significantly underrepresented in the real world of healthcare [3]. In this respect sports medicine can make a contribution that benefits society as a whole regarding both therapeutic rehabilitation and prophylaxis/prevention. It is precisely now under the conditions of the Corona pandemic, which have no doubt entailed considerable difficulties and adjustments for everyone in our country, that sports medicine practitioners and therapists can make positive interventions at all levels – therapeutically, conservatively or surgically, rehabilitatively, prophylactically and nutritionally. This is precisely the best time to integrate sports medicine even more systematically into the real world of healthcare and to increase the benefit for all concerned, from doctors, thera-

pists and sports scientists/trainers to the patients/athletes. This involves, in short, exercise as a subtype of sport, nutrition, conservative and surgical treatment options, prehabilitation, and also the implementation of mental and clinical psychological interventions including relaxation techniques. It is also the very combination of these individual areas, individually adjusted to the patient, that offers enormous potential and enhances the effect overall.

It is not a question of inventing something new. Rather, it is a matter of systematically and efficiently putting well-established strategies into clinical practice. A look at the guidelines for osteoarthritis of the knee reveals a plethora of useful and wonderful templates for the integration and implementation of further innovations and treatment concepts at all levels with the aid of sports medicine. This is precisely why we would like to use this to provide food for thought and thus also to urge practitioners to promote the individual application of the guidelines, use them as a meaningful decision aid and integrate them into routine sports medical practice.

FOCUS ON BASIC TOPICS

In this brief paper we will focus on sport/exercise, weight management, nutrition medicine and inflammation as well as natural treatment as an accompanying measure to conservative treatment. Due to their complexity, we will dispense with comments and explanations regarding injections, PRP/ACP, hyaluron, blood derivatives/BCs and other conservative and surgical treatment options such as shock wave treatment, cryotherapy, laser, electro-physical therapies/TENS and other physical treatment options; their use is already adequately addressed and well presented in the guidelines for osteoarthritis of the knee. Nevertheless, it should be noted that there have also been extremely positive developments in these areas in particular, which reinforce discussions with our scientific

advisors and insights from the current studies available (see also the update to the guidelines for osteoarthritis of the knee). Discussing all these topics here, however, would go beyond the scope of this paper, but they will be further discussed and presented in future articles and papers. We will therefore first address the basic topics stated above and discuss their potential and effects, thus allowing even more evidence-based, individualised and practice-oriented work in these areas.

The crucial role of the doctor and the interpretation of sports medicine and its practitioners should not be underestimated. Looking further afield, this is something that is also observed elsewhere. For example, the S2k guidelines for osteoarthritis of the hip (last revised 2019) point out that the recommendation of exercise therapy by a doctor is the decisive factor in motivating many patients to take up regular training [4]. It is very much the same with nutrition. Here too, doctors and, where applicable, therapists can – and should – make the required recommendation in order to really get things moving, for example regarding the positive effects of weight reduction/weight management (see also [5]). Whatever is recommended should always be agreed upon along with the athlete/patient, as they are ultimately the biggest part of the problem and its solution – compliance vs. “patient laziness”.

Weight management should be supported by concomitant exercise therapy, a change of diet and also nutritional supplements in accordance with the latest scientific findings in sports medicine. This applies especially to both top athletes who, particularly with regard to nutrition, also increase their performance potential by taking nutritional supplements, and above all to elderly patients. It also applies to hospitals, with preoperative and postoperative nutrition management that requires optimising and which, to make matters worse, is often outsourced for cost reasons.

The optimised nutrition of elderly patients with protein and vitamin substitution is also indicated partly in accordance with sports medical guidelines for top athletes, particularly in terms of postaggression metabolism/postoperative recovery. This applies, incidentally, not just for the postoperative part but also for prehabilitation.

WEIGHT MANAGEMENT/NUTRITION

To underline the importance of nutrition in this context once again, we refer at this point to the statement made by Prof. Herbolt in an expert talk on osteoarthritis of the knee in the sportärztezeitung (04/18) [2], which puts it in a nutshell:

“The topic of weight reduction is in my opinion one of the most important, but also one that is most frequently misunderstood and underestimated. The potential of weight reduction is often dismissed by patients as trivial. It should, however, be more or less the basis for many orthopaedic measures, as the effectiveness of both conservative and surgical measures is dramatically reduced if weight is not kept within normal limits. Osteoarthritis treatment seeks to compensate for the degenerative process in the joint, alleviating the symptoms despite sometimes massive degeneration. An important element of this compensation is most certainly mechanical loading, which is substantially influenced by body weight or the weight force. The biggest mistake in my opinion is just the trivialisation of the problem of weight and its treatment. Treatment should be conducted by professionals under interdisciplinary medical supervision and above all with support. The recommendation “to be simply be a little more disciplined “ should be considered negligent and frivolous.”

This issue is also an important factor particularly in osteoarthritis of the knee, as is also stated, for example, in the S3 guidelines for evidence and consensus-based indication criteria for total hip replacement in osteoarthritis of the hip. Here it is stated that although there is no direct evidence that weight reduction has an effect in osteoarthritis of the hip, an effect has been proved for osteoarthritis of the knee, which would therefore seem biomechanically plausible for osteoarthritis of the hip as well [6]. In the course of discussions and literature searches, we also came across a small practice-oriented Australian study in which it was shown that video-based, telemedical individualised training and weight loss programmes/meal replacement with online educational support improved pain and function in overweight or obese patients with osteoarthritis of the knee [7]. This is just one example of current work in modern weight management. In this context, a BIA measurement to record body composition might also be useful in connection with meal replacement, as shown in an as yet unpublished study by Dr Manfred Claussen on outpatient weight reduction in medical practice

using meal replacement therapy (will be published in Current Nutrition Medicine, Thieme Verlag). The results of this study will be presented in the next newsletter of the sportärztezeitung.

These recommendations should of course also be implemented in orthopaedic and trauma surgery practices. We shall take a look here at an orthopaedic practice (MVZ OCP Kassel Lichtenau gGmbH) and the work as team doctor for MT Melsungen, a team in the German handball league, to give a small insight into what this can involve and how it can be done. In recent years, and particularly in elite sport, there has been a distinct increase in performance in both individual and team sports. The reasons are manifold: optimised training methods and regeneration cycles (which unfortunately are often not observed often enough in professional sports due to deadline pressure); the implementation of holistic athletics training; and improvements in sports physiotherapy and sports medical support, in terms of both orthopaedics, trauma surgery and general medicine and internal medicine/sports cardiology. Other performance-enhancing opportunities have also been achieved in recent years particularly for individually adjusted, sports nutritional reasons and have been implemented by many athletes, and especially by professional clubs with new nutrition concepts. In addition to nutrition optimisation in terms of content and time and the corresponding laboratory monitoring, targeted vitamin and trace element substitution, and especially also protein supplementation, are adjusted to the rhythm of both daily and seasonal competition. Of course, these sometimes also very costly measures in high-performance sports medicine are not directly transferable on a one-to-one basis to other areas (for example, elderly, multimorbid osteoporosis patients with a fracture of the femoral head). However, a large number of the aspects stated can also be implemented cost-effectively and for many patients, particularly the elderly. This includes preventive exercise therapy, including fall prevention for the elderly, and counselling for the overweight with a subsequent change of diet and weight reduction or, where applicable, protein supplementation. All of this can also be implemented at home and in old people's homes, as well as in groups. Reference has already been made above to optimising nutrition for hospital patients. Orthopaedic and trauma surgery practices should most certainly provide patients, particularly those with symptoms of osteoarthritis of the knee and who are overweight, with advice about weight reduction, change of diet and exercise. In the latter case, for example, this might involve a change of sport (from the age of 55 onwards exercise more on a bicycle instead of only running), going to fitness studios and sports clubs, training at home with modern exercise therapy apps, such as Ortho Hero, available on prescription, and finally, of course, rehabilitation sport, which can also be prescribed by a doctor.

NATURAL TREATMENT FIRST INCLUDING PHYTOPHARMACEUTICALS, EXERCISE AND SPORT

At the same time, the further development of non-drug therapies should also be considered. Natural Treatment First, including phytopharmaceuticals, serves as a supplement and accompanying measure to traditional drug therapies and their use. With this expansion and the developments in this area, such options will be used in an even more targeted manner in future. In this respect, self- and home care in particular, always in consultation with the doctor and therapist, also has considerable potential to counteract drug misuse or also simply incorrect use. In recent months, more and more studies have been published on oral enzyme combinations and also in relation to undenatured type II collagen and other anti-inflammatory foods/phytopharmaceuticals and nutrition - an area which is continually growing and improving in quality. In overview, suitable and worth mentioning in this context are papers by Klein et al. (2006) [8], Egerton et al. (2022) [9] and the article by Pöttgen/Hotfiel on anti-inflammatory nutrition in the sportärztezeitung (2018) [10]. Equally worth recommending are papers by Liu et al. (2018) [11], and also the study initiated and already applied for by our advisor Dr Paul Klein and co-workers on the effect of the oral intake of UC-II on pain and function in patients with osteoarthritis of the knee compared to placebo. The initial results will be presented in the sportärztezeitung.

An even greater effect is achieved in combination with targeted sport (exercise), to which reference is made, amongst others, in the guidelines for osteoarthritis of the knee in subsection 5.2 Physiotherapy/exercise therapy, recommendation 1: “Exercise therapy measures for strength, endurance and mobility training should be used for the first-line treatment of osteoarthritis of the knee” [1]. Subsection 5.2.3 stresses the importance of combined programmes: “Exercise therapy interventions should be conducted in combination with educational interventions for pain relief“. [1] Patients should, however, receive professional guidance and the training must be individually adjusted, which falls within the scope of sports scientists and specialist physiotherapists. This is also stated, amongst others, in the guidelines for osteoarthritis of the hip: “Land-based exercise therapy is the core element of conservative, non-pharmacological treatment of osteoarthritis of the hip. Training should initially be conducted under the guidance of a physiotherapist or another professional group engaged in exercise therapy. Exercise therapy contributes to pain relief, improved function and quality of life in patients with osteoarthritis of the hip. (...) It is recommended to conduct training initially under professional guidance“. [4] Further on, it is stated in recommendation 4.4 that “Instruction should be given for self-management during training. This should include guidance in pain management skills and tech-



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ROBERT ERBELDINGER



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niques, relaxation and encouragement to perform regular exercise (strong consensus)“ [4]. In Australia, exercise physiologists (exercise therapists), whose services are available on prescription, have been engaged as trainers/experts to excellent effect in the treatment of diseases that are sometimes even more serious than osteoarthritis, including even cancer, and are a further good option in the treatment strategy of patients.

The topic of sport and osteoarthritis of the knee in particular is, however, still often misrepresented. There is also increasing scientific evidence that targeted sports activity can be viewed as having a positive effect on the course of osteoarthritis of the knee. A longitudinal study, conducted as part of the OA initiative, has shown that jogging, for example, is not a factor driving osteoarthritis, but has in fact positive effects on pain development [12]. Even elderly osteoarthritis patients can accordingly still benefit from strength training of the lower extremity [13] and both pain and joint function can improve with targeted training [14]. The resulting

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improved quality of life and pain reduction in patients with osteoarthritis of the knee – without recourse to drugs or surgery – have been demonstrated in many meta-analyses [13, 14] and doctors and therapists should focus more on them. It is therefore our task to emphasise the positive link between sport and osteoarthritis of the knee and exhaust all the available modalities. It is particularly the combination of individualised training/sport and weight management and nutrition that provides the greatest opportunities for the treatment of osteoarthritis of the knee and hip. The new guidelines for osteoarthritis of the knee can be used for this purpose for the benefit of our patients.

Where the emphasis is put and which particular combination is meaningful and useful must always be determined anew in each individual case. The discussions between the doctor, therapist, trainer, patient and athlete play a particularly decisive role here. The aim of the uniform assessment standard (EBM) 2020 is to promote better doctor-patient communication. However, to many doc-

PROF. GÖTZ WELSCH, MD



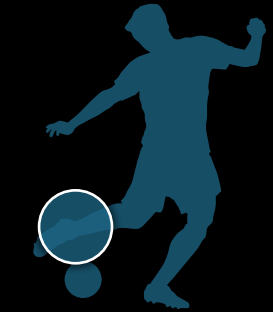
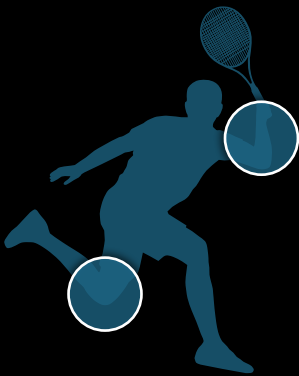
is an orthopaedic and trauma surgery consultant and medical director of the UKE Athleticum at the University Hospital of Hamburg Eppendorf. He is also the lead team doctor of the Hamburg football club, HSV. His clinical focus is regenerative cartilage therapy, the treatment of sports injuries and overuse damage.

tors in clinical practice it is not completely clear how they can invoice this “verbal medicine” in accordance with the statutory scale of fees for physicians (GOÄ) and the EBM. Good invoicing options are available, however, to which the German Association of Medical Practitioners in Private Practice (Virschowbund) refers [15]. The guidelines for osteoarthritis of the knee provide sufficient leeway in their high-quality explanations – this must be specifically implemented in clinical practice and then expanded and supplemented, where appropriate, with new findings from science and practice. All parties are urged to follow this course. Let us continue to support the guidelines (both the current and updated guidelines for osteoarthritis of the knee) and the outstanding work by the doctors contributing to them, learn from one another, make connections and further develop the real world of healthcare with good sports medical therapy. It is our mission to provide even more specific recommendations for action in these areas.

The literaturliste can be found at the Article on www.sportaerztezeitung.com

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PROFESSIONAL SPORT

better injury prevention through radial extracorporeal shockwave therapy

Injuries are always inconvenient, especially in elite sport. And soccer is no exception. Around 30 percent of soccer injuries are muscle injuries, which can lead to long lay-offs. One treatment method that is increasingly attracting the interest of medical professionals is radial extracorporeal shockwave therapy (rESWT).

Originally conceived for the treatment of tendinitis, it has also been used for some years now to treat acute muscle injuries such as contusions, strains, or even structural injuries like muscle tears. Professor Christoph Schmitz and

James Morgan, Head of Physiotherapy, Rehabilitation, and Prevention at St. Pauli soccer club and visiting fellow at LMU Munich, have carried out a retrospective analysis of rESWT as used to treat acute muscle injuries in elite sport. For this purpose, they investigated the success of this treatment method by means of a retrospective analysis of its application at one soccer club in one season. The name of the club, which comes from either the first or the second division of the German Bundesliga, and of its players have been kept anonymous.

When professional soccer players get injured, they receive multi-stage treatment. The watchword here is “multi-modal,” as soccer clubs do not rely on just one methodology, but combine various approaches. In addition to cryotherapy – that is, treatment using extremely cold temperatures – the clubs also employ manual therapies to get patients back in action as soon as possible. After all, this is what counts in professional sport: rapid rehabilitation to get players back on the pitch and into the next match. At the same time, it is vital that the player does not suffer any setbacks. This is where rESWT comes into its own, as it is used in addition to other treatments and can significantly shorten player absences: “Depending on the type of injury, lay-offs were shortened by up to 50 percent in our observations,” explains the physiotherapist Morgan. This applied particularly to contusions and strains. Structural injuries generally needed a bit more time, but even here there was a 20-percent reduction in the average lay-off.

SHOCKWAVE RESEARCH

Extracorporeal shockwaves are single acoustic pulses that pass through soft

tissue such as skin and fat almost without energy loss. They are stopped only at the surface of muscle, where they activate the cell receptors located there. In medicine, this is called mechanotransduction. Repeated treatment with shockwaves stimulates the blood supply at a microscopic level. This results in the formation of new capillaries, the smallest blood vessels in humans. In the tendon sheaths and fasciae, a fluid is responsible for keeping the tendons lubricated. To this end, the molecule lubricin binds to water. This molecule is produced by the body only when the person moves. Through shockwave therapy, production can be stimulated, which makes a decisive contribution to injury prevention. “In the medical field, extracorporeal shockwaves were initially used above all for removing kidney stones,” explains Professor Schmitz. This was until researchers at LMU and other institutions discovered by chance that the shockwaves were able not only to remove the stones, but also to positively stimulate the bones or muscles behind them and even to relieve pain. For some ten years now, LMU has been an international pioneer in the application of rESWT to treat muscle injuries.

PREVENTION

In the retrospective analysis of shockwave treatment on players, the researchers made a valuable discovery. As Professor Christoph Schmitz explains, the therapy also achieved outstanding results in so-called secondary prophylaxis; that is to say, the treatment of existing muscle injuries. “This was the really exciting bit of the study,” says Schmitz. “We discovered that players with light muscle injuries did not pick up any further heavy muscle injuries in the course of the season when they were consistently treated with rESWT.” Players undergo rESWT treatment every second day at least. “The therapy can be individually adapted,” reports Morgan. “The goal is to go as close to the pain barrier as possible, because that’s when it’s at its most effective.” The therapy is extremely beneficial

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in the case of initial contusions or muscle stiffness, he adds, in order to prevent worse injuries such as muscle tears.

USE AT THE OLYMPIC GAMES

“Incidentally, rESWT is not just used in professional soccer,” explains Schmitz. Other professional sports also regularly use this form of therapy. “In 2012, I was at the Olympic Games in London, where I treated athletes with shock waves,” recalls Schmitz. And the therapy was also used at this year’s Winter Olympics in China: “Just recently, I underwent rESWT therapy, which quickly and successfully cleared up my muscle injury,” says bobsleigh pilot Melanie Hasler, who represented Switzerland at the Olympic Games in Beijing. “If not for this therapy, I wouldn’t have been able to take part in the rest of the Bobsleigh World Cup this season.” Chief physio for the Swiss bobsleigh team, Felix Zimmermann is also a member of the international team of experts led by Professor Schmitz for the use of rESWT to treat injuries and diseases of the musculoskeletal system.

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TENDON REGENERATION WITH FRESH, UNCULTURED, UNMODIFIED, AUTOLOGOUS ADIPOSE-DERIVED REGENERATIVE CELLS ISOLATED AT THE POINT OF CARE

A short update of the current status

PROF. CHRISTOPH SCHMITZ, MD / LMU MUNICH
PROF. NICOLA MAFFULLI, MD / QUEEN MARY UNIVERSITY OF LONDON



When talking about regenerative medicine in general, and stem cells in particular, it is necessary to clarify at least some of the aspects of the physiology of these cells. Many lay people automatically think of embryonic stem cells when "stem cell therapy" is mentioned, but in reality at present no clinical application exists for embryonic stem cells.

This is based not only on ethical concerns and the risk of development of certain tumors derived from embryonic stem cells, but also on the fact that these cells are not the patient's own cells. This may cause transplant rejection reactions, and prevent integration of cells derived from embryonic stem cells into the host tissue. Even for so-called induced pluripotent stem cells (iPS cells) clinical applications are missing, not only for the complexity of the procedure, but particularly based on the risk of the development of cancer by these cells.

To better understand the general idea behind the application of stem cells in regenerative medicine, one should realize that, under physiological conditions, maintenance and restoration of organ function is mostly achieved by local cells, including so-called tissue resident stem cells. However, in the event of acute trauma or disease, the sudden demand of new cells during the healing response may exceed the plasticity of the local cell populations. Furthermore, the ability of the tissue resident stem cells to re-enter the cell cycle and to asymmetrically divide is limited: this eventually limits the extent of self-renewal (and, thus, the self-healing power of the body) following major loss of cells in damaged tissue.

However, there is a further type of stem cells present in the adult body, with the potential to develop (differentiate) into cells of all three embryonic germ layers (ectoderm, mesoderm, endoderm). These cells, which are termed vascular

associated pluripotent stem cells (vaPS cells), are located in the walls of small blood vessels. Since blood vessels are the basis for the formation of tissue and organs in a developing body, these vaPS cells are also found in every organ of the adult body. It is currently unknown to which extent these vaPS cells participate in the physiological maintenance and restoration of organ functions. In any case, unlike embryonic stem cells and iPS cells, vaPS cells do not have their own, intrinsic program for the formation of new tissue, but become active in response to specific signals released and transmitted by diseased tissue. Considering this fundamental difference, the vaPS cells have become an attractive option for regenerative therapy purposes without the risk of malignant transformation.

As long as the aforementioned local self-healing power of the body is sufficient to restore physiological body structures and functions in the event of trauma or disease, all treatment efforts should primarily focus on this. A variety of methods, including but not limited to physiotherapy, osteopathy, extracorporeal shock wave therapy (ESWT), laser therapy and the injection of platelet-rich plasma (PRP), can make valuable contributions through stimulation of local regeneration.

However, a patient's body's localized self-healing power can eventually exhaust. As a consequence, physiological body structures and functions can no longer be restored by the local stem cell pool. If this happens in the musculoskeletal system, further conservative measures will have a high risk of failure. In essence, one can treat the patient with as much physiotherapy, ESWT, laser or other modalities as desired, and one can inject as much PRP as one wishes and patients request: these interventions will not work, or they only work to a limited extent because the cells that are supposed to effect the repair are simply not there any longer, or cannot adequately react to stimulation.

This is exactly where the targeted use of the body's own vaPS cells comes into play, because they can be harvested and isolated from the body's own adipose tissue. Practically every one of us has a certain amount of body fat, which the organism can spare, and which can be obtained by mini-liposuction on the abdomen, the flanks or the thighs in an outpatient procedure with low risk and without general anesthesia; 100 grams of adipose tissue are sufficient in most instances. Adipose derived regenerative cells (ADRCs) (which contain the vaPS cells) can then be isolated from the adipose tissue using relatively simple technologies. ADRCs are a mixture of cells including vaPS cells, progenitor cells, cells of the walls of the blood vessels (pericytes, endothelial cells, endothelial precursor cells and fibroblasts) and blood cells. Until a few years ago, it was thought that it was important to isolate the stem cells from the ADRCs in the next step and to multiply them in the laboratory (i.e. in cell culture) before using them therapeutically.

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YOGA AS STRESS MANAGEMENT
Prof. Tobias Esch, MD / Steven Koch



UPDATE: MUSCLE INJURIES
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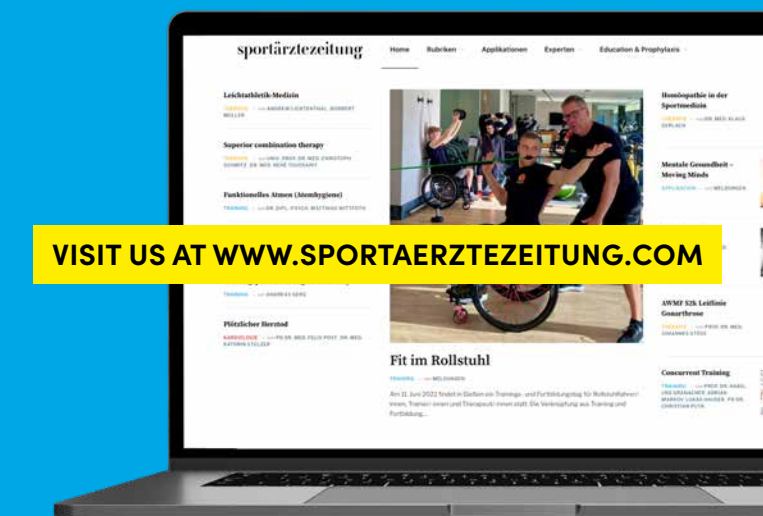
DOCTORS AND THE MEDICS
Gavin Blackwell



ORTHOBIOLOGICS FOR TENDINOPATHIES
Christian Teusch / Christian Derveaux



SUDDEN CARDIAC ARREST IN FOOTBALL
Andrew Massey, MD



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is one of the world's leading clinical and academic experts in tendon pathology and regeneration, with academic affiliations in Italy (University of Salerno) and the UK (Queen Mary University of London, London, England; Keele University School of Medicine, Stoke on Trent, England). Dr. Maffulli's unique expertise is documented by >1400 publications listed in PubMed, among them 600 addressing tendons.

peutically, resulting in so-called adipose derived stem cells (ADSCs). However, there is now good evidence that uncultured ADRCs are superior to cultured ADSCs for regeneration of tendons and bone. One of the reasons for this is that uncultured ADRCs contain cell types that can no longer be found in cultured ADSCs.

The use of fresh, uncultured ADRCs instead of cultured ADSCs has two other important advantages for the patient: (i) as the cells are not cultivated in a laboratory, the possible risk of contamination by bacteria and viruses is avoided, and (ii) treatment with uncultured ADRCs is a real point of care procedure. Within a very short time span and in the same surgical setting, the adipose tissue can be obtained by mini-liposuction and the ADRCs can be injected to the point in the body where they are needed.

As evidenced by a large number of animal studies, treatment of pathologies of the musculoskeletal system with ADRCs is safe (i.e. does not lead to the development of cancer and other undesirable side effects) and treatment with ADRCs or ADSCs leads to a significant improvement of the structure and function of a damaged organ or tissue. Based on these highly positive results, treatment of human patients specifically with uncultured ADRCs started a few years ago. Both of us have been involved in a feasibility study approved by the U.S. Food and Drug Administration (FDA), that demonstrated for the first time that in patients suffering from symptomatic, partial-thickness rotator cuff tear (sPTRCT) who had not responded to over six weeks of conservative management, a single application of ADRCs led to rapid and long-lasting improvement in the clinical situation, with an improvement in the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) total score from 58.7 ± 19.2 (mean $\pm$ standard error of the mean)

before treatment to 86.1 ± 4.9 at 24 weeks post treatment and 89.4 ± 4.9 one year post treatment (Hurd et al., J Orthop Surg Res 2020;15(1):122). The results of a control group of patients treated with corticosteroid injections (a standard therapy for the condition at hand) were statistically significantly worse than the results of the patients treated with ADRCs (in the control group the mean ASES score was 50.6 ± 6.7 before treatment, 60.8 ± 6.2 at 24 weeks post treatment and 68.4 ± 4.4 one year post treatment). In retrospect, the poor performance of the standard therapy (injection of corticosteroid) is not really surprising when it becomes clear that, when the local self-healing power of the body is exhausted, the injection of corticosteroids certainly leads to reduction of inflammation (and thus pain relief) in the affected shoulder, but cannot result in healing. To verify the results of this initial safety and feasibility pilot study in a larger patient population, a randomized controlled trial on 246 patients suffering from sPTRCT is currently ongoing.

Of note, no special follow-up treatment is necessary after the application of ADRCs. Accordingly, patients can return to routine care immediately after the application of ADRCs.

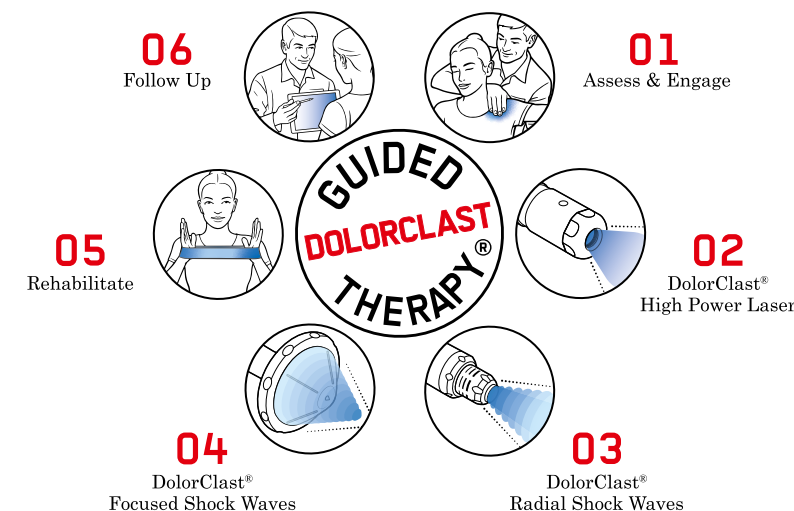
SUMMARY

In summary, the use of ADRCs in the management of pathologies of the musculoskeletal system (including tendons) seamlessly fits into modern orthopedic treatment concepts. The patients receive treatment with their own body's self-healing power, which is just recovered and transferred from one "healthy" site to another site of the body in need for repair. This reflects a natural and intrinsically existing mechanism of the body, to mobilize stem cells from adipose tissue (however, in often not sufficient amounts) and transfer cells for "self-healing" to damaged organs and tissues in need for repair.



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INFRARED THERMOGRAPHY

Examples of use in orthopaedic and sports medicine disorders

STEFAN MATTYASOVSKY, MD /
GALENOS ORTHOPAEDICS AND SPORTS MEDICINE, MAINZ

The diagnostic value of body temperature has been known for centuries. Disorders such as encephalitis (symptoms: fever, tremor, seizures, confusion, delirium, anxiety and vomiting) were even described by Hippocrates and Galenos in ancient Greece. Body temperatures that are too high or too low affect metabolism, metabolic processes and organ function and can even damage tissue.

Infrared thermography has long been used in veterinary medicine as a routine diagnostic procedure (see the book by Barbara Bockstrahler MD: Physical medicine, rehabilitation and sports medicine in a nutshell – VBS (publisher) 2019). In just a few seconds it allows the visual assessment of internal inflammation in animals, compensating postures, impaired gait, hoof disorders, painful pressure points and muscle and joint inflammation. Based on these findings in veterinary medicine, we began to use this procedure two years ago in the diagnostic assessment and rehabilitation of muscle injuries in professional football and have now also integrated

infrared thermography as a complementary imaging procedure into our routine clinical practice for the clarification of musculoskeletal and neurological disorders. Case studies follow below as an illustration.

CASE STUDIES

CASE 1 (SEE FIGS. 1 + 2)

A 58-year-old female marathon runner presented with pain around the insertion of the right Achilles tendon. Clinical examination and imaging (ultrasound, X-ray and MRI) showed Haglund's deformity with a partial tear in the deep layers of the Achilles tendon at the calcaneal insertion. Under ongoing treat-

ment, the patient complained of sciatica on the right without a sensory motor deficit after returning to full sports loading. Clinical examination and imaging showed a facet joint cyst at L4/5 on the right with marked narrowing of the spinal canal on the right and nerve root compression at L5 and S1 on the right.

CASE 2 (SEE FIG.3)

A 34-year-old male patient with bilateral cam-type femoracetabular impingement. Due to the lack of success under conservative treatment, hip arthroscopy was performed on the right with debridement of the torn labrum and offset restoration (removal of a bony hump).

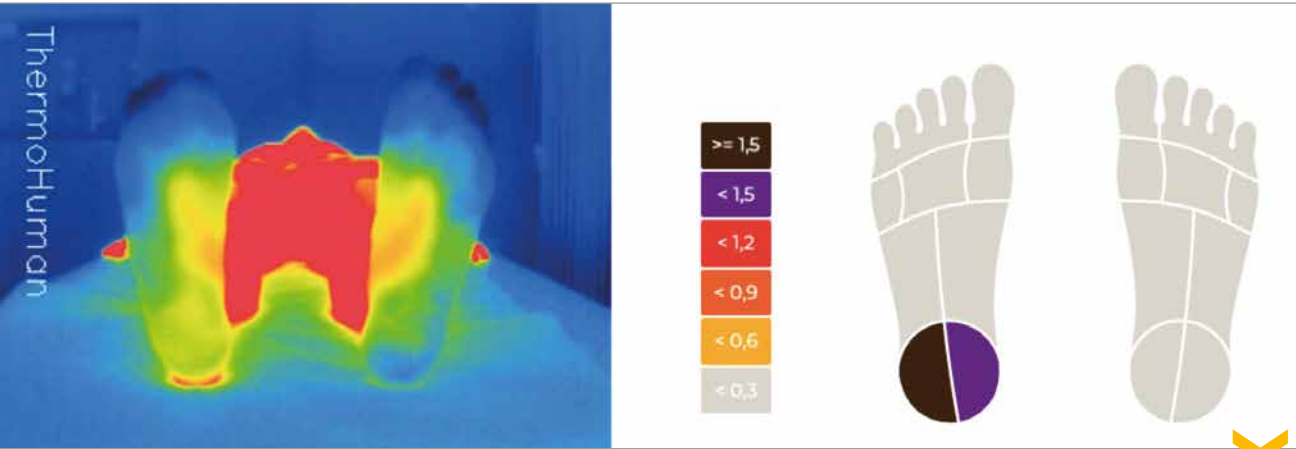


FIG. 1 Infrared thermography of the soles of both feet. Thermographic images assessed using the Thermohuman software, camera: X4Vlson by HT ITALIA SRL. Temperature difference between the right and left heel, 2.19°

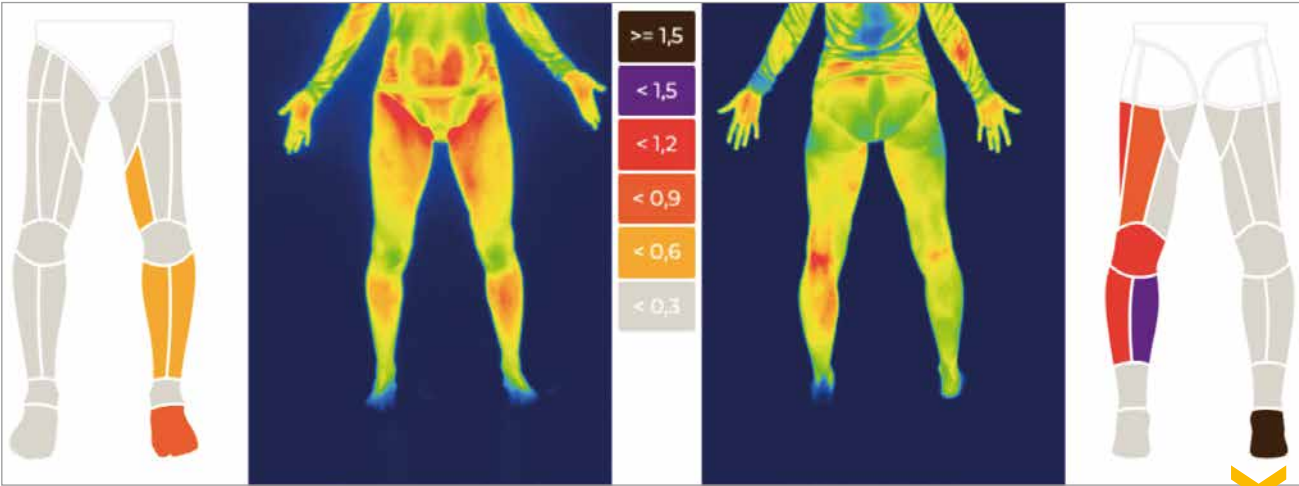


FIG. 2 Thermography of both legs. Six weeks post microsurgical root decompression at L5 on the right and resection of a facet joint cyst at L4/5 on the right. Although the patient was entirely free of pain, a temperature difference between the medial left and right gastrocnemius was still detectable (1.2 – 1.5°). Temperature around the Achilles tendon insertion and the heel markedly warmer on the right than on the left (2.5°)

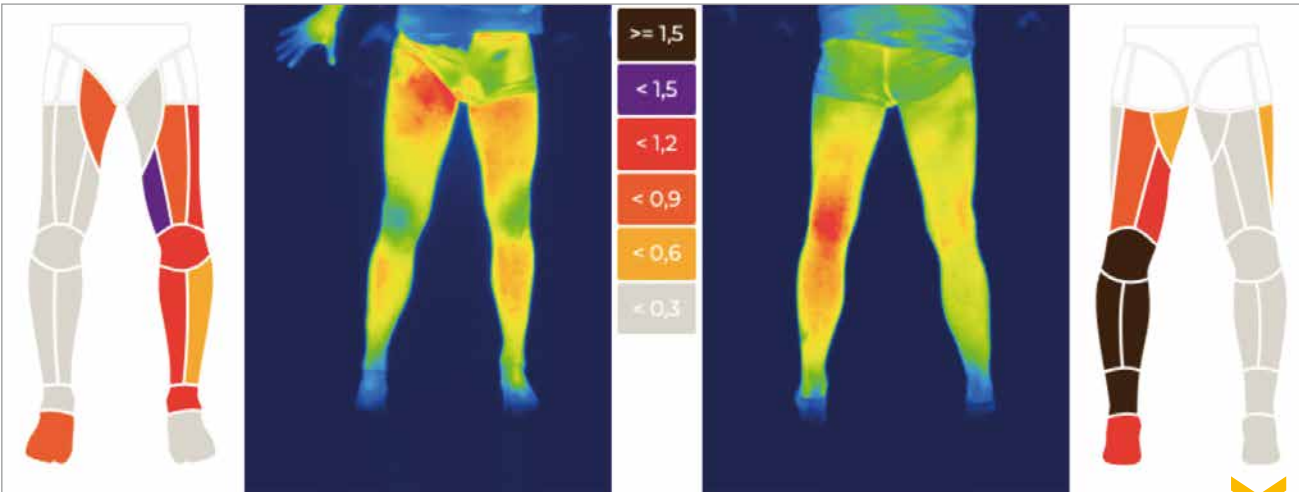


FIG. 3 Thermography of the legs on suture removal twelve days post-surgery with partial weight-bearing on the operated right leg (sole contact, approx. 15 kg). Postoperatively, abnormal warmth in the area operated on still detectable in the right hip and groin. On the other hand, the temperature of the entire right leg under partial weight-bearing on the rest of the thigh and lower leg is lower than that of the left leg under full weight-bearing (0.42° – 2.14°).

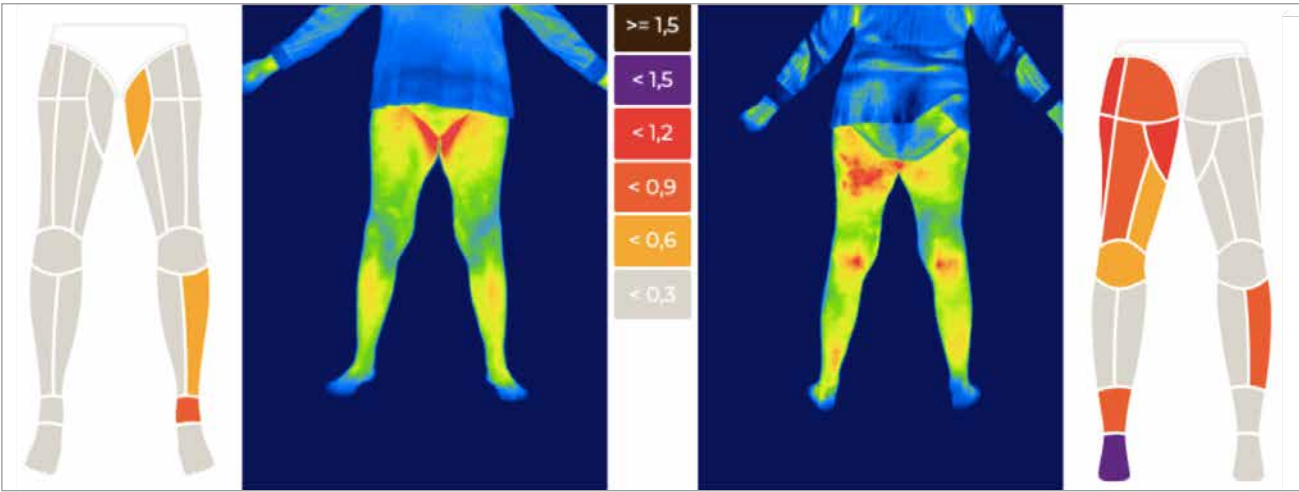


FIG. 4 Thermography of both legs shows a temperature difference between the left and right dorsal thigh (0.8 – 1.06°). The temperature difference between the right and left heel is 1.38°.

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CASE 3 (SEE FIG. 4)

An 80-year-old female patient with activated osteoarthritis on the left confirmed by imaging and immobilising pain under weight-bearing. Alleviation of the symptoms under conservative treatment.

CASE 4 (SEE FIG. 5)

A 48-year-old male runner with ongoing heel pain for the previous six months. Clinical examination and imaging (MRI) confirmed the diagnosis of plantar fasciitis with a degenerative partial tear of the plantar tendon at the calcaneal insertion.

CONCLUSION

Infrared thermography provides us in our orthopaedic and sports medicine practice with a complementary imaging procedure that is fast, non-invasive, painless, objective and above all radiation-free. The colour-coded visualisation of slight differences in skin temperature and the specialist Thermohuman software (camera: X4V Ison by HT ITALIA SRL) allow assessment of thermographic images that is easily standardised. In an

online article in the sportärztezeitung, the sports scientist Kornelius Kraus MD wrote about his many years of experience in infrared thermography as an assessment method for sports medicine and performance physiology (www.sportaerztezeitung.com/rubriken/therapie/10735/infrarotthermografie/). This included the finding that pain correlates with coordination deficits and that the ability to relax was poorer in the warmer hamstrings (Kraus 2019). To date, the diagnostic interpretation of the images depends to a great extent on the investigator and requires experience. In our view, infrared thermography has the potential of becoming a valuable and innovative complementary imaging procedure in orthopaedics and sports medicine alongside established diagnostic procedures such as ultrasound, MRI and electromyography. To date, there have been no randomised prospective studies comparing the informative value of this procedure with that of other imaging procedures. Well-designed studies are required to further investigate the value of this imaging procedure in musculoskeletal diagnostics.

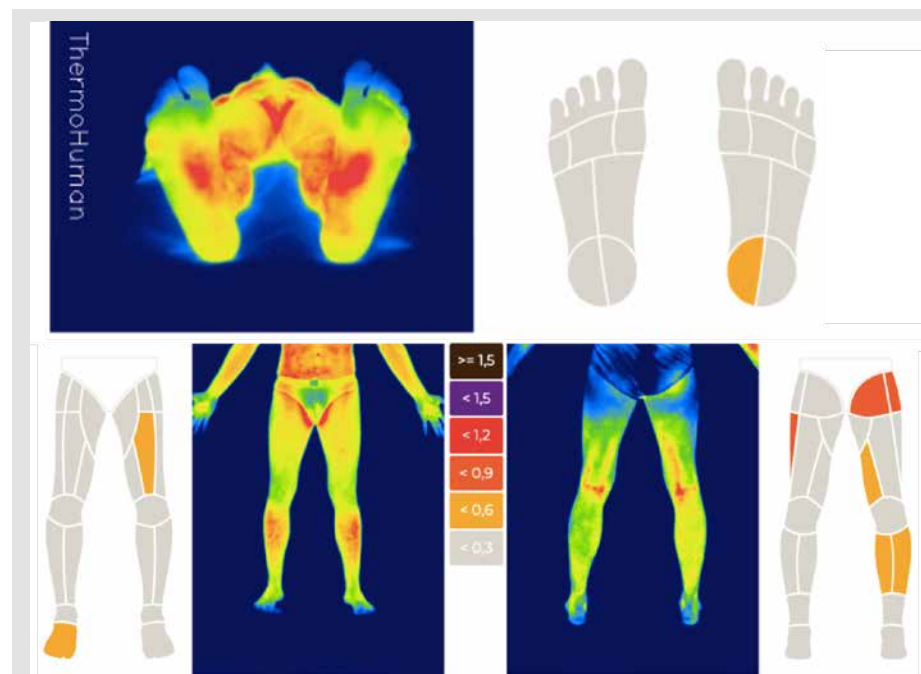


FIG. 5 This shows a rise in temperature around the medial left heel (1.13°). On the other hand, the temperature around the left calf is lower, possibly indicative of pain-induced compensation (0.53°)

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DISCOGENIC BACK PAIN

ACP treatment for degenerative intervertebral discs

PROF. CHRISTIAN WOICIECHOWSKY, MD / SANSSOUCI HOSPITAL, POTSDAM

In a disease burden study conducted by the Robert Koch Institute between October 2019 and March 2020 (BURDEN 2020) 5,009 adults were questioned about the frequency and intensity of back and neck pain. It was shown that 61.3% of those questioned had suffered from back pain in the previous 12 months.



Lower back pain was about twice as common as upper back pain; 15.5% of those questioned said they suffered from chronic back pain [1]. The causes of back pain are manifold. A distinction is drawn between specific and non-specific back pain. In the SK2 guidelines on specific lumbar or back pain, lumbar discogenic pain syndrome is mentioned alongside others as a separate entity in vertebral osteochondrosis, i.e. intervertebral disc-induced back pain [2].

DEHYDRATION OF THE INTERVERTEBRAL DISCS

Intervertebral discs consist of a soft, inner gel-like core (nucleus pulposus) and an outer fibrous ring (annulus fibrosus). The ideal combination of a soft core and an outer ring acts as a cushion. In the course of life, however, the core dehydrates, i.e. loses water and "shrinks" (in much the same way as a grape becomes a raisin). The cause is a decline in chondrocytes, which produce chondroitin sulphate and proteoglycans. These molecules have a high water-binding capacity. The loss of these molecules leads to dehydration/drying out of the intervertebral disc, a process which is known as discopathy. The wear-and-tear process is readily visible in an MRI. The modified Pfirrmann grading system is generally used to assess the severity of discopathy. It defines 8 grades of severity [3]. It has been shown in various studies that discopathy is far more common in elite athletes than in non-athletes (75% as opposed to 31%) [4]. This seems to be especially the case in sports involving rotation of the upper body (tennis, baseball, golf) and in those that tend to cause hyperlordosis (butterfly and breaststroke in swimming) particularly if training begins in early childhood and adolescence [4–6].

TREATMENT OPTIONS

Initial treatment for discogenic back pain, usually associated with reflex muscle tension, involves physiotherapy and pain medication, but may also include shock wave therapy, acupuncture etc. Both anti-inflammatory nutritional supplements (e.g. Omega 3 fatty acids, turmeric, ginger, chilli and Indian frankincense) and special products such as glucosamine,

chondroitin and MSN are suitable supporting treatments. Micronutrients, which protect against oxidative stress, enzymes such as papain and bromelain and secondary plant metabolites (flavonoids and carotenoids) can support the healing process. To reduce loading on the intervertebral discs, delordosing back braces such as the Aspen Elite Active + are suitable specifically in the damaged lumbar area. This often results in an improvement in the symptoms. However, should the acute pain become chronic, the question then arises as to what other treatment should then be considered. Various destructive intradiscal procedures, such as intradiscal electrothermal therapy (IDET), nucleoplasty and percutaneous endoscopic laser discectomy, have been attempted. Success with these procedures has been limited in most cases, and there is also the added disadvantage that the destruction involves the removal of vital chondrocytes, which tends more to accelerate the wear-and-tear process [7]. It is for this reason that the use of biologics is increasingly being tested in clinical practice to achieve long-term alleviation of the inflammation and some degree of repair of the intervertebral discs. Biomolecular, cell-based and tissue-engineering strategies are followed, depending on the severity of the intervertebral disc damage [8]. With regard to biomolecular procedures, most of the clinical experience has been with the intradiscal application of platelet-rich plasma (PRP). Unlike other platelet-rich plasma products, the autologous conditioned plasma (ACP) used here has a low concentration of white blood cells (e.g. neutrophil granulocytes), which can hinder the healing process at high concentrations. ACP is a blood concentrate that contains natural concentrations of growth factors and cytokines and which is currently widely used in clinical settings for tissue regeneration and repair. It has the great potential of stimulating the cell proliferation and metabolic activity of intervertebral disc cells. Several studies have shown

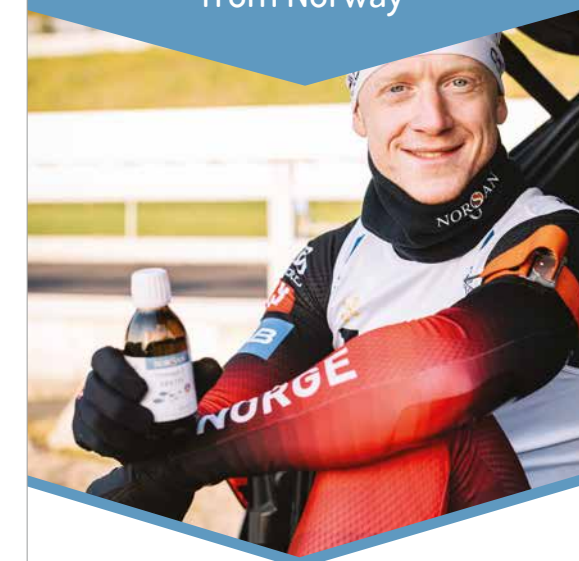
that an injection of platelet-rich plasma products into degenerated intervertebral discs can restore structural changes and improve matrix integrity. Furthermore, they can restore intervertebral disc height, initiate the healing of annular lacerations and have an anti-inflammatory effect by down-regulating inflammatory factors, thus helping reduce pain and improve bodily function [9, 10]. The platelet-rich plasma product ACP is collected by separating the patient's blood in a centrifuge. Venous blood is withdrawn using the special ACP double-syringe system, which allows rapid sterile separation and plasma collection with a 2-3-fold increased platelet concentration within a safe, closed system.

CASE REPORT

A 29-year-old recreational athlete (football) complained of back pain. The symptoms showed no signs of improvement despite conservative treatment with physiotherapy and pain medication. The patient complained of load-induced pain of 6 on the numerical rating scale (NRS) of 1–10. MRI was accordingly indicated. This showed grade IV discopathy at L4/5 and 5/S1 on the modified Pfirrmann scale [3]. There was also a high-intensity zone (HIZ) representing a fissure/tear in the posterior annulus at L4/5 (Fig. 1). High-intensity zones are a phenotype that shows as a hyperintense area of the intervertebral disc in a T2-weighted (T2W) MRI and which has been described as a potential imaging biomarker for identifying symptomatic intervertebral discs [11]. We consequently conducted provocative discography at L4/5 and 5/S1. Puncture of the intervertebral disc was performed in the trajectory/coaxial view. The patient lies in the prone position. The lumbar spine is delordosed with a roll. The entry point for the cannula is then marked. This involves positioning the image converter towards the centre of the intervertebral disc. For this, the base plate and cover plate are placed parallel to each other in the anterior-posterior

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**PROF. CHRISTIAN
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is a neurosurgeon and sports medicine practitioner and is specialised in the minimally invasive, endoscopic and regenerative treatment of back pain. He is a trainer in spinal endoscopy and a university professor at the Charité University Medical Hospital, Berlin. He conducts clinical and experimental research in intervertebral disc regeneration.

(ap) beam view. The image converter is then swung to one side by approx. 45°, so that the annulus in the dorsal region is in the Parviz Kambin triangular safe zone (Fig. 2). We use coaxial cannulas size 23G/0.6, 100 mm or 21G/0.8, 120 mm for puncturing. These allow good guidance and their fineness significantly reduces the risk of nerve damage. Antibiotic prophylaxis is performed with Ampicillin 1 g iv 30 minutes before the procedure. The puncture is performed under sterile conditions. The position of the cannula is monitored in the ap beam and lateral beam view. Once the cannula is in the correct position in the centre of the intervertebral disc, contrast agent is applied via an injection pressure monitor to semi-quantify the opening pressure. Depending on the pressure, approx. 1 – 1.5 mL contrast agent is applied intradiscally. This results in a further increase in pressure and, with a positive outcome, in typical memory pain, i.e. the pain the

patient otherwise also feels during corresponding pain attacks (Fig. 3). The contrast agent should not drain out, i.e. the fibrous ring should be closed so that the ACP also remains within the disc.

This manoeuvre was performed in our case study, thus allowing the intervertebral disc to be identified as the pain generator. The distribution of the contrast agent in the posterior section of the annulus is typical, as that is where the defects are localised (Fig. 3). As the patient had reacted positively to the provocative discography at both L4/5 and L5/S1, the application of ACP in both intervertebral discs was indicated. The puncture was performed for this purpose using the technique described above. Small amounts of contrast agent (0.2 – 0.3 mL) were applied to monitor the position of the cannula, followed by approx. 1.0 – 2.0 mL ACP up to a maximum of 20 PSI, depending on the pressure (Fig. 4). As expected, this provoked pain. Afterwards, the patient had to lie down on his back in the treatment room for approx. one hour to recover and was then able to leave the practice with an accompanying person. During this time, the ACP coagulates and becomes embedded in the intervertebral disc. We performed three injections at intervals of one week. As ACP therapy is an immunomodulatory therapy, improvements do not become manifest until at least six weeks after the start of treatment. Our patient presented three weeks after the last injection and reported a marked reduction in pain by approx. 50 % (NRS 3), with the pain often not occurring until after prolonged loading. He was also able to resume training. Physiotherapy was performed as an adjunct treatment to improve trunk stability.

CONCLUSION

Previous studies and our own experience show that the intradiscal injection of platelet-rich plasma products such as ACP is safe and feasible for the treatment of patients with back pain due to degene-

rative intervertebral discs (discopathy). This treatment seems to be particularly suitable for young and middle-aged adults when the discopathy is still moderate (up to grade V on the Pfirrmann scale). It has also been shown that a significant effect does not become manifest until at least 6 – 8 weeks afterwards and that further improvement is possible up to 6 months after the start of treatment.

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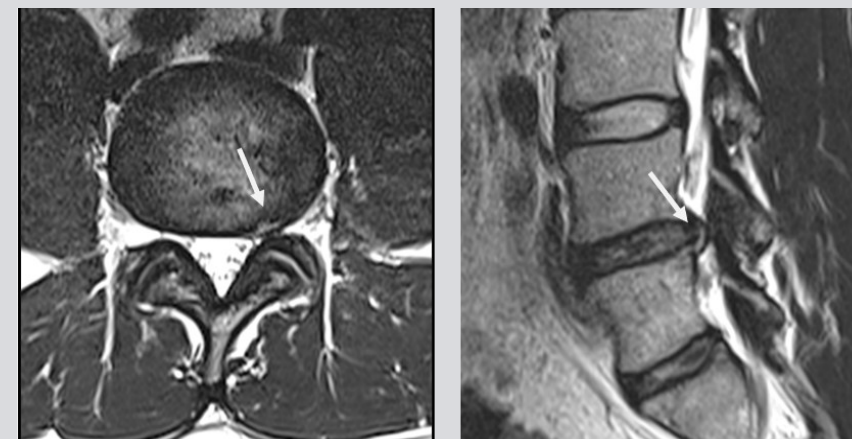


FIG. 1 T2-weighted MRI images, axial on the left, sagittal on the right. This shows grade IV discopathy at L4/5 and 5/S1 on the modified Pfirrmann scale. There was also a high-intensity zone (HIZ) representing a fissure/tear in the posterior annulus at L4/5 (see arrow). High intensity zones are a phenotype that shows as a hyperintense area of the intervertebral disc in a T2-weighted MRI and which has been described as a potential imaging biomarker for identifying symptomatic intervertebral discs.

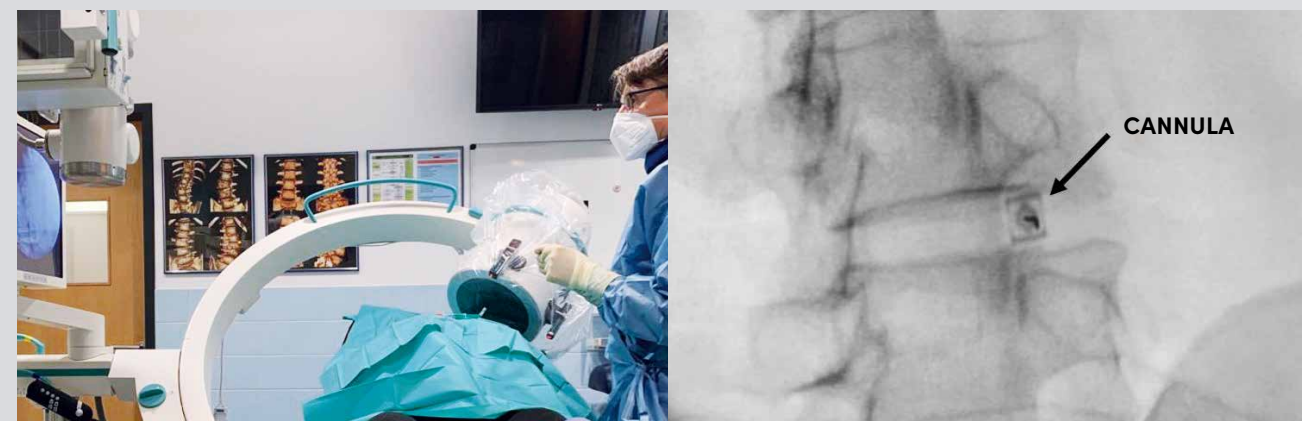


FIG. 2 Positioning of the image converter for puncture of the intervertebral disc in the trajectory/coaxial view. For this, the base plate and cover plate are placed parallel to each other in the anterior-posterior (ap) beam view. The image converter is then swung to one side by approx. 45°, so that the annulus in the dorsal region is in the Parviz Kambin triangular safe zone. With an ideal puncture, the cannula is visible as a dot (see arrow).



FIG. 3 Image converter images ap and lateral with contrast agent in the intervertebral disc compartment. The contrast agent is distributed mainly in the posterior section, where the laceration in the fibrous ring is usually localised. The contrast agent should remain within the intervertebral disc, as otherwise the ACP would also drain out.



FIG. 4 The ACP is applied once the cannula is in the correct position and if the contrast agent does not drain out.

THERMOGRAPHY AND CRYOTHERAPY

Innovative diagnostic investigations and treatment of trigger points in the shoulder girdle

**PROF. OLIVER TOBOLSKI, MD /
MEDICAL DIRECTOR, SPORTHOMEDIC COLOGNE**

Myofascial trigger points are palpable areas of muscular hardening, usually in the neck or between the shoulder blades, which may be associated with considerable impairment of the quality of life.

Due to pain in the region of the shortened musculature and the associated stiffness of the affected mobile segments, e.g. the atlanto-occipital and atlantoaxial joints in the cervical spine or the shoulder, the further course may lead to postural imbalance in more distant joints (ascending/descending chain) and to chronified pain syndromes that often have to be treated with drugs. One can differentiate between active myofascial trigger points that are frequently extremely painful and often weaken the affected muscle, latent myofascial trigger points that are only painful on movement, and associated myofascial trigger points that develop due to dysfunction of the neighbouring muscle groups.



FIG. 1 thermography

In many cases the latter myofascial trigger points are areas of painful muscular tension in the muscles of the shoulder (girdle) (rhomboides major/minor muscles) that react to muscular shortening, particularly at the superior border of trapezius or in the short cervical muscles. The causes of trigger points are many and varied: shortening of the muscle groups due to damp/cold/draughts, associated fascial adhesions, postural imbalance, overstrain, or blunt trauma. Imaging has only been of very limited use for trigger points to date. Many patients with chronified neck problems show no structural anomalies on imaging (MRI, digital volume tomography, radiographs of the cervical spine). Ultrasonography is also only of limited use for assessing trigger points.

A dedicated manual examination gives indications of shortened muscle groups. Intensive examination of the ranges of movement of the atlanto-occipital and atlantoaxial joints often reveals muscular swelling at palpation. More recently clinicians have been turning their attention to thermography because this specific examination system can demonstrate hyperaemia in the affected muscular segment. Thus, for the first time ever, trigger points can be visualised without exposure to radiation, relatively problem-free, and in a short time.

CASE EXAMPLE

A young athletic woman presented at our surgery with progressive recurrent episodes of symptoms in the region of her left trapezius radiating cranially to the left occipital area that she had had for several weeks. She said she did sports regularly (tennis). The patient is right-handed and could not remember any trauma. She has a sedentary occupation (works at a computer). Her intensive stress situation had worsened over the last few weeks as she had had to take on additional work due to staff reductions as a result of coronavirus. She had treated herself with deep heat, massage and analgesic gels. Clinical examination showed marked elevation of the left shoulder with massive tension of the superior border of trapezius and considerably restricted mobility of the atlanto-occipital and atlantoaxial joints on right rotation. She had tenderness to pressure over the insertions of the short cervical muscles on the occiput and along the course of the left levator scapulae muscle. Palpable myogeloses / trigger points, particularly at

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the superior border of trapezius and in the rhomboideus minor muscle.

Slight pain relief in the affected muscle groups on extension of the neck. Clinical examination revealed no attributable radiculopathies. The MRI of the cervical spine the patient brought with her showed findings in the cervical spine that were compatible with her age without any higher-grade degenerative changes of the facet joints/intervertebral discs. No neuroforaminal narrowing. In the infra-red thermography we initiated (FLIR E75 thermal imaging camera, Fig. 1) the camera displays more than 75,000 measuring points with a thermal sensitivity of <0.04 degrees temperature difference, and can thus accurately demonstrate small areas of hyperaemia (trigger points). In the present case the clinically diagnosed trigger points in the region of the superior border of trapezius and in the short right cervical muscles are shown (Fig. 2, see black circles). In order to confirm the diagnosis further we also ran EMG tests on the muscles in the shoulder girdle that gave clear evidence of elevated resting tone in the left trapezius (Fig. 3 and 4). Therapy was given at the same

sitting as treatment with neuroreflex cryotherapy (Cryolight). With the help of the applicator and a temperature probe, the entire muscle area (in this case the trapezius on the left) is “cooled down”. During the treatment, the entire trapezius muscle is treated from the shoulder area to the area of the short neck muscles for approx. 60–90 seconds and then a dosed stretching treatment is carried out. The total duration of therapy per session is a maximum of 2 minutes. Depending on the intensity of the symptoms, 3–5 sessions are usually necessary (Fig. 5). Taping was then applied (Fig. 6). The thermography we repeated directly after the cryotherapy showed marked regression of the size of the pre-existing left nuchal trigger points (Fig. 7). In the further course the follow-up (EMG) examination also showed a marked reduction of the imbalance with clear harmonisation of muscle tone (Fig. 8). The patient’s treatment was repeated once. After the second sitting (six days after the first treatment session) there was almost complete regression of the symptoms with a considerably improved range of movement and no residual muscular limitations.

SUMMARY
Thermal imaging (thermography) readily demonstrates trigger points – especially in the region of the cervical spine – with associated muscle weakness, restricted mobility and chronified pain syndrome. The application of cryotherapy is recommended for confirmed trigger points (neuroreflex cryotherapy) followed by taping. Furthermore, EMG testing (with concomitant biofeedback training) can be used for further diagnostics/treatment or used to evaluate the outcome of cryotherapy. Our EMG tests showed a marked reduction of muscular tension after cryotherapy indicating in summary that this technique, which is simple to apply, is a fast-acting form of treatment and is virtually free of side effects.

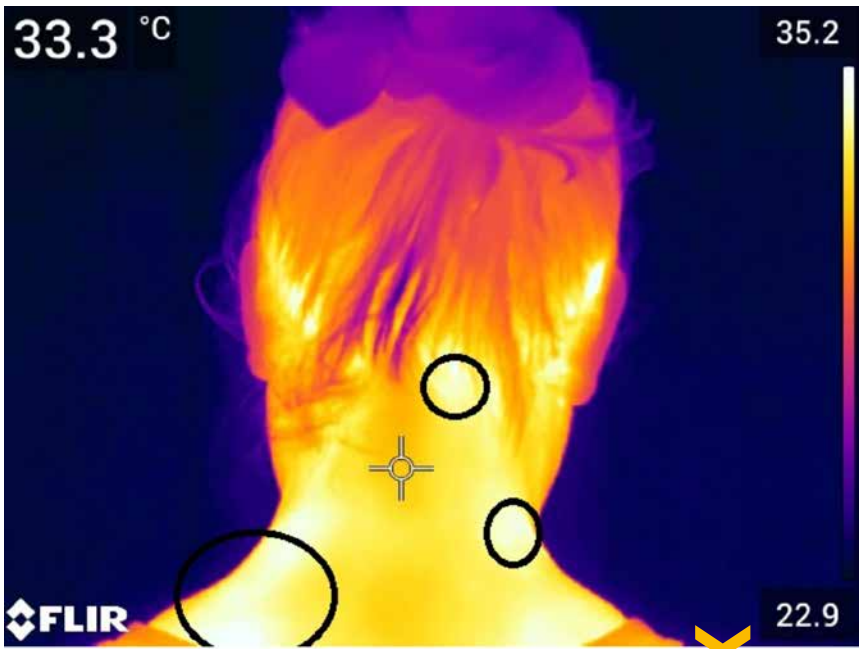


FIG. 2 Trigger points are shown



FIG. 3 Positions of the EMG electrodes

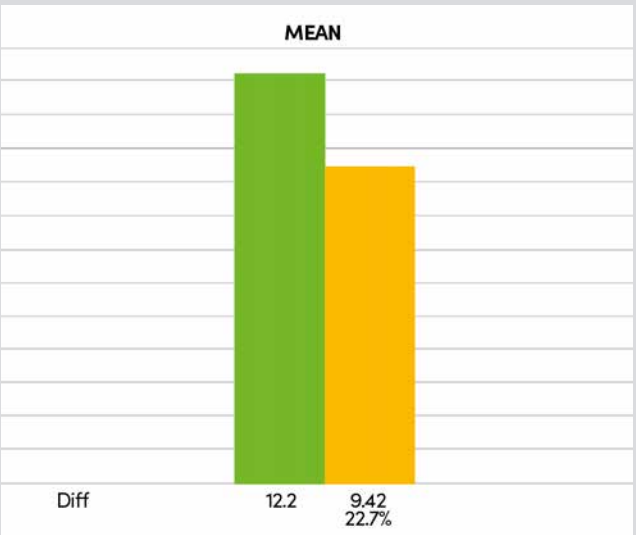


FIG. 4 Elevated resting tone in the left paravertebral cervical muscles



FIG. 5 Cryotherapy



FIG. 6 Taping



FIG. 7 Thermography after cryotherapy

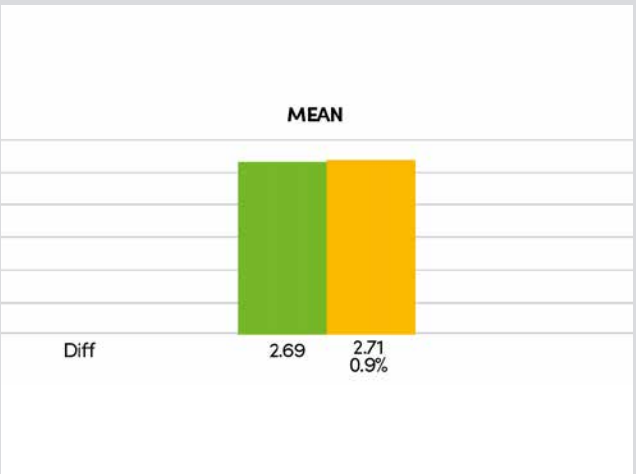


FIG. 8 Follow-up EMG after cryotherapy

REGENERATIVE THERAPIES

Helping the body self-heal damaged structures

THILO HOTFIEL, MD / PROF. STEFAN NEHRER, MD

The goal of regenerative medicine is to rebuild diseased or damaged body tissue, with the aim of creating tissue with biological properties that are comparable to healthy tissue. This is in contrast to the traditional approach of repair, which seeks to restore normal function to diseased or damaged tissue but without restoring the tissue itself in terms of quality and quantity as in the Latin *restitutio ad integrum* (restoration to the original condition). This often ultimately results in failure and in artificial joint replacement, for example. Regenerative medicine seeks to achieve improved outcomes using biotechnological techniques, biological methods and stimulation and modulation of natural healing and to restore tissue homeostasis and adaptation and self-healing mechanisms.

ORTHOPAEDICS AND REGENERATIVE MEDICINE

The translation of preclinical results in regenerative research into products that can be used in clinical practice is slow. The reasons range from authorisation issues to ethical discussions about gaps in scientific understanding through to psychosocial issues. Nonetheless, orthopaedics can be viewed as a pioneer in the clinical application of regenerative medicine with the restoration of musculoskeletal structures, such as the menisci, cartilage, bone and intervertebral discs. Given the high prevalence of injury in athletes, regenerative medicine is playing an increasingly important role in sports orthopaedics. This includes, on the one hand, tissue engineering, which involves the use of cultured cells of various origins on substrates and the addition of growth factors to support

tissue regeneration and, on the other, the use of both complex blood derivatives (e.g. platelet and cell concentrates with a high proportion of mesenchymal stem cells (MSCs) from bone marrow or adipose tissue) and individual factors such as vesicles or small molecules that intervene in healing and regeneration cascades. The methods have a low adverse effect profile and are often better tolerated than traditional pain and inflammation inhibitors, which furthermore provide only symptomatic relief and do not support any regenerative potential. In sports medicine in particular, the natural regeneration potential of the mostly young patients is high and should be researched more intensively.

GENERAL STRATEGIES IN REGENERATIVE MEDICINE

In general, regenerative strategies are based on 4 cornerstones:

- » cells
- » a supporting matrix (biomaterial)
- » signals for tissue and cell differentiation
- » and environmental factors, such as biomechanical stimuli.

CELLS AND THEIR SOURCE

Cells are the first cornerstone for regenerative medicine applications. Autologous cell transplants, as in chondrocyte transplantation, are already being used. The evidence for ACT has markedly improved and there are randomised studies confirming by biopsy and MRI the clinical efficacy of the method with restoration of the cartilaginous joint surface in isolated cartilage defects. Long-term studies with a follow-up period of up to 20 years have also confirmed the sustained effect of ACT. In approx. 75 % of cases, the morphology of the joint cartilage is substantially regenerated, which also supports joint longevity and, compared to microfracture, results in improved outcomes, especially beyond the five-year threshold. Just the microfracture-induced bleeding alone results in repair tissue consisting of mixed fibrous tissue and, as recent studies have shown, often in increasing bone formation in the defect, which thins out the cartilage above and ultimately results in failure.

The above impressively demonstrates that repair methods such as microfracture are clinically successful in the short

term but are unable to treat cartilage defects in the long term. It is essential, therefore, that cell transplantation be used for large defects in particular, not least because microfracture also negatively affects the outcome of any subsequent cartilage surgery in the long term. Despite these successes with ACT, the logistics, administration and technology costs are so high that their cost-effectiveness is hard to justify. These criticisms, however, always have to be seen against the background of joint longevity and the associated improved quality of life and social health economics. Modern approaches are increasingly focusing on stem cells and progenitor cells. Stem cells from bone marrow, umbilical cord blood and adipose tissue have long been used in clinical practice; embryonic stem cells would be another very promising option but for the ethical issues involved. A modern alternative to embryonic stem cells might be induced pluripotent stem cells (iPSC). These are primarily somatic cells that have been reprogrammed to an embryonic stem cell-like state.

MATRICES

Matrices are the second cornerstone of regenerative medicine; they are primarily used to provide a support and attach the inserted cells at the defect site. They are thus a scaffold on which new tissue can form. Modern matrices actively emit signals to promote the regeneration process and accordingly provide impulses for regeneration, which can be biological, chemical, or physical. How they emit these signals depends on their design. Modern, smart matrices react to environmental stimuli, whereas more traditional matrices, which are typically absorbable, release their factors as they are absorbed. Matrices consist of a wide variety of natural and synthetic materials and are often copolymers of different components. Natural materials are natural collagens, hyaluronates and fibrin, which are sometimes manufactured recombinantly. Synthetic biomaterials are polylactides and polycaprol-

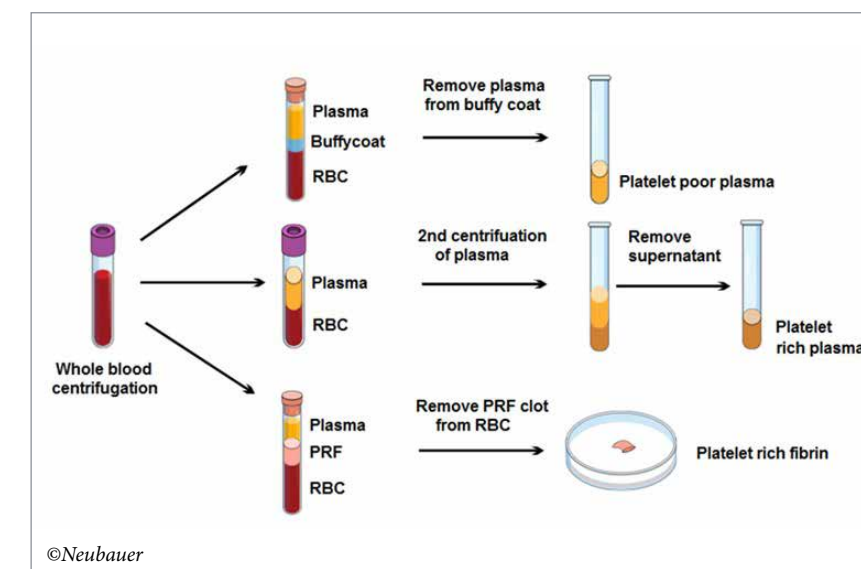
actones or combinations of the two. The type of material selected depends on a wide variety of factors, such as porosity, biocompatibility and absorption rate. Modern matrices may also have a micro or nano structure or even be manufactured according to the individual anatomy. In this instance, bioprinting allows cells and growth factors to be integrated into the individually manufactured construct. To support the minimally invasive character of modern regenerative approaches overall, increasing use is also being made of matrices made of injectable, self-hardening gels or pastes.

SIGNALS FOR DIFFERENTIATION

Signals/morphogenetic stimuli that stimulate cells to differentiate into specific tissue are the third cornerstone for regenerative medicine applications. The best known example of this are growth factors such as transforming growth factor beta (TGF- β), which plays an essential role in chondrogenesis. Alongside other stimuli such as transcription factors, trophic factors and small active molecules, the environmental milieu (e.g. hypoxia) can also initiate differentiation processes. A common problem here is that these factors can hardly ever be applied systemically but usually have to be applied locally at the site to be regenerated for days and even weeks. Local application over a prolonged period is

the aim of smart scaffolds that are programmed to release such factors. However, to date it is often unclear what factor is required precisely when, in what concentrations it should be applied and what precise form the kinetics should take.

One pragmatic approach which avoids this problem altogether involves once more MSCs and other substances harvested from blood such as platelet-rich plasma (PRP). The abundance of individually different trophic factors automatically associated with these products saves the user the task of providing the precise concentration/isolating the individual factors. But this also turns a critical eye on blood products such as ACP and PRP. Their clinical efficacy has been demonstrated in both destroyed tissue and degenerative processes such as osteoarthritis. The mixture of anti-inflammatory, immunomodulatory and regenerative factors can act on the healing cascade and support tissue healing. With chronic pathologies in particular, the introduction of blood components reactivates healing processes through the release of platelet factors and with mesenchymal stem cell-derived microvesicles and can make good a failed attempt at healing that has become chronic.



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MECHANICAL STIMULI

Mechanical stimuli are the fourth cornerstone for the success of regenerative methods. They are crucial for the function and development of skeletal structures. The mechanical influence plays an essential role particularly in the initial differentiation phase but also in the later remodelling phase of healing. The use of continuous passive motion devices (CPM) plays an important role in the rehabilitation of cartilage defects. Much movement, little loading is the motto here and ensures optimum cartilage formation post cell transplantation. Another interesting application of mechanical stimuli to promote bone regeneration is extracorporeal shock wave therapy (ESWT). This is essentially also a regenerative measure to mechani-

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cally reactivate stalled healing processes using shock waves. The field of mechanical stimuli would seem to be a fertile ground for innovative rehabilitation protocols and might come more to the fore in regenerative medicine due to the above mechanisms.

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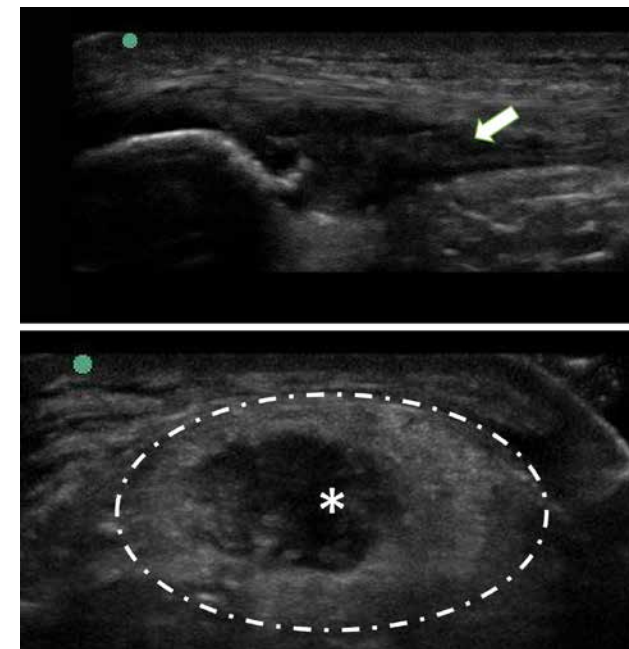
Blood-derived products in regenerative orthopaedic sports medicine
The physiological support of blood-derived products for tissue repair and regeneration is attracting attention for many applications in regenerative medicine. Platelet-rich plasma (PRP) is one of the best known blood products commonly used as a supplement in in-vitro cell cultures and for therapeutic applications. The quantity of growth factors

and cytokines available in the platelet alpha granules in PRP provides all the necessary anabolic factors to maintain proliferation, differentiation and cell phenotypes. Deviations that arise due to different PRP manufacturing protocols are responsible for the large number of different platelet-rich plasma products in laboratories globally.

SCIENTIFIC VALUE OF PRP ETC IN TENDON INJURIES

Tendon disorders of any kind make high demands in terms of diagnostics, treatment, rehabilitation and prevention at a fundamental level and often require interdisciplinary collaboration. Interest in and the use of orthobiologics (e.g. platelet-rich plasma and autologous conditioned plasma – PRP and ACP) has steadily grown in the last decade. Orthobiologics and the procedures followed for their application are often mentioned in the context of tendon injuries. The results of a current survey in the AOSSM (American Orthopaedic Society for Sports Medicine) confirm just how frequently they are used in routine clinical practice. Tendon injuries, together with osteoarthritis, are the second most common indication for the use of platelet-rich plasma. However, in this context it is viewed critically that with its increasing popularity the indications for its use are not always based on scientific evidence and therapeutic efficacy.

Acute tendon injuries and those due to overuse, together with functionally related structures (bone insertion areas, surrounding synovial tissue, myofascial interfaces), are one of the most common injuries and clinical pictures in athletes across all sports and ages. Epidemiologically, the (weight-bearing) tendons of the lower extremities (e.g. the Achilles tendon, patellar tendon) in particular are commonly involved. A large number of injuries in sports can be ascribed to different forms of overuse with or without concomitant risk factors. Fundamental knowledge of the



Infrapatellar longitudinal and transverse ultrasound scan of advanced proximal patellar tendinopathy with low echo spindle-shaped swelling.

pathogenesis is essential to understand damage mechanisms and be able to address them adequately and treat them successfully and appropriately depending on the stage. Where the aetiopathogenesis cannot be fully explained, an interaction between a change in metabolic activity (including tenocyte activity), a change in the structural integrity of the tendon and the presence of more or less inflammatory metabolic disorders can be assumed. The individually selected treatment methods share the goal of clinically identifying and improving impaired tendon function in a continuous and progressive treatment process. Careful selection and structuring of the treatment methods is essential here.

APPLICATION AND/OR INFILTRATION AS A PROCEDURE ROUTINELY AVAILABLE IN CLINICAL PRACTICE

When PRP etc were first used, the available evidence was inadequate due to the inadequate methodological quality of the studies then available. The at times method-related limitations of these studies and the different methods used to collect PRP resulted in different compositions and dosages. Moreover, the application and follow-up protocols were not uniform and still hinder scientific analysis and thus ultimately the assessment of this treatment method today. In principle, the cytokines and growth factors found in PRP can enhance the inflammatory and healing process. PRP, applied at the correct time and in the correct work-up, might thus have a positive effect on tissue regeneration. However, if the timing and work-up are inadequate, then the opposite effect may be triggered. It has now been generally established that the clini-

cal efficacy of PRP depends on both the biological milieu (application as a supplement perioperatively as opposed to purely conservatively) and localisation of the application. The question therefore is no longer whether PRP is generally useful (e.g. irrespective of localisation and severity) but whether it should be applied in each individual case.

POSITIVE EFFECTS FOR THE PATELLAR TENDON, ROTATOR CUFF AND RADIOHUMERAL EPICONDYLOPATHY

The scientific data currently available demonstrate positive therapeutic effects, particularly for the patellar tendon, rotator cuff and radiohumeral epicondylitis and for perioperative application in Achilles tendon reconstruction. Application of PRP for Achilles tendinopathy does not appear to be superior to other treatment methods and, based on current knowledge, cannot be fully recommended.

SUMMARY OF THE USE OF ORTHOBIOLOGICS FOR TENDINOPATHY

- » Heterogeneous data available on clinical efficacy – biological milieu and localisation are crucial
- » Indication must take into account the localisation and be adjusted to the underlying pathology
- » Solid data available: patellar tendon, rotator cuff, radiohumeral epicondylitis, Achilles tendon reconstruction
- » No monotherapy, no unique selling point!

NB: The indication for infiltration treatment in tendinopathy should always be subject to strict scrutiny irrespective of the active substance applied. The user is in each case responsible for the infiltration and must always check what specific treatment goal is being pursued with the infiltration. In tendinopathy, the purpose of infiltrations (of any kind) is not to maintain sports activity or weight-bearing capacity at a symptomatic level. The goal of all those involved in the treatment should always be to enable, within a continuous rehabilitation process, a safe return to training and competition in line with the severity of the damage.

First published: GOTS* newsletter

GOTS*: The trinational (Germany, Austria, Switzerland) Society for Orthopaedic and Trauma Sports Medicine (GOTS) is the largest European association of sports orthopaedic and sports trauma specialists. It is the first point of contact in the care of sports injuries and a guarantee of quality in sports trauma care. Its goal is to improve the understanding of sports loads and injuries in order to maintain musculoskeletal function and quality of life. To this end, GOTS promotes training and continuing education, research and the sharing of information and expertise internationally among doctors active in sports orthopaedics and sports trauma and professional groups in related specialisms.

BIOREGENERATIVE TREATMENT METHOD

The use of platelet-rich plasma
PRP on the vertebral column

MORITZ DAU, MD /
PRAXIS ORTHOPÄDIE AM RHY RHEINFELDEN,
SWITZERLAND

Spinal pain is a very common reason for the limited ability to pursue sport for athletes in almost all types of sport. Therefore, concerning oneself with the vertebral column is very important in sports medicine for the locomotor apparatus. The use of PRP (platelet-rich plasma) as a therapeutic procedure for disorders of the locomotor apparatus is already widely established. PRP is finding increased acceptance as a promising minimally-invasive alternative form of treatment for the vertebral column.

In exactly the same way as throughout the entire locomotor apparatus, chronic inflammatory and degenerative changes play a decisive role as the cause of the relevant symptoms here, too. The now extensive relevant literature contains a high level of evidence in favour of treating osteoarthritis (e.g. osteoarthritis of the knee), [1, 2] tendinosis (e.g. tennis elbow, jumper's knee, achillodynia) and ligamentosis [3 – 6]. Essentially similar structures and the corresponding pathological changes also play a decisive role in disorders of the spine. One of the main causes of spinal pain is segment degeneration in the lower lumbar spine where the high loads, often repetitive, imposed by sport activate inflammatory processes which lower the threshold of the nociceptive pain generators. Activated osteoarthritis of the lumbar and cervical facet joints, activated costotransverse joints, the SI syndrome and painful iliolumbar ligamentous apparatus are among the main indications for the use of PRP [7]. PRP is also successfully applied for discogenic and peri-/neural symptoms. The therapeutic benefit of PRP is based above all on its high proportion of growth factors released by the platelets. These have both anti-inflammatory and regenerative-proliferative effects on the affected tissues, and stimulate and accelerate healing processes [13, 21]. In my practice I use the low-leukocyte PRP from Arthrex, ACP (Autologous Conditioned Plasma), also because of its simple handling and the sterile double syringe system. A correct and exact diagnosis is essential for the efficacy of PRP treatment. Finding this can be a challenge, especially in the vertebral column. The pain focus and the pathological changes shown in the scans are correlated with the manual medicine examination. The affected anatomical structures of the spinal components (vertebral bodies, facet joints, nerve roots, intervertebral discs) and the related soft tissues (muscles, fasciae, ligaments) should all be identified as exactly as possible. The diagnosis can be verified by a therapeutic test infiltration. The pain relief the patient experiences contributes towards good patient compliance.

TREATMENT OF THE FACET JOINTS

Activated facet joint osteoarthritis is the most common indication for the use of PRP in the spine. This can be imaged well using a linear transponder (e.g. 9 to 12 MHz) in slender, athletic patients. A convex probe is used for deeper imaging (Fig. 1).

The cervical facet joints are very readily accessible to ultrasound. Joint effusion, synovial swelling and osteoarthritic changes are recognised during the diagnostic scan, correlated with the pain, and treated specifically (Fig. 2).

In the case of pronounced inflammatory changes, corticosteroid injections are often successfully used to "calm down" joints, especially painfully activated facet joints. However, steroids do not prompt a healing process and moreover, they

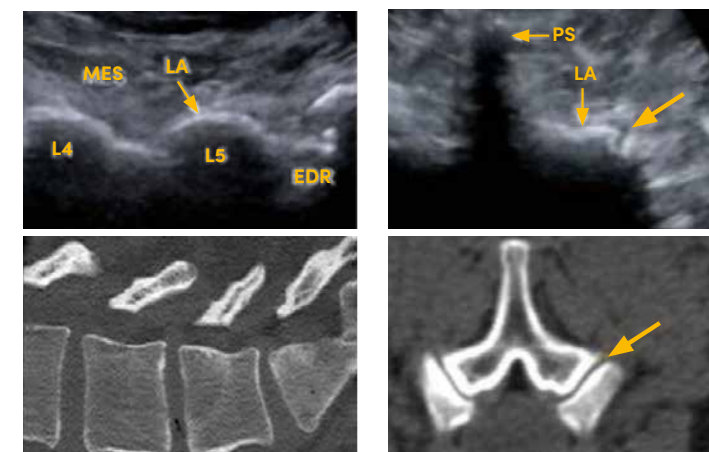


FIG. 1 It is essential to identify the affected structure in the spine and to apply the platelet-rich plasma exactly to the spot. Besides the established procedure using radiological guidance (computed tomography or fluoroscopy) ultrasonography has increasingly proved effective for guided injections: left, sagittal visualisation of the facet joints L3 to S1 and the indicated direction for infiltration on ultrasonography (top) and the computed tomography correlation (bottom). Right, analogously in transverse section L3 to S1 (PS = spinous process, LA = lamina, MES = erector spinae muscle, EDR = epidural space) EDR = Epiduralraum)

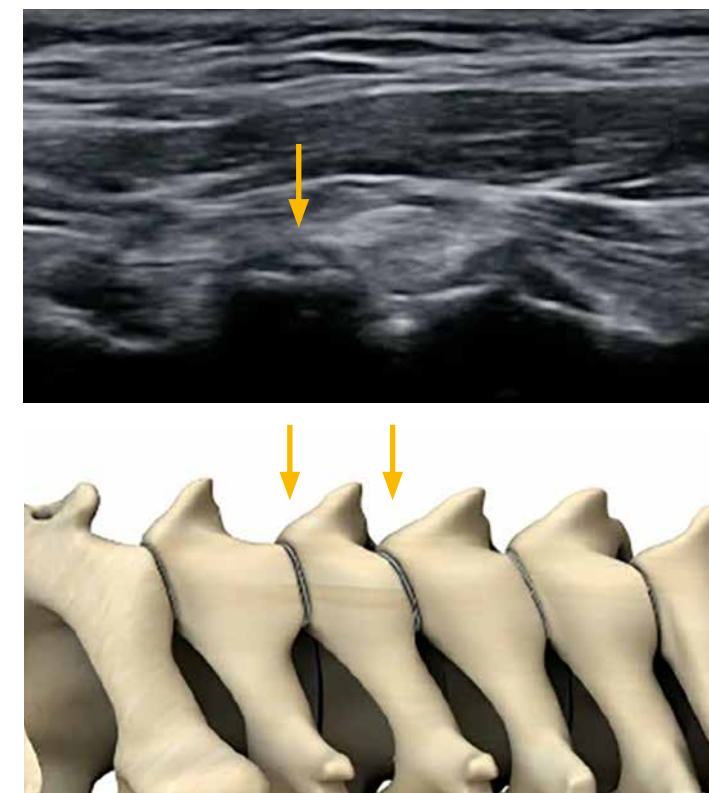


FIG. 2 Example of cervical facets; joint space C3/4 and C4/5 →

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also cause chondral degeneration which limits their use [9]. Numerous studies confirm the better long-term effects of PRP treatment in direct comparison with steroids [2]. There is also corresponding evidence of this in the spine [10, 11]. In a comparison of the intra-articular use of corticosteroids with PRP in patients with facet syndrome, Wu et al. showed that pain perception in patients treated with steroids initially regressed but then increased again continually, while the pain perception decreased continually and significantly over the entire 6-month observation period in patients given treatment with PRP [12]. Similar superiority regarding

the long-term effect of PRP treatment was also observed in the study by Braun et al. [13]. In my many years' personal experience, the use of PRP on facet joints (intra- and periarticular) has very low rates of complications and side effects. PRP often has a longer-lasting effect on the patients treated. Nevertheless, the patient should be informed about possible initial exacerbation of the pain and delayed improvement (contrary to local anaesthetic/steroid injections). Alternatively, in view of advanced degenerative changes, for example in severe hypertrophic osteoarthritis of the facet joints, ablation of the "medial branches" (facet rhizotomy) must be considered for a good long-term outcome [14].

CASE REPORT CERVICAL FACETS

At his first consultation at the end of 2016, the 56-year-old intensive amateur athlete (racing bike and kayak) complained of high right cervical pain radiating into the shoulder and arm. The MRI confirmed the diagnosis of severely activated osteoarthritis of the right C 2/3 facet joint (Fig. 3). The patient decided for treatment with ACP (low-leukocyte PRP). A series of five treatments at weekly intervals was able to reduce the symptoms almost completely. To date he has had one relapse which was again treated successfully with a series of three injections.

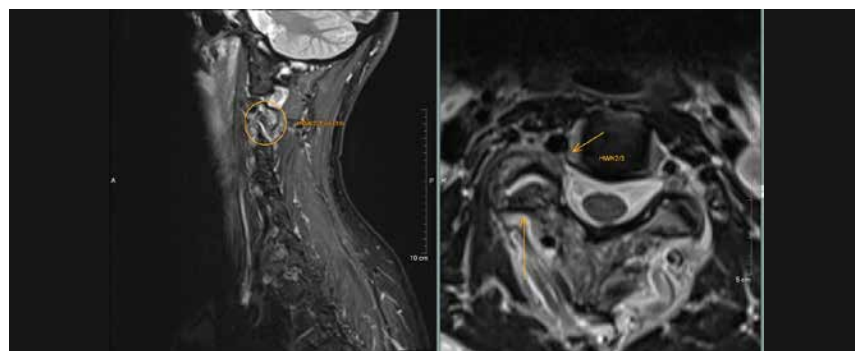


FIG. 3 MRI: isolated unilateral hypertrophic osteoarthritis of the right C 2/3 facet joint with activation demonstrated by bone marrow oedema, articular effusion and extensive periarticular soft-tissue oedema: higher-grade right foraminal stenosis as a consequence of this.

TREATMENT OF THE SACROILIAC JOINTS

Daily practice routine also shows good results in the use of ACP for disorders of the sacroiliac joint. The lower pole of the SI joint space is readily shown on ultrasound and easily infiltrated (Fig. 4). The literature reports better results of using PRP for the SI joints than with intra-articular methylprednisolone injections. In their randomised prospective study, Singla et al. enrolled a total of 40 patients and observed a long-lasting improvement in PRP patients as shown by established scores such as VAS and MODQ [7]. In my own experience, rheumatological inflammatory disorders of the sacroiliac joints respond well to PRP treatment.

CASE REPORT SI

The 48-year-old recreational athlete came to my practice in 2015 with intensive predominantly buttock pain. In view of his typical medical history with alternating nocturnal pain at rest without any precipitating factors, morning stiffness and evidence of florid bilateral sacroiliitis with oedematous changes of the anterior vertebral bodies (shiny corners) in the MRI, the diagnosis of ankylosing axial spondylitis (Bechterew's disease) was made. He was initially given steroid infiltrations into the sacroiliac joints, and later the TNF- α antagonist Humira (adalimumab) was

established as a systemic treatment. All the steroid injections into the SI joints showed a very good effect, but as the pain returned after 5–6 months each time, the injections had to be repeated. In 2017 we switched to treating the SI joints on both sides with 5 mL ACP each as a series of three injections guided by ultrasonography. The patient definitely prefers this treatment to cortisone due to the "gentler and longer-lasting effect" – even if the PRP infiltration is more painful and does not offer instant relief. The injection series have been successfully repeated every 9 to 12 months to the present day. In some cases activated osteoarthritis of the facet joints of L4 to S1 and accompanying enthesiopathies (e.g. lateral epicondylitis) have to be treated as well.

PELVIC LIGAMENTOSIS

The chronically overloaded iliolumbar ligamentous apparatus responds very well to PRP in a multimodal treatment programme. Ligamentous instability and overload are an important cause of pain in the sacral region. This affects the iliolumbar, sacroiliac, sacrospinous and sacrotuberous ligaments [15, 16]. Hackett proposed the theory of musculoskeletal pain being caused by ligamentous laxity secondary to enthesiopathies [17]. Various factors such as muscular imbalance, weak posture, overloading and instability can trigger chronic in-

flammatory reactions in the periarticular structures as well as in the ligamentous apparatus [18]. Corticosteroid injections provide effective therapy for inflammation and local pain associated with ligamentous disorders. However, they also impair tissue regeneration. In ligaments and tendons with chronic inflammatory degenerative changes they inhibit fibroblast activation and, in turn, collagen synthesis required for healing [19]. Collagen necrosis at the injection site is possible [20]. Therefore, multiple use of local steroids is not advisable. In contrast, alternative PRP therapy can induce regenerative processes and can be recommended as an injectable for modern prolotherapy. Precisely in connection with this, PRP therapy must be embedded in a multimodal treatment programme to counteract the cause of overload. An exercise programme to improve posture and to recondition and improve muscular torso stability should be established. Loading exercises lead to efficient and successful remodelling in the affected and treated structure.

SUMMARY

Due to the very promising results, both in daily use and in the literature, the focus is turning increasingly to treatment with platelet-rich plasma for spinal symptoms. Activated osteoarthritis of the lumbar and cervical facet joints,

sacroiliac syndrome and the painful iliolumbar ligamentous apparatus are among the main indications for the use of PRP. Activation of regenerative processes leads to long-lasting pain relief and improved function. According to the literature, the long-term outcomes are better than those with corticosteroid injections. Successful treatment is based on a correct diagnosis and targeted treatment of the affected structure. Ultrasound enables simple, quick and specific administration to many sites in the spine. In my own practice, ACP from the Arthrex company has proved its worth due to the low risk use that is practically free of side effects. To this extent, PRP treatment should be embedded in a multimodal treatment programme wherever possible.

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The complete literature can be found at the Article on www.sportaerztezeitung.com

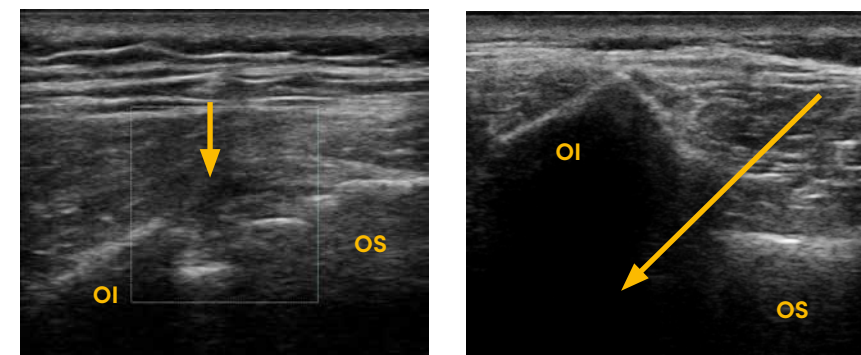
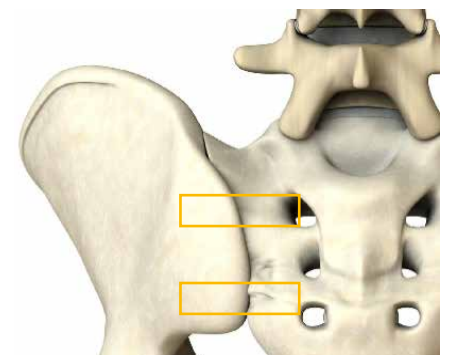


FIG. 4 Sacroiliac joint in a transverse sonogram: joint space and indicated direction for infiltration → at the lower pole. Image 1 left and central, image 2 right (position of the probe indicated by the boxes); OI = ilium, OS = sacrum





ANTI-GRAVITY TRAINING

Revision and update

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The AlterG is a treadmill that allows virtually natural running under reduced gravity using differential air pressure technology. The user wears special neoprene shorts during training and is lifted by increased pressure, which allows body weight to be reduced by up to 80 % in increments of 1%.

This means that at the final setting someone weighing 75kg is exposed to loads equivalent to 15kg. What is particularly noteworthy is that gait and even running hardly differ from natural movement patterns at high speeds. This is a very significant and valuable difference from other forms of weight-re-

duced running, e.g. running in water or using harnesses or crutches.

USE AT THE ZFS MÜNSTER

The AlterG anti-gravity treadmill first came into operation at the ZfS Centre for Sports Medicine in Münster on 01/10/2015 and has been used daily for

the treatment of patients with a wide variety of indications ever since. Physiotherapeutic support is provided at the ZfS, i.e. a physiotherapist gives the patients initial instruction and guidance for training and is also present throughout the training session (essentially, 1 to 1 treatment). The treadmill first became known in the early 2010s through its use in elite sports. This also led us to focus initially at the ZfS on indications for the rehabilitation of competitive athletes and aspiring recreational athletes. In addition to its use in the rehabilitation of injured or operated athletes, this included runners, who were

interested by the anti-gravity treadmill, as it can be set to speeds from 0 to 19km/h and even to different gradients. This allows runners with injuries or repetitive strain damage to continue to train with incentive and helps prevent or at least reduce any fall-off in performance. Studies by the developers of the AlterG show that if the speed of the treadmill is increased during running training/running by approx. 0.96 km/h for each 10 % reduction in body weight, metabolic stress remains more or less the same.

OUR OWN EXPERIENCE

With increasing experience, it became clear that the options for use with this new therapy equipment go far beyond the accelerated rehabilitation and gentle joint and tendon training of elite athletes. It has also been interesting for non-athletes of all ages following injury or surgery. The treadmill opens up unknown opportunities for getting back on one's feet, particularly after hip or knee surgery, with virtually no loading involved. Due to the precision with which patients can be unweighted, it allows the early mobilisation of freshly injured or operated patients and thus significantly shortens the time they are unfit to return to work/competition. The positive results of long-term studies following the integration of the AlterG into rehabilitation are consistent with our own experience (cf. Palke et al. 2022). Some advantages over rehabilitation in water have been shown in relation to gait and running-oriented rehabilitation. Unlike running in water, no resistance needs to be overcome. Therapy can also start substantially earlier, as in water the risk of wounds becoming infected with microorganisms in the water must first be excluded. The training creates new opportunities especially for osteoarthritis sufferers. For many people with osteoarthritis, being able to walk or run without pain is an almost impossible dream. The reduced loading on the treadmill allows many osteoarthritis sufferers not only to walk but even to perform training runs.

The therapy equipment is also being increasingly used in patients with neurological disorders such as stroke patients and patients with Parkinson's disease or craniocerebral trauma. For these patients, it is helpful to carry out walking and running movements with virtually no loading, thus allowing them to gradually restore their natural gait. Running movements are recorded by a set of cameras, and patients can follow and correct their running movements via a monitor. During the training, the treating doctor and physiotherapist can first diagnose any walking and running deviations on the monitor and then directly show them to the patients while they are training. In this way corrections can be made immediately. This direct feedback while training allows patients to reduce even habitual or complex gait and running disturbances that could not be addressed with traditional gait training.

INDICATIONS

- » following sports injuries and/or repetitive strain damage
- » surgery of the lower extremities, e.g. hip or knee surgery
- » osteoarthritis
- » degenerative lumbar spine syndrome
- » overweight
- » neurological disorders
- » gait or running disturbances
- » arteriosclerotic changes in the legs
- » impaired lymphatic drainage
- » beginners and former athletes returning to sports
- » elderly athletes who want to be able to run

HOW IS THE TREATMENT INVOICED?

We conduct training on the AlterG as a single physiotherapy session. As supplementary strengthening exercises are usually performed on training equipment and the training is integrated into an overall concept, it is considered a physiotherapy service and is invoiced in accordance with our price list for physiotherapy services. Of course, the price could also be calculated in the

same way as a fitness studio subscription or a 10-session ticket.

WHAT IS THE SETTING FOR PRACTICAL ROUTINE USE?

- » Two treatments a week (from the perspective of science-based training, three sessions would also be meaningful; ideally, there should be a break of one day between each training session)
- » One treatment series comprises ten sessions to begin with
- » The pure training time per session is usually approx. 20 min (in combination with blood flow reduction training [BFR]); other loading times, e.g. 5 x 1 minute intensive training
- » In combination with strength, mobility and coordination training
- » Especially for neurological patients, the evaluation of gait via a 3-camera system and combined with medical gymnastic (physiotherapy) on a neurophysiological basis

THE FUTURE AND PATIENT EXAMPLES

The AlterG will no doubt continue to be a wonderful adjunct to the treatment of athletes in the future. However, elderly patients with osteoarthritis of the knee or imminent (or actual) loss of the ability to walk might also be a patient group that benefit to an even greater extent from this training in the future. To date, there has been little targeted focus on these groups. See also the guidelines for osteoarthritis of the knee, 5.2.1. (Treadmill training with body-weight support improves walking speed and reduces pain). Another alternative treatment mentioned is aquatic training (recommendation 5.1.1), which results in significantly greater pain reduction than land-based training.

Example patient 1: 54 years old, osteoarthritis of the knee, affinity for sports. Any form of running training under normal gravity conditions results in

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knee pain/joint effusion. The previously well-developed leg muscles have atrophied significantly in recent years. The patient has not run fast for 10 years. The opportunity to do so again would act as a powerful incentive to train.

Example patient 2:74 years old, mild obesity, marked sarcopenia/dynapenia, maximum walking distance has shortened from approx. 200 m to 1 – 2 m now in the last 4 years. The patient is no longer able to go upstairs and now uses a wheeled walker even for short distances. Due to osteoarthritis of the

shoulder, the patient avoids distances of more than 10 m. His family fear that he will soon lose the ability to walk completely.

MORE THAN NORMAL STRENGTH TRAINING?

The transfer to everyday walking and running is higher, as anti-gravity training is much more similar to the target activity in terms of movement speed, intramuscular coordination, intermuscular coordination, sensory motor activity than, for example, strengthening of the quadriceps on a leg curl machine. The combination of targeted strength training with the AlterG training is ideal. An important factor in itself is that the AlterG training is fun for most patients. The recurring experience of running without pain is also a significant success factor in our personal view, as this experience generates confidence and pleasure in walking/running, also when not training. For some patients, this positive experience has an almost euphoric effect.

FURTHER IDEAS – NEW TREATMENT AND TRAINING INCENTIVES

We have been experimenting with this equipment at the ZfS for several years and combining it with other treatment measures. More recently, we have combined it with BFR training. The aim is to develop hypertrophic muscle effects during the AlterG training. Our initial experiences have been positive and we consider this approach to be highly interesting. However, due to the lack of a CE certification for BFR training equipment such as AirBands, we have so far refrained from integrating these measures into our standard procedures. The training allows patients even with severe osteoarthritis of the knee to run at very high speeds. The high movement speed in particular has surprising therapeutic effects. When combined with BFR training, it also has a good hypertrophic effect. There is a very marked difference between this training and the patients' everyday weight-bearing as

well as the therapy incentives that have been previously used in most physiotherapy practices. This training thus provides a far greater incentive to train.

Fast running is a very appealing training incentive particularly for athletes over the age of 45. Study results are consistent with our experience that the attainable running speed at 80% partial loading is approx. 20% higher, and at 60% partial loading is even 30% higher. The high running speeds act as a "new" training incentive for the person training, which is thrilling particularly for older people. This training is also interesting in terms of the typical marked leg muscle atrophy associated with ageing, which affects type II fibres much more than type I fibres. Fast running is also a valuable training aid in this respect.

WARNING: Impact forces that arise during running on the treadmill are determined not only by the reduced weight-bearing set on the AlterG but also, of course, by the speed. This is one of the reasons why we conduct this training at the ZfS only with operated and injured patients in a one-to-one physiotherapy session. A study on tibial impact acceleration peaks in 2019 showed, for example, that impact forces for the tibia are determined by running speed in particular. If this is not taken into account, there is a risk of overload. For example, a patient for whom the surgeon has currently planned 50% partial weight-bearing, can go on the AlterG at a 50% setting. If I let this patient run at 15 km/h with 50%, for example, the resulting impact forces would be far too high.



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LIFE AFTER A CAREER IN PROFESSIONAL FOOTBALL

IAN BEASLEY, MD / QUEEN MARY COLLEGE AND
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We all love watching the beautiful game and cheer our favourite team. Players seem to be part of our family. It has oft been said that the footballers' career is a short one, and although everyone knows some footballers earn large sums during their career, this does not apply to all players.

Those having played in the lower leagues may need to find a job when they have finished playing-this obviously applies also to those who have had a career cut short due to illness or injury. Being able to work depends, in part, on good health. Although it has been reported that ex-footballers live longer, mental health problems, degenerative joint disease, and neurodegenerative disease are the cause of appreciable morbidity, which can have an impact on day to day living and working.

HEALTH RISKS AND PROBLEMS

A survey of players in the major European leagues, despite a low response, found the prevalence of mental health problems and/or psychosocial difficulties in current and former professional footballers to be high when compared to the normal population. Burn-out (5% – 16% current-former players) and anxiety/depression (26% – 39% current-former players). Low self-esteem (3% – 5% current-former players) and adverse nutrition behaviour (26% – 42% current-former players) were the issues surveyed.

Degenerative joint disease is something that ex-players encounter earlier in their lives than the normal population, with knee osteoarthritis being twice as

common, and total knee replacement three time more common. Knee pain arrives 10 – 15 years earlier than might be expected. Degenerative changes in the hip are associated with a loss of quality of life for ex-players, and daily pain and arthroplasty are significant obstructions to leading a healthy and productive life, completely contrary to the experience of being a football player.

Neuro-degenerative disease is one of the hottest debated issues in football and the effect that heading the ball and head injuries (and just participation) have on players' central nervous systems. It is well known that dementia pugilistica was described way back in the 1930's (Millsbaugh), after being first named 'punch drunkenness' in the previous decade (Martland). It is also well known that some high profile players have suffered with dementia in later life. A three-fold increase in mortality from neuro-degenerative conditions was noted in a study involving Scottish ex-footballers, versus matched controls. Heading the ball has been associated with white matter changes, with one study counting headers in players over a season. Some of these players had headed the ball over 5000 times (!) in training and matches, with changes in memory scores and on MRI imaging when this

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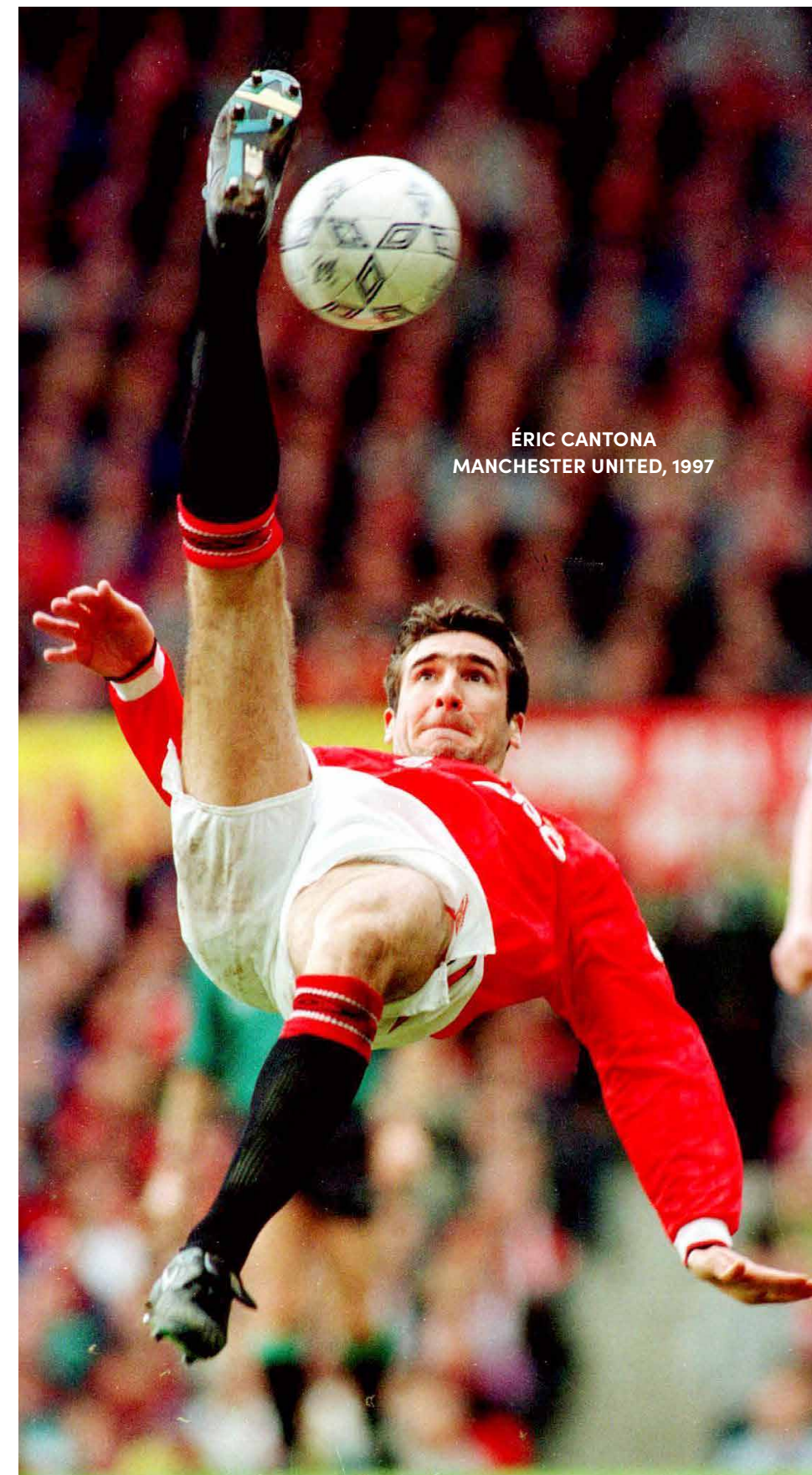
is a Consultant in SEM in the UK. He started worked in professional football in 1987, working for 4 EPL clubs, as well as the England men's national team. He currently works with the global performance unit at Manchester City, and for the Royal Ballet Company in London. He has attended 3 Olympic Games as physician, and two senior, one under-20 FIFA World Cups, and two UEFA European Championships. He is a board member of the International Concussion and Head Injury Foundation, and lectures regularly to postgraduates on football medicine. He is due to work as a Venue Medical Officer at the FIFA World Cup in Qatar.

figure exceeded 1800. Amyotrophic Lateral Sclerosis, or Motor Neurone Disease was noted to be more common and diagnosed earlier in life in two studies carried out on Italian footballers, with a relative risk of 11 and 18 across the two studies. Not to put all the blame on football, is some information

from the U.S.A. ALS registry, which states that those who have exercised vigorously before the age of 35, were more likely to be diagnosed with ALS before the age of 60, although the point was made that the causes of ALS are multi-factorial. Another multi-national study concluded that vigorous physical activity had an impact on the incidence of ALS, but an additive effect was seen in sports that involved repetitive central nervous trauma, such as football, with heading, and sustaining concussions. The now famous successful litigation achieved by players in the NFL in 2017 had a total timeline of 65 years, with \$52.6 million the estimated total that would be paid out in that time. In fact, by 2018, \$146.5 million had already been paid out (this is from an article in the New York Times). As stated earlier in this piece, ex-footballers do live longer, based on their lower incidence of cardio-vascular disease and cancer, but it is apparent that they do suffer disproportionate health issues after retirement, when compared to the normal population.

THE QUESTION IS, WHAT SHOULD WE BE DOING ABOUT IT?!

It is clear that those in the game are trying to holistically assess the size of the problem, so that resources can be accessed and applied appropriately. One prospective pan-European study is conducting a ten year survey of footballers transitioning from the playing side of the game to achieve this. Employers in other industries now conduct 'exit interviews' which give guidance to the soon ex-employee as well as take account of experiences whilst employed. Doing this for footballers may iron out some of the creases involved in such an event. As well as this, the hazards and potential health sequelae are shared with the employee in other work environments prior to the commencement of a contract, so that a career is undertaken with eyes wide open to the possible risks involved. Neither of these practices occur formally in football.



ÉRIC CANTONA
MANCHESTER UNITED, 1997

There is money in the game, and to set up any service will take resources. If, after their playing days, we are to support those who continue to entertain

us, whether from our sofas or from the terraces, we need to determine what is needed, and undertake to provide such support.



COVID-19 INFECTION IN PROFESSIONAL ATHLETES

Cardiac abnormalities during and post infection

JOCHEN VEIT, MD / JOINT PRACTICE F. EMSCHERMANN / J. VEIT MD, NORDWALDE

As already described in a previous article in the sportärztezeitung, COVID 19 can cause endothelial changes and induce systemic disease [1]. If an athlete becomes infected with SARS-CoV2, this is especially significant in terms of myocardial involvement. Equally relevant is the observation that transient myocardial changes can develop even after recovery from a Covid-19 infection.

Hanneman, Hubois and Schoffel published a cohort study in January 2022 in which PET imaging suggested evidence of myocarditis subsequent to a COVID-19 infection [2]. It was in this

context that Gänsslen et al. developed a return to play protocol for the German ice hockey league [1] that sought to return athletes to their sport as safely as possible, depending on the symptoms

and medical findings. The following presents and interprets the study findings in a team who largely became infected with SARS-CoV2.

BASELINE

25 of a team of 32 active male professional athletes (80 %) aged 18–60 became infected with SARS-CoV-2 within the 11 days following a shared bus journey of several hours. The cohort comprised solely those actively engaged in sports, i.e. only players and trainers were included in the cohort. Others in immediate contact with the squad (staff) were excluded, even though further positive and negative cases of Covid were identified in those in the team's environment. After the initial positive rapid antigen test, diagnosis was confirmed with a PCR test. The CT values in the tests were between 14.88 and 29.7. In some tests, there was molecular genetic evidence of an N501Y mutation without an L452R mutation, indicating an Omicron variant, specifically SARS-CoV-2 B.1.1.529. At the time of the infection, everybody in the cohort was considered as vaccinated or recovered. Two of the infected athletes were considered as having received a booster shot.

The vaccination/recovery status in detail was as follows:

- » 20 had received two doses of the Pfizer/Biontech vaccine
- » 1 had received two doses of the Astra Zeneca vaccine
- » 4 had received one dose of the Johnson and Johnson vaccine
- » 1 had received two doses of the Johnson and Johnson vaccine
- » 2 had received two doses of the Moderna vaccine
- » 1 had received one dose each of the Moderna and Pfizer/Biontech vaccine
- » 1 was considered as recovered and had received one dose of the Pfizer/Biontech vaccine
- » 2 had been considered as recovered since October
- » 3 were considered as having received one Pfizer/Biontech booster vaccine in the period up to seven days prior to infection

STUDY FINDINGS

As the return to play protocol provides for a medical examination post recovery and the scope of the tests is based on the symptoms and physical examination, but in this case well over half the team were infected, it was decided to conduct an initial examination in the course of the infection. This first involved performing a medical history and physical examination. A blood sample was then taken. The following blood parameters were determined:

- » basic blood count and additional differential blood count
- » iron
- » CK, CK-MB
- » GOT, GPT, γ -GT, ALP, GLDH, total bilirubin
- » creatinine, GFR
- » NT-proBNP, Troponin T
- » ferritin

These tests and examinations were performed between 3 and 8 days post infection. When their medical history was taken 3 of the cohort stated that they were asymptomatic. The remaining 22 athletes reported symptoms ranging from mild irritation of the pharynx and larynx to fever, night sweats, dyspnoea, hyperhidrosis and dizziness. At no point did any of the patients require hospitalisation. The auscultation findings for the heart and lungs in the physical examination were unremarkable. In laboratory tests, however, there was a noticeable CRP increase above 5 mg/L in 3 of the cohort, an elevated troponin T level above 0.014 ng/mL in a further

3 patients and a CK-MB of 33 with a total CK of 219 U/L, equivalent to 15 %, in one other patient. Although a further 4 patients also had an elevated CK-MB level, total CK was normal. This finding was accordingly considered as not clinically relevant, though it is a matter of debate as to whether this might nevertheless indicate irritation of the myocardium. A monocyte count of between 10 and 21 % was found in 15 athletes, in 2 of whom neutropenia was also identified (40 %, 37 % and 28 %). The findings for transaminase and kidney parameters in clinical chemistry did not provide any useful indications.

The symptoms of all patients improved in the following 10 days. Follow-up tests and examinations were provided to the infected patients subsequent to the quarantine imposed by the authorities. The procedure followed was based on the return to play protocol. Fortunately, no clinically relevant arrhythmias were identified in the resting ECG and ergometry (up to a max. of 450 W) (Tab. 1 – ergometer step protocol).

The results of laboratory tests also indicated regression. Although the findings of the pulmonary function tests conducted were normal, they nevertheless indicated loss of function when compared to the pulmonary status in the preseason physical fitness test (Fig. 1 (pulmonary function test), Table 2 (pulmonary function)). In the case of the athletes this means that in the preseason physical fitness test the lung volumes of

TAB. 1 Step protocol of the ergometry

	TIME [MM:SS]	LOAD [W]	HF [/MIN]	BD [MMHG]	ST V5 [MM]
Bevor	0:06	0	102	120/70	0,3
Load 1	3:00	100	124	140/65	0,2
ST-Max.	3:56	150	146	-	0,2
Load 2	6:00	150	154	130/70	0,9
Load 3	9:00	200	179	135/70	1,8
Load 4	10:48	250	182	140/70	1,3
Regeneration	3:00	25	118	130/70	0,9
EoT	3:11	25	129	-	0,7

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each athlete were markedly greater than those of a normal patient. The follow-up test after quarantine now showed reduced function when compared to the preseason test but one which was nevertheless classified as “normal”.

An echocardiography was performed in 15 patients. This was indicated in patients with either positive troponin T, elevated CK-MB, previous fever or elevated resting pulse rate. A mild, haemodynamically nonsignificant pericardial effusion was detected in one patient 18 days after a positive PCR test. This finding also regressed in the further course. Three athletes with elevated troponin T or a persistent markedly elevated resting pulse rate underwent cardiac MRI. Fortunately, none of the findings indicated any pathology. A chest X-ray in PA and laterally was performed post Covid infection in one patient with persistent cough and dyspnoea. The cardiopulmonary findings were unremarkable with no indication of pneumonia. As the symptoms regressed in the further course, it was not considered necessary to perform a chest CT scan to detect milk glass opacities. On completion of the tests and examinations, all the athletes were able to begin the reintegration part of the return to play protocol. This lasted on average 7-10 days. As loading was gradually increased, one athlete complained of dyspnoea and another of dizziness at

high loads. The return to play protocol was adjusted accordingly. The heart rates determined by the HR belt worn at each training session were similarly too high for the respective load provided for in the protocol. The training intensity had to be adjusted for 2–4 days (Figs. 2, 3).

SUMMARY AND DISCUSSION

25 of a team of 32 men (80 %) actively engaged in sport and aged 18–60 became infected with SARS-Covid-CoV2 although all of them had either previously recovered from the infection or had been vaccinated or had received a booster shot against it. Of those who became infected, only 3 (12 %) were asymptomatic and 3 (12 %) were found to have an elevated troponin T level. Mild pericardial effusion was initially identified in one person (4 %). Of the 3 athletes who had received a booster shot, one did not become infected and the other two reported only mild symptoms (Fig. 4). Due to the small size of the cohort it was not considered necessary to establish individual vaccination status in relation to the severity of the course of the disease.

All the infected athletes became infected even though they had either recovered from the infection or been vaccinated against it. Although vaccination does seem to provide protection against a severe course, this is not sufficient to prevent infection with the Omicron variant. As cardiac involvement cannot be ruled out in a SARS-CoV-2 infection, even if the patient is asymptomatic and has been fully vaccinated, and is likely to be detected in laboratory tests and imaging, it is recommended that patients actively engaged in sports be closely monitored subsequent to a Covid-19 infection to minimise the risks of cardiac affection to the fullest possible extent. Laboratory diagnostics including troponin T and a resting ECG at minimum are recommended in addition to the physical examination. If a patient had developed a fever during the course of the infection, it seems sensible to perform further laboratory diagnostics. In patients with an elevated troponin T level or echocardiography abnormalities, in my judgement, particularly considering previous test and examination findings for recovered patients, even in those who were reportedly asymptomatic,

TAB. 2 pulmonary function

		SOLL	BESTE	%SOLL	MESSUNG 1
FVC	[L]	5,83	5,67	97	5,67
FEV 1.0	[L]	4,87	4,33	89	4,33
FEV 1.0/FVC	[%]	83	76	92	76
PEF	[L/s]	10,63	6,42	60	6,42
MEF 75 %	[L/s]	9,07	6,06	67	6,06
MEF 50 %	[L/s]	6,01	3,80	63	3,80
MEF 25 %	[L/s]	2,91	2,40	82	2,40
VC	[L]	6,12	0,00		

the indication for cardiac MRI should be liberally interpreted.

As a study on 789 athletes by Martinez et al. published in March 2021 confirms, implementation of a return to play protocol noticeably reduced the risk associated with training loads in sports subsequent to a Covid-19 infection [3]. As in this case athletes became infected with the Omicron variant despite being vaccinated and there was suspicion of cardiac involvement, the return to play protocol available to the German ice hockey league (Penny-DEL) as a guideline should be regularly discussed and adjusted. The cohort data collected shows that the Omicron variant of the Covid 19 virus can also impact different organ systems in those who have recovered

or been vaccinated, the risks of which can be noticeably reduced by systematic monitoring and individual adjustment of the scope of examinations and training tests as part of reintegration into sports.

Literature

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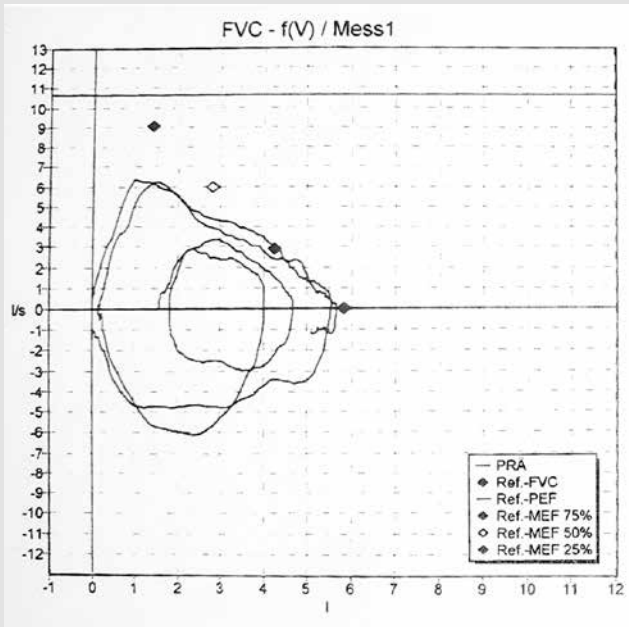


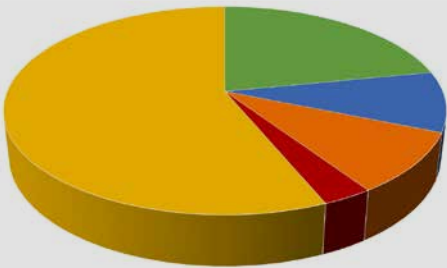
FIG. 1 pulmonary function test



FIG. 2 training report 1



FIG. 3 training report 2



- asymptomatic (3)
- unremarkable clinical findings (18)
- abnormal troponin T (3)
- not infected (7)
- pericardial effusion on echocardiography (1)

FIG. 4 Overview of the cohort in relation to infection and illness and patients with relevant test results.

EXPERT TALK

Our scientific advisor, Felix Post MD, Medical Director of Internal Medicine/ Cardiology at the Catholic Hospital of Coblenz-Montabaur, where he is also the head of the Corona task force, had the opportunity to read the article by Jochen Veit MD before publication and discussed it with him, as one expert to another.

Felix Post (FP) Hello Jochen, I was lucky enough to read your article before it was published in the sportärztezeitung. Congratulations! The data are really interesting and should really interest any practicing team doctor.

Jochen Veit (JV) Thank you. I simply wanted to know what effect Covid has on athletes who are asymptomatic. Does asymptomatic really mean that it has no effect whatsoever? Unfortunately, I discovered evidence of changes even in asymptomatic athletes.

FP You even visited players when they were in quarantine, which allowed you to obtain data, such as elevated troponin. What did that exactly involve?

JV It wasn't an easy job. I had to visit each player in quarantine, as they were not allowed to visit me. I had to perform the examination in full PPE. That is no routine matter. The data did surprise me though and of course also had consequences. Many players required further cardiac evaluation, in some cases even cardiac MRI.

FP You write that virtually all the players suffered some impairment, or performed worse than in their preseason fitness physical, albeit still within the normal range. What does this tell us about the sometimes very early return to play of professional athletes after Covid infection?

JV That is hard to say. On the positive side, there are as yet no known cases of players suffering harm after apparently returning to play too early after Covid. That does not mean, however, that no such cases exist. Looking at my players, I did discover one case of pericardial effusion and that only happened because I was more thorough in my testing than required. I would

not be happy with a player with pericardial effusion being considered as "fit for return to competition" after 7–10 days' quarantine.

FP That is the way I see it too. But what about all the amateur athletes? Sometimes they train just as hard as professional athletes and in lower divisions loads during play are often also just as high.

JV That is indeed a problem. I would really advise any dedicated athlete to have a proper medical check-up before they resume training. But I am also aware that in individual cases it can be hard to get a prompt appointment. And if we are also talking about an echocardiography, then that is virtually impossible.

FP As we are on the subject of problems, one problem that I have at the moment in supporting clubs is that not all the players live in the same administrative district. This means that the responsible health departments are not the same for all the players and so the quarantine regulations differ too. This is baffling for players and makes things complicated. So much for German federalism.

JV Luckily, it's not a problem I share; all the players I support live in the same area. But the different quarantine regulations of the different health departments are really a problem in the league.

FP Many athletes who are either asymptomatic or have few symptoms nevertheless carry out gentle cardio exercises in quarantine to stay in condition. How do you view that?

JV I have urged my players to stop all sport and I think my results also back this up. Many players, even those who were asymptomatic, had blood count changes

Felix Post, MD



suggesting viraemia. Doing any sport would be counterproductive.

FP I can understand that. Finally, a look into the glass ball. What do you think will happen next with Covid?

JV I am not sure how to answer that. Can anybody answer that? The Omicron wave will pass and I think the numbers will go down in March. I also think things will get better in the summer. But nobody can say what will happen in the autumn and how we will deal with it. COVID and the restrictions imposed by it are a major burden, in professional sports too. It is particularly the inability to plan ahead that is a major challenge for many clubs, both logistically and also, of course, financially.

FP Thank you for talking to me. Please continue exactly as you are doing. Sport and athletes deserve motivated team doctors such as yourself.

Final question from the editors

Should amateur/recreational athletes self-monitor their pulse rate during and after return to sport? And would it also be advisable, for example, to dispense with stimulating, distracting music in this phase to increase self-awareness through to prophylaxis training?

JV Yes, in my opinion it is very important to monitor the pulse using an HR belt or smartwatch. With some devices it is also possible to make an ECG recording. This allows early detection of extrasystoles and arrhythmias. Any background music should also be initially avoided during workouts to allow more focused listening to the body. In general, I would also recommend amateur athletes to gradually increase loading in steps as laid out in the return to play protocol (see the sportärztezeitung). If in doubt, be mindful that it is better to take one or two steps back than to progress too fast to maximum loading and be exposed to all the health risks that may entail.

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VITAMIN K2

In combination with vitamin D

In the last issues of the sportärztezeitung, but also online on our new sports medicine portal www.sportaerztezeitung.com, we focused on the topic of vitamins, particularly on vitamin D deficiency and the positive effects of vitamin D combined with vitamin K. The results collated to date with additional current information, including also vitamin C and the immune system, can be found at www.sportaerztezeitung.com/category/rubriken/ernaehrung/

We are delighted that our long-term partner and scientific advisor to the sportärztezeitung, Klaus Pöttgen, has now picked up this thread, giving in this issue an interesting insight into current research and discussing further its importance for athlete care.

KLAUS PÖTTGEN, MD / TEAM DOCTOR FOR SV DARMSTADT 98 WITH THE YOUTH ACADEMY, TEAM DOCTOR FOR THE GERMAN TRIATHLON UNION

The important role played by vitamin D in bone metabolism and thus in sport has been studied in detail in recent years. The importance of an adequate supply of vitamin D in sports medicine, however, lies not only in regeneration following bone injury but also for many years in prevention and the positive effect on the immune system.

As presented in the article by Prof. Ghanaati, Dr Volz et al. in the 04/2020 issue of the sportärztezeitung (pp. 96–98), the following functions also play a role:

- » anti-inflammatory effect via cytokines
- » expression of proteins as transcription factors via vitamin D receptors on body cells (muscles)
- » immunomodulation
- » improved cardiopulmonary loading capacity.

VITAMIN D AND VITAMIN K

Without vitamin D, calcium ingested in food cannot be absorbed and used by the body. Vitamin D controls the syn-

thesis of proteins that later require activation by vitamin K. The vitamin K group is named for its indirect effect on coagulation (after the Danish/German word “Koagulation”). Nowadays, a distinction is drawn between the different forms of the fat-soluble vitamin, primarily between K1 and K2 with its subforms (menaquinone – MK).

VITAMIN K FORMS – SUPPLIED IN THE NUTRITION AND BY SYNTHESIS

Vitamin K1 (phylloquinone) is synthesised by plants and algae. 70–90 % of this vitamin is ingested in green leafy vegetables such as kale, Brussels sprouts, broccoli and spinach and smaller amounts in soya oil, rapeseed oil, liver and eggs. Vitamin K2 (menaquinone) is both produced in small amounts in humans by the enzymatic conversion of K1 and ingested in its subforms in fermented products such as yoghurt and cheese, is formed by bacteria and occurs typically in amounts of less than 25 % [1,2]. Following a review by the European regulatory body, the EFSA, vitamin K2 was approved for use in European food and nutrition supplements in 2009. In terms of prevention and treatment, menaquinone-4 (MK-4) and menaquinone-7 (MK-7) are the two most important vitamins in the vitamin K group [9,10]. There is a traditional food in Japan called natto, which is made from soybeans that have been fermented with *Bacillus subtilis* and which contains high amounts of MK-7 [3]. 10–50 % of our daily K2 requirement is met by specific gut bacteria generally responsible for producing K2 [5,6] and requires a healthy individual gut microbiome for vitamin K-dependent physiological processes. MK-4 is the only menaquinone that cannot be formed by bacteria in the gut microbiome and is only produced in indivi-

dual organs from plant-based K1 (phylloquinone) [4]. As there has been a marked deterioration in gut health and fewer fermented foods are being consumed, studies doubt that the amount of K2 produced by the body is sufficient to meet our daily K2 requirement and assume that vitamin K deficiency is widespread in western countries [5–8].

METABOLISM – CARBOXYLATION CARDIOVASCULAR SYSTEM

Matrix Gla protein (MGP) and osteocalcin are the two extrahepatic vitamin K-dependent proteins that have been best studied [11]. Whereas osteocalcin promotes the integration of calcium into the bone matrix and thus supports bone metabolism, vitamin K-dependent MGP helps prevent calcification of the blood vessels, the development of inflammatory atherosclerosis with focal plaque formation and age-related wear and tear of the arteries. It thus protects the blood vessels against calcium overload [12,13]. Vitamin K2 activates MGP by carboxylation. It is only in this carboxylated state that it binds and transports free calcium in the blood [14,15]. In vitamin K2 deficiency, the calcium-binding proteins are undercarboxylated and thus inactive. In the 2004 Rotterdam heart study of 4,807 subjects over a ten-year period, it was shown that people who consumed foods naturally high in vitamin K2 (min. 32 µg daily) had markedly fewer calcium deposits in the arteries. Vitamin K2 reduced the risk of developing blood vessel calcification and of dying of cardiovascular disease by 50 % [16]. Increased vitamin K2 intake lowered the mortality risk in elderly patients by 25 % [18]. This was also shown in other studies to be the case for vitamin K2 alone but not for vitamin K1, some of which is converted to K2 [17]. This relation seems to be confirmed by increased blood vessel calcification under treatment with vitamin K antagonists [19]. In another study, rats were administered a vitamin K antagonist to induce calcification of the arteries. If rats were then given food

containing vitamin K2, this reduced the calcium content of the arteries in the rats by 50 %. Thus, vitamin K2 not only prevented calcification but even reversed it [20]. Vitamin K2 is an isoprenoid quinone like CoQ10, has structural and functional similarities with coenzyme Q10 and acts as an electron carrier in certain species of bacteria. Vitamin K2 was therefore ascribed an important function as an electron transporter in the mitochondria of eukaryotic cells and, as regards the mitochondria, was thought to mimic the role of coenzyme Q, which supports mitochondrial ATP production in the respiratory chain [21]. In 2019, however, it was shown that vitamin K2 cannot replace coenzyme Q10 as an electron carrier in the mitochondrial respiratory chain of mammal cells (mice with a genetic defect). Further studies on this subject are therefore necessary [22].

BONE

Active vitamin D regulates transcription of osteocalcin and only functions when it has been carboxylated by vitamin K. Vitamin D and vitamin K therefore act in synergy in bone formation. Vitamin K, primarily MK-7, also likely inhibits the transcription factor NFκB and by so doing helps improve bone formation [24]. Inadequately carboxylated calcitonin has a lower affinity to calcium phosphate in the bone matrix. Only carboxylated osteocalcin (cOc) promotes mineralisation of the bone matrix, increases bone strength and reduces the risk of fracture. Patients with atrial fibrillation who were not treated with vitamin K antagonists to prevent blood clotting had a lower risk of osteoporosis [23]. Elderly women with osteoporotic hip fractures had markedly lower serum levels of vitamin K [25]. Low vitamin K intake and high levels of undercarbo-

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The literature list can be found with the article at www.sportaerztezeitung.com

xylated osteocalcin (ucOc) are independent risk factors for hip fractures [27–29]. In Japan, pharmacological doses of MK-4 (10–90 mg/d) are routinely used to treat osteoporosis and in postmenopausal women over a period of one to three years demonstrate a positive effect on maintaining bone density and fracture risk, as shown in a meta-analysis of 6,759 subjects [30].

K2 DEFICIENCY – UNDERCARBOXYLATED OSTEOCALCIN (UCOC)

In vitamin K deficiency, the calcium-binding proteins are undercarboxylated and thus inactive. Blood samples of healthy subjects showed that although all coagulation proteins had been completely carboxylated by vitamin K, most of the study subjects had high levels of undercarboxylated γ -carboxyglutamate acid proteins (osteocalcin, matrix Gla protein). Undercarboxylated osteocalcin (ucOc) and matrix Gla protein (ucMGP) are functional laboratory parameters for vitamin K deficiency and are associated with an increased risk of

bone fractures and/or blood vessel complications. Based on the results of this study, it must be assumed that a large part of the population does not have an adequate supply of vitamin K2 [31].

ADMINISTRATION OF VITAMIN K2

There is increasing evidence that the recommended daily vitamin K requirement given by professional nutrition societies for the γ carboxylation of the osteocalcin and matrix Gla proteins cannot be adequately met by a normal nutrition [32]. Both MK-4 and MK-7 are almost completely ingested from food and supplements. However, there is a big difference in the half-lives of the two forms in the body: MK-4 is eliminated after just a few hours, whereas MK-7 remains available in the blood for a full 72 hours. MK-7 thus demonstrates a far better and longer efficacy [33–35]. The body can only process the trans form of MK-7, a fact which is therefore particularly important when selecting a vitamin K2 product [48]. However, in 2018 it was shown that some products contained only a minimal amount of

the effective trans form [49]. As daily supplementation with MK-7 can significantly affect anticoagulation, the authors advise against administration in patients under treatment with vitamin K antagonists [35,36]. Increased ucOsteocalcin also increases the risk of other chronic inflammatory diseases, such as type 2 diabetes. In a study in 2020, separate or combined supplementation with vitamins D3 and K2 significantly lowered glucose levels and the proportion of functional pancreatic beta cells. Administration of D3 + K2 induced a reduction in the uOC/cOC index [37]. Apart from its function in calcium-dependent metabolic pathways initiated by vitamin D, vitamin K also has its own anti-inflammatory effect by inhibiting the expression of pro-inflammatory cytokines. As an electron carrier, vitamin K protects against oxidative stress and thus helps inhibit inflammatory processes. Studies in both humans and animals have shown that vitamin K2 improves not only insulin sensitivity due to the involvement of the vitamin K-dependent protein osteocalcin but also regulation of adipokine levels, anti-inflammatory properties and lipid-lowering effects in type 2 diabetes [38, 39].

LABORATORY TESTS

Tests to determine the level of vitamin K2 in the blood are unsuitable for status analysis, as vitamin K2 is fat soluble, and the tests only show the blood level on the day of testing but not what is stored in tissue. It is an unstable molecule and pre-analysis is difficult, involving centrifugation and frozen transportation to the laboratory. Furthermore, levels fluctuate dramatically due to the short biological half-life of (MK-4 – 1 h, MK-7 approx. 72 h). Although vitamin K1 increases osteocalcin carboxylation, it is only MK-7 intake that results in a further increase in carboxylation levels. Vitamin K2 is an essential cofactor of osteocalcin carboxylation, i.e., the conversion of undercarboxylated “uc” osteocalcin to its carboxylated form. Undercarboxylated osteocalcin correlates with low bone density and increased fracture risk [40]. When the supply of vitamin K2 is poor and/or bioactivity is low, only a small proportion of the osteocalcin is carboxylated. This leads to an increase in ucOsteocalcin. Increased values indicate absolute and/or functional vitamin K2 deficiency. Various authors recommend determining the uOC/cOC or cOC/uOC index or an index with the total osteocalcin level (uOC/tOC) [41–43].

SPORTS

In cases of insulin resistance, Vitamin K2 improves mitochondrial function by improving respiratory capacity and by enhancing biogenesis and the enzyme activities of mitochondrial complexes by SIRT1 (Sirtuin 1) signal transduction [44,45]. Sirtuin 1 is involved in the differentiation of muscle cells, metabolic switching to lipolysis and retardation of apoptosis. An in vitro study in 2018 showed that vitamin K2 (MK-4) has a positive effect on the migration and proliferation of muscle – two important early steps in myogenesis [46]. If im-

proved cardiac function under K2 administration had hitherto only been demonstrated in ill patients, this was also successfully demonstrated in healthy athletes in 2017. An 8-week intake of vitamin K2 was associated in 26 aerobic trained male and female athletes with an increase in maximum heart rate capacity of 12 % in the cycle ergometer test [47].

FOOTBALL

Vitamin D: In preliminary tests on 28 players in a Bundesliga squad, the mean vitamin D level in summer was 47.45 $\mu\text{g/L}$ (24.1 – 75). In 26 players in January, it was 32.5 $\mu\text{g/L}$ (14.5 – 62.2), with 8 players more or less taking regular supplementation.

The table below of six of the players not taking supplementation is intended to illustrate how dramatically vitamin D levels can fall.

VITAMIN D LEVEL IN MG/L						
PLAYER	1	2	3	4	5	6
SUMMER/AUGUST	36,4	65,8	67,7	58	69	62
WINTER/JANUARY	14,5	32,4	22,5	34,2	25	33
FALL IN MG/L	21,9	33,4	45,2	23,8	43	29

Vitamin K2: 14 of the 28 players were shown to have increased ucOsteocalcin in the preliminary tests. This is an indication of vitamin K2 deficiency.

This could be followed up with nutrition counselling and a microbiome test. Vitamin D should be administered in combination with K2.

CONCLUSION

- » In addition to its effect on bone health, vitamin K2 is also likely to play an important role in protecting arterial walls against calcification.
- » Vitamin K2 in the trans form of MK-7 seems to be the best form of supplementation.
- » Vitamin K should not be administered to patients under treatment with vitamin K antagonists.
- » Tests to determine the level of vitamin K2 in the blood are unsuitable for status analysis.
- » Increased values of ucOsteocalcin indicate absolute or functional vitamin K2 deficiency. (Some authors also recommend determining quotients of ucOsteocalcin/total calcitonin or ucOsteocalcin/cCalcitonin).
- » In the above case, administration of vitamin D in combination with K2 is particularly to be recommended.
- » Vitamin K2 has a positive effect on diabetes.
- » There is evidence of improved mitochondrial function and increased aerobic performance.

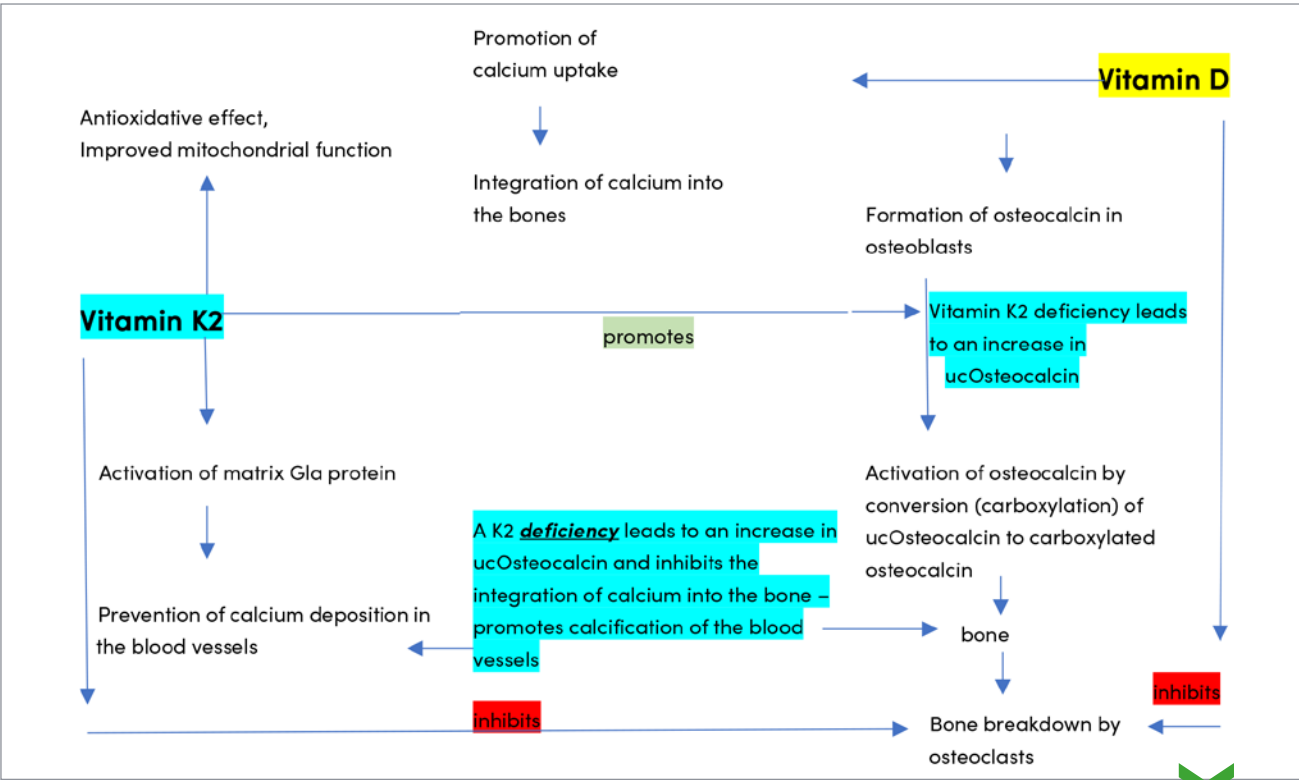
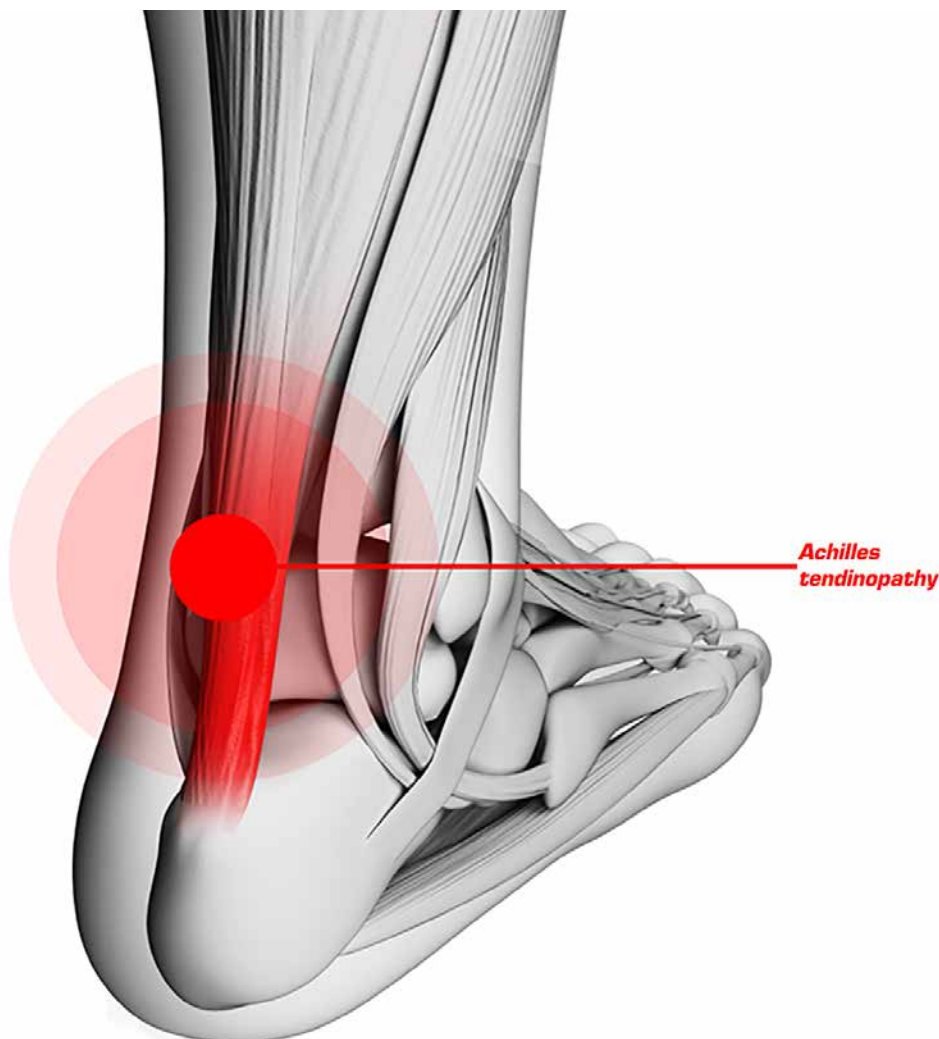


DIAGRAM Vitamin D and K2 model

ECCENTRIC LOADING VERSUS ECCENTRIC LOADING PLUS SHOCK-WAVE TREATMENT

for midportion Achilles tendinopathy: a randomized controlled trial

Methods: All patients had an established diagnosis of chronic mid-portion tendinopathy of the Achilles tendon for at least 6 months before treatment and a history of unsuccessful nonoperative management that involved: peritendinous local injections, nonsteroidal anti-inflammatory drugs, and physiotherapy.



The study cohort consisted of two carefully selected groups:

- » Eccentric loading group (N=34) – control group involved patients with an established diagnosis of mid-portion tendinopathy of the Achilles tendon who underwent eccentric training. Patients performed 3 sets of 15 repetitions with 1 minute of rest between the sets twice a day 7 days per week for 12 weeks.
- » Eccentric loading with repetitive low-energy shock-wave therapy (SWT) group (N=34). Patients with an established diagnosis of mid-portion tendinopathy of the Achilles tendon underwent an identical eccentric training regimen and, after 4 weeks, SWT.

Repetitive low-energy shock-wave therapy consisted of 3 sessions at weekly intervals. DolorClast® Radial Shock Waves device (Electro Medical Systems, Nyon, Switzerland) was used for shock wave treatment. Each session involved 2000 impulses with a pressure of 3 bar (equals an energy flux density of 0.1 mJ/mm²). The treatment frequency was 8 pulses per second. Following the principle of clinical focusing, the authors have treated the area of maximal tenderness, beginning at the point of maximum pain level. No local anesthesia was applied.

OUTCOMES

All patients underwent pretreatment evaluation. The clinical outcomes were determined by:

- » the VISA-A questionnaire was used to evaluate clinical severity,
- » 6-point Likert scale was used for general assessment,
- » the 11-point numerical rating scale was used for pain assessment.

RESULTS

In order to allow time for collagen turn-over and remodeling, observer-blinded outcome assessments were performed 16 weeks after baseline assessment.

VISA-A SCORE

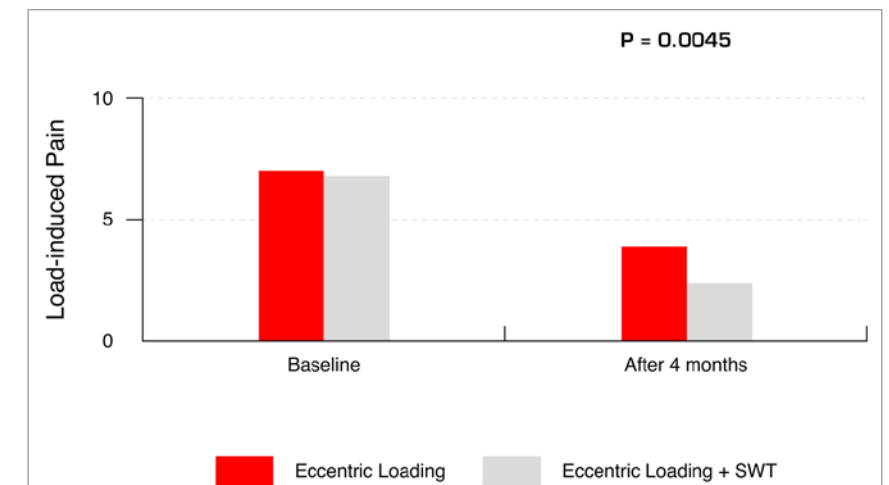
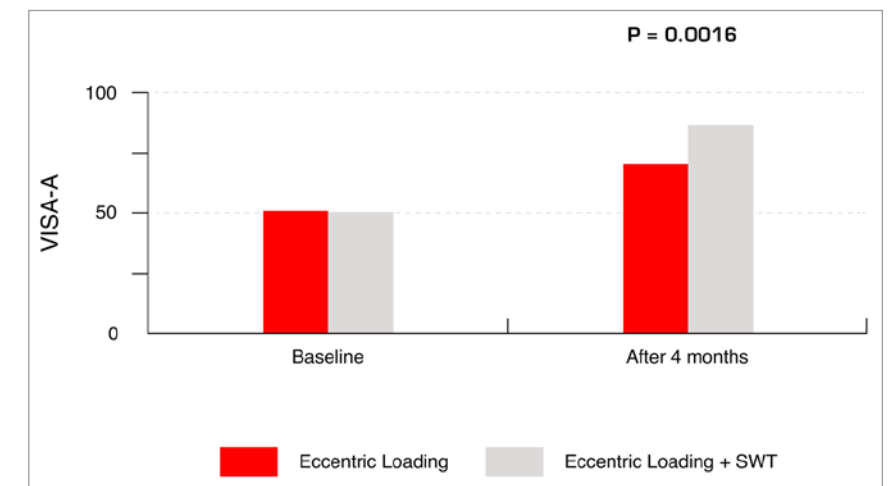
An increase in VISA-A Score has been demonstrated in both groups, from 50 to 73 points in group 1 (eccentric loading) and from 51 to 87 points in group 2 (eccentric loading with shock-wave treatment).

GENERAL AND PAIN ASSESSMENT

A Likert scale of 1 (defined as complete recovery) or 2 points (defined as “much improved”) was reported in 56 % of patients in group 1 and as much as 82 % of patients in group 2. A pain rating decrease has been demonstrated in both groups, from 7 to 4 points in group 1 and from 7 to 2 points in group 2.

SIDE EFFECTS

The authors reported a zero occurrence of serious complications. All patients who underwent SWT experienced transient reddening of the skin after low-energy SWT but no bruising. There were no device-related complications. Although patients reported an ache in the calf due to eccentric loading, there was no interruption of the eccentric loading training regimen. Throughout the study period, there was no incidence of Achilles tendon rupture.



“Eccentric loading alone was significantly less effective when compared with a combination of eccentric loading and repetitive low-energy shock-wave treatment. Combined treatment allows to substantially alleviate pain.”

CONCLUSION

This study has conclusively proven that combined treatment of eccentric loading and repetitive low-energy shock-wave treatment allows to significantly reduce pain and improve function. Shock wave therapy constitutes a highly valuable addition to eccentric loading as it stimulates soft tissue healing and inhibition of pain receptors. Patients wishing for quick and effective relief of

chronic symptoms together with a return to full activity should opt for the combined treatment.

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BACK TO THE TOP OF THE WORLD

the DFB Academy Medical Centre

**DR THOMAS HAUSER / HEAD OF MEDICINE AND SCIENCE,
MEDICAL CENTRE, DFB ACADEMY, FRANKFURT A.M.**

The DFB Academy in the heart of Frankfurt is the engine for all DFB national teams, a networking and exchange platform, an innovation driver as well as a further education and training institution for experts in football. As part of the DFB Academy, the new Medical Centre is responsible for the medical and physiotherapeutic care of all national players, football medical research as well as medical training and further education programmes for doctors and physiotherapists in professional and amateur football.



Through new scientific findings, their application in football practice and the transfer and exchange of knowledge, we are helping German football to return to the top of the world. With over 100 doctors and physiotherapists, we offer a large network of experts who are responsible for the medical care of our junior and senior national teams during international matches worldwide. The medical centre is also home to an outpatient clinic that provides all active athletes on the DFB campus with the best possible first aid for injuries and illnesses. Thanks to a long-term cooperation with Frankfurt University Hos-

pital, serious treatments and complex diagnostics such as MRIs can be carried out at the hospital as a maximum care facility.

In addition, we conduct football-specific research projects together with the university hospital and other universities. For example, we are looking into football-specific nutrition, the influence of neuroathletic training on performance development, decision-making in complex situations or the healing process of muscular injuries at the cellular level. Interdisciplinary research groups consisting of scientists, doctors and coaches

DR THOMAS HAUSER

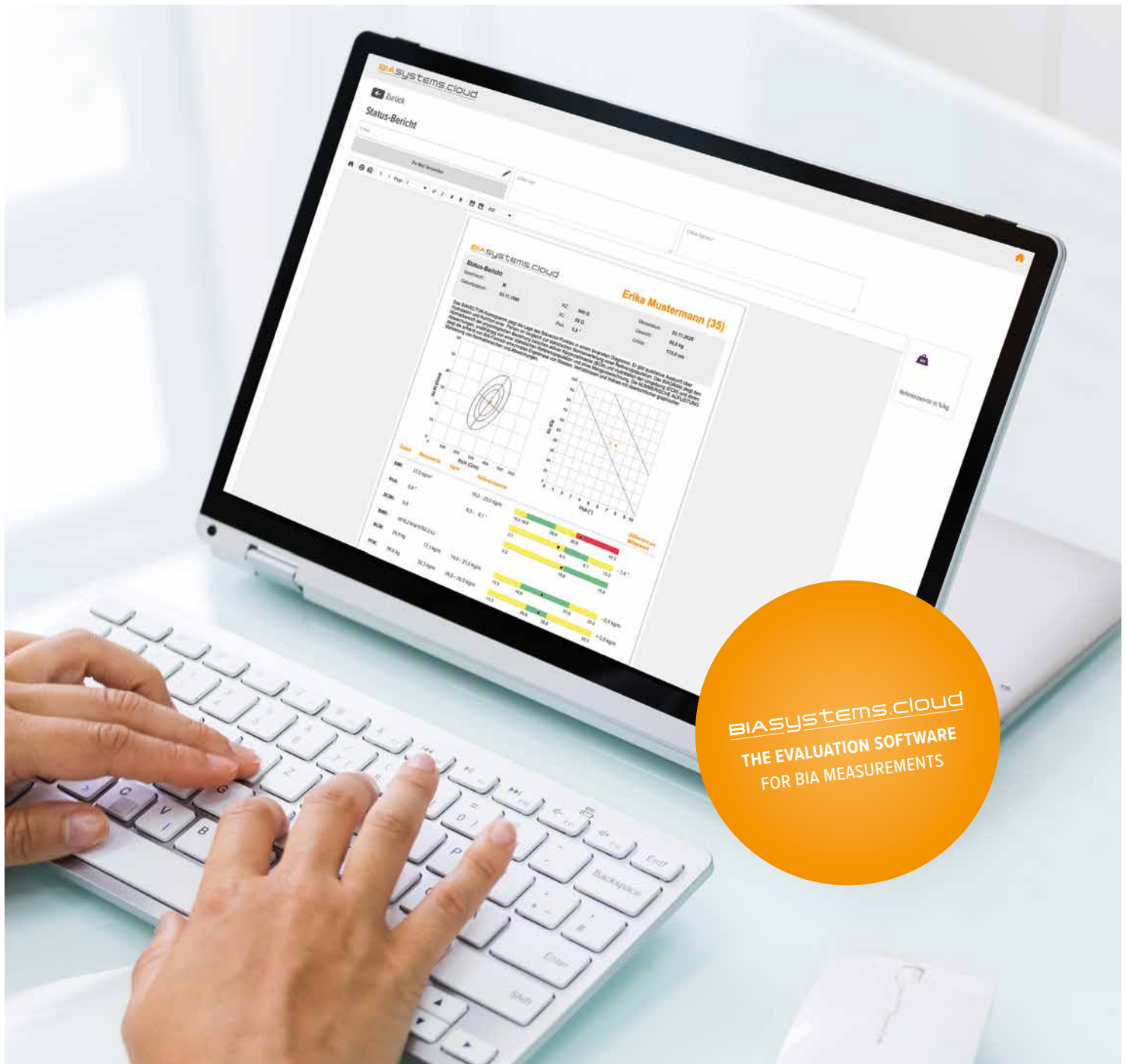


is Head of Medicine and Science, Medical Centre, DFB Academy, Frankfurt a.M. He is member of the Medical Committee of DFB and holds the UEFA A- license for coaching.

work together on the research project in order to transfer the results into practice in the best possible way.

However, the Medical Centre has not only set itself the goal of researching and applying new findings, but also of sharing them with interested medical staff. Twice a year, for example, we run the certified advanced training course in football medicine, which is available in hybrid form in the winter and digitally in the summer as an advanced training course for national and international doctors from professional and amateur football. The from UEFA co-financed programme cover topics such as heart disease after COVID19 infection, rehabilitation after muscle injuries and the influence of head ball play on the brain. Furthermore, we provide information about the latest scientific studies on football medicine via www.dfb-akademie.de

Creating, applying and sharing knowledge – this is our objective at the DFB Academy Medical Centre. The DFB Campus is a place of encounter. We would be delighted to welcome you to the new campus as well.



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