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# 2021  
international edition of  
sportärztezeitung

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

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



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## » CONSERVATIVE TREATMENT & REHABILITATION



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### GENDER GUIDELINES

When people of both genders are intended,  
only the masculine form is used to simplify  
the text and improve readability.

### COVER

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## GREETINGS FROM THE PUBLISHER

The team from thesportgroup is proud to cooperate with the Isokinetic Conference and the innovative and strong network in football medicine since 8 years. We look forward to next year's conference in Lyon and we wish the organizers all the best and much success. Best regards yours thesportgroup-Team!



## ISOKINETIC CONFERENCE 2022

The next Isokinetic Conference will be held on the 4th, 5th, 6th of June 2022. The venue will be, as planned, the Convention Centre il Lyon, France. The Scientific Programme is already available on the conference website [www.footballmedicinesstrategies.com](http://www.footballmedicinesstrategies.com)

Due to the recent global pandemic, Isokinetic Medical Group was forced to wait for a safer period of the year to hold an in-person Conference. We are looking forward to enjoy again the special atmosphere of friendship that we have always created putting the international football medicine community under the same roof.

Until we arrive at the Conference in Lyon, we had organised 4 Virtual Summits, every three months. These Summits brought together leading researchers, field based practitioners and thought leaders from across the world of Football Medicine, including "The Player's Voice".

For example, let's take a look at the "Ongoing ACL dilemmas" Summit scientific programme that was held on the 18th April, and now available on-demand.

- Big decision? The role of graft selection in ACL surgery Volker Musahl (USA)
- Brain power for the ACL patient Dustin Grooms (USA)
- More risk, more reward for female athletes after ACL injury? Nicole Surdyka (USA)
- Not again! Strategies to reduce the 2nd ACL injury Francesco Della Villa (ITA)
- And with the testimony of 4 players Zlatan Ibrahimovic, Hector Bellerin, Rebecca Smith and a young female footballer

Save the date – the next Virtual Summit: Sunday 20th March 2022 – FIFA MEDICAL: preparing for World Cup 2022

### IN THE END WHAT ABOUT THE CONFERENCE IN LYON?

After this especially difficult period, which has been tough for everyone, it is vital to meet and exchange face to face with our colleagues and experts, it is important to hold the Conference to gather around the scientific program and to come and visit the event marked by the presence of our industry partners. Sharing of scientific knowledge is one of the foundations of our profession.

The Isokinetic Conference Team is looking forward to welcoming you in Lyon in June 2022.

We take this opportunity to thank our Sponsors, that always stay by our side, believe in scientific sharing, gave us support and trust. You can learn more about them in a dedicated page of the Conference website. Amongst them, The Sport Group, cooperates with us for long time.

# XXIX Isokinetic Medical Group Conference

# Football Medicine

# THE PLAYERS' VOICES

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# TREATMENT OF MUSCLE INJURIES

What do the data say, and what is the practical procedure

**PROF. ANJA HIRSCHMÜLLER MD,**  
**ALTIUS SWISS SPORTMED CENTER, RHEINFELDEN, SWITZERLAND**

**The treatment of muscle injuries is based first on the physiology of muscle healing, and second on the site and severity of the injury. The “Munich Consensus Classification” according to Dr Müller-Wohlfahrt and the “British Athletics Classification” are most commonly used to assess the severity of the injury. While the first also takes ultrastructural injuries into account, the second is considerably more clearly differentiated regarding the structural lesions.**

It also takes into account the localisation within the musculature and possible involvement of the intramuscular tendon, and classifies the extent of the injury depending on the cross-section of the muscle. A correlation with the total downtime in professional football has been proved for the Munich Classification. If there is no evidence of a structural injury it is vitally important to search for possible neuromuscular causes or muscular imbalance as the precipitating factor, especially in repeat cases.

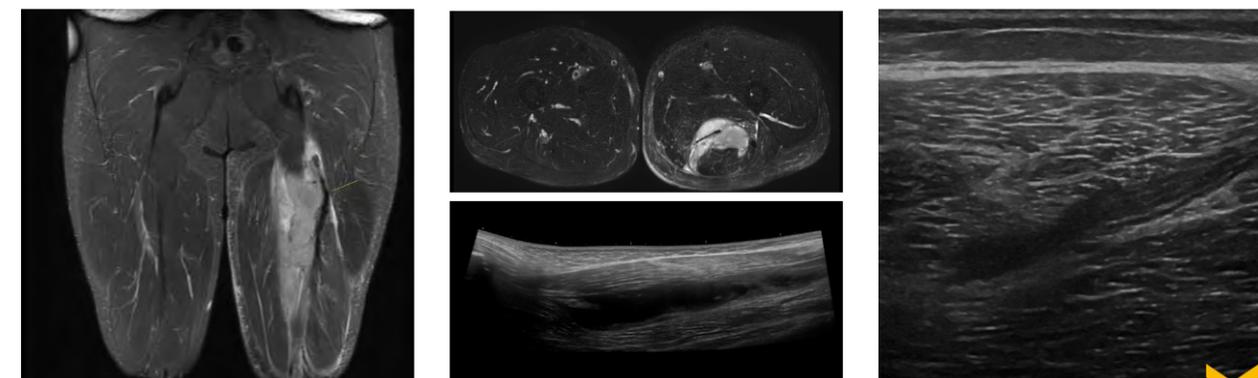
**PHYSIOLOGY OF MUSCLE HEALING**

The physiology of muscle healing is divided into different phases, some of which overlap and affect each other mutually. During the first so-called “degeneration phase” the destroyed structures undergo controlled breakdown followed by an inflammatory phase in which myoproliferation begins, and a repair and regeneration phase during which the myoblasts differentiate and form myotubes which then coalesce to myofibrils, thus repairing the injured

muscle fibres. Some of the cellular and cytokine processes in the individual phases run consecutively, others also overlap. Inflammatory processes occur both in the early phase of the injury (between about days 2 to 7) as well as in the late phase. In this context the inflammatory processes most certainly have positive effects, so according to our current understanding, they should not be completely suppressed by drugs. Thus it is recommended to stop the non-steroidal anti-inflammatory agents which are used initially to relieve pain after 48 hours and to replace these with plant-based preparations (e.g. Wobenzym®, Traumeel®).

During the initial phase of the injury cooling and compression are the most important measures for reducing the extent of the injury and the haematoma. The so-called “PRICE” scheme (Protection = immediate interruption of the exercise, Ice = cooling, Compression and Elevation) or the “POLICE” method (Protection, Optimal loading, Ice, Compression, and Elevation) has become

established in this respect although the clinical data on file is limited, even for these simple measures. However, a new paper by Hotfiel et al. illustrates very clearly that the combination of compression and cooling achieves an adequate reduction in the blood flow without a subsequent rebound effect when it is removed. Rapid compression and immediate cooling after an injury are essential to prevent the formation of a haematoma – which in turn compromises healing. The rule of thumb that “every minute treatment is delayed prolongs rehabilitation by one day” underlines the importance of treatment within the first half hour after the injury. Maximum pressure should be exerted for the first 20 to 30 minutes, followed by moderate compression for the first 48 – 72 hours. Cooling is best achieved with sponges soaked in iced water, later in professional sports with commercially available long-term cooling systems such as Game ready® or Hilotherm®. Conversely, if relevant structural damage has occurred, immobilisation is kept very short. A relevant haematoma should be aspirated as early as possible, ideally within the first 36 hours. However, in the author’s opinion, attempted aspiration later under strictly sterile conditions for larger haematomas or seromas is very useful for achieving rapid healing, even if this is incomparably more difficult with coagulated blood. The early phase is followed by the structured rehabilitation process



MRI and ultrasound images of a large muscle injury of the ischio-crural musculature before and after ultrasound-controlled puncture of the hematoma.

**PROF. ANJA  
HIRSCHMÜLLER MD**



is a specialist in orthopaedics and accident surgery, and senior physician at the Altius Swiss Sportmed Center in Rheinfelden / Switzerland. She has been the senior team doctor of the German National paracycling team since 2007, and has been the senior physician for competitive sports for the Deutsche Behindertensportverband e. V. (National Paralympic Committee Germany) since 2017. Among other things, Professor Hirschmüller is also a member of the Scientific Board of the German Association of Sports Medicine and Prevention (DGSP), chair of the expert committee "Conservative Treatment Methods and Rehabilitation" of the German Society for Arthroscopy and Joint Surgery (AGA), and a member of the German Society for Orthopaedic Traumatologic Sports Medicine (GOTS) Committee Muscle/Tendon. In 2021 she was voted GOTS sports physician of the year.

which is guided by subjective pain perception and should be directed by specific functional tests. For instance, the ASPETAR protocol has reviewed this very nicely for hamstring injuries; the protocol is available on the Internet for a free download.

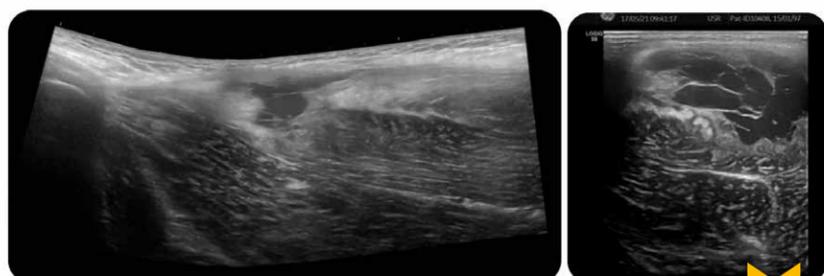
**SUPPORTIVE TREATMENT**

Supportive treatment includes support bandages with tape or supports (incl. Myotrain®), nutrient supplementation, physical measures (ultrasound, shock-wave therapy, magnetic fields) and infiltration. The most commonly used substances here are homoeopathic complex preparations such as Traumeel® and Zeel® as well as Actovegin® and Myopridin®, local anaesthetics and PRP/ACP. Clinical studies of different forms of infiltration treatment are unfortunately still only available in very limited numbers, although in vitro studies have revealed the mechanisms of action and very promising healing results in animal models. For instance, Actovegin® increases myoblast activity and satellite cell activation, so that its use during the initial phase of muscle healing between days 3 and 10 can be recommended. However, there is evidence of this from clinical studies, and it must be pointed out that as the preparation has not been licensed in Germany or Switzerland, patients must be informed about its off-label use.

Traumeel contains 14 mainly plant-based constituents including arnica, calendula and echinacea. In animal models the preparation showed a reduction of in-

flammatory activity and stimulation of the repair mechanisms by stimulation of anti-inflammatory cytokines (incl. TGF-β ↑ (regulatory T-cells) and inhibition of pro-inflammatory cytokines (TNF-α, IL-1β, IL-8). The hypertonic part of the muscle can be relaxed with local injections of muscle relaxants and local anaesthetics. By contrast, cortisone preparations are obsolete. With regard to the PRP preparations, which are now in very common use, as the current data on file suggest a shortened return-to-sport time, in our opinion they are most certainly justified in professional sports. On the other hand, it remains to be seen whether we may expect better healing results or lower relapse rates.

Adjunctive manual therapy and physical measures support the muscle relaxation of hypertensive parts of muscle and the return transport of lymphatic fluid. Close clinical and ultrasonography follow-up examinations are recommended to monitor the course of healing and to react to demarcating (haemato-)seromas. Structural remodelling should be verified, particularly for injuries prone to recurrence and with involvement of the intramuscular tendon to ensure a safe return to sports. In closing it must be noted – without going specifically into it in this article – that preventive programmes are capable of very effectively reducing the prevalence of muscle injuries – but only if they are carried out. Therefore, athletes, coaches and staff should never tire of taking every possible opportunity to stress how important these are.



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# UPDATE: MUSCLE INJURIES

A conversation with Dr. Hans-Wilhelm Müller-Wohlfahrt, MD

When we entered sports medicine over 16 years ago, he was already a long-established figure in the field. We were there when he opened the MW Praxis für Orthopädie & Sportmedizin (his orthopedics and sports medicine practice) and agreed that we would one day work with him on a project in the service of sports medicine. Of course we followed this man's career as it developed—a career that often placed him in critics' crossfire and equally as often found him misunderstood. Nevertheless, he has always had many advocates, athletes and friends who believe in his work. All the more reason for us to be pleased when Robert Erbelinger and Masiar Sabok Sir had an opportunity in the summer of 2021 to meet with him in person and discuss his ideas and the story behind his Munich practice. The discussion had been scheduled for one hour, but lasted instead for nearly two hours of lively, emotional sports medicine in an exceptionally relaxed, pleasant atmosphere. We are grateful for his many interesting insights and would now very much like to give Dr. Müller-Wohlfahrt the floor.

## Experience & Expertise

**“MY KEY CONCERN WAS ALWAYS TO DO ALL I COULD TO AVOID SURGERIES.”**

My career as a team physician began in the mid-1970s with the Hertha BSC Berlin soccer club. My boss recommended me as a young assistant, trusting me with a such a big responsibility. Back then, Hertha had a number of national team players and was one of the strongest teams in the league. I'm going to go for it, I told myself. So I jumped right in. The Bavarians noted that and probably thought, This guy must be crazy, we could use him. So I ultimately ended up with Munich's FC Bayern München. My key concern from the very beginning was to do all I could to avoid surgeries. To opt for conservative treatments whenever possible and responsible. And without taking any risks with patients' health. Even though it maybe seems a little cocky—which it absolutely isn't—after 45 years of treating elite athletes, I felt the need to tell my story to colleagues too.

That was basically what motivated me to write the new booklet, “Update: Muscle injuries after 45 years of professional sports care. Diagnosis and therapy of neurogenic muscle hardening, muscle strain, muscle fiber tear and muscle bundle tear.” I wanted to do it for German sports physicians and physical therapists and to reach as many people as possible. I've been very pleased that interest in my classification system—and in the end, that's what it's all about—and in therapy is extremely high. My muscle book has since been translated into several languages and has been published internationally.

## Natural medications & biological medicine

**“THE MUSCULATURE LOOSENS UP AND RELAXES, AND THE HEALING PROCESS GOES FASTER.”**

When I joined Bayern München, I thought, If I give Franz Beckenbauer the wrong shot and something happens, then I'm finished. So I made a very con-

scious decision to use natural medications and to practice biological medicine, which has no side effects. I noticed that muscles contract when injured, becoming highly tense in order to protect themselves, and that hinders circulation. So I thought, why not use Actovegin as my primary response to muscle injuries—back then it had just been introduced as the “Munich Development.” Studies had shown that it promotes blood flow. And what happened? The musculature loosened up and relaxed, and the healing process went visibly faster. That's how my medical regimen came to include that medication: intramuscular injection of Actovegin and Traumeel. I was attacked for that for a long time, because they thought it couldn't work. But I stood my ground anyway, and was vilified by a lot of colleagues. They said none of it had been scientifically proven. But then two scientists (from LMU Munich and German Sport University Cologne) took a look at it and found that it did promote healing; only then did the critics quiet down. I still remember when the two researchers called to congratulate me.



I'd found something that demonstrably promoted the healing process. They discovered that Actovegin activates the satellite cells on the muscle cell membranes. These in turn form new muscle fibers and no scar tissue forms – no collagen fibers, in other words (see also the study from Dr. Stefan Mattyasovszky: *Effect of Actovegin® and Traumeel®S on Human Skeletal Muscle Cells*, <https://sportaerztezeitung.com/rubriken/therapie/1800/muskelerletzungen/>).

**“ACTOVEGIN HAS BEEN PROVEN TO PROMOTE REGENERATION.”**

And the second scientific study shows that Actovegin inhibits inflammation. I prescribe two, three treatments for Achilles tendinitis, for example. Usually the inflammation is in the tendon sheath, not so much in the tendon itself, and adhesions often form. So I insert the injection needle between the tendon and its sheath. You have to have an instinctive feel for that. I administer an anesthetic, and if I notice that the needle isn't positioned right, I'll proceed with a 5mL infiltration of Actovegin in order



to distend the paratenon, potentially breaking up adhesions and inhibiting inflammation. Palpation is critical for muscle injuries: Where exactly is the injury? Which muscle is affected? Only after palpation will I insert several needles filled with anesthetic into the center of the injury along with needles (two each) positioned proximally and distally from the center. That does indeed have a relaxing effect. Once that step is complete, I use the needles I've positioned to introduce a mixture of Actovegin and Traumeel to promote healing. In the case of neurogenic muscle injuries, treatment is most effective when you palpate the irritated motor nerve tracts that are causing overexcitation of the muscle and then bathe these with an anesthetic. This procedure results in isometric relaxation of the muscles supplied by the nerves. Only after that do I administer an infiltration of Actovegin and Traumeel to accelerate the full healing process.

**Feeling with your hands & training your hands**

Unfortunately, an MRI often prompts people to overinterpret the images. And athletes are often shoved into the tubes much too early. I've seen a lot of Bundesliga athletes that no one's even touched – just sent them straight to an MRI. Too few colleagues feel, sense and listen to the athletes. Case history, diagnostics – it all starts with your relationship to the patient, with a conversation, with communication. Patients can provide so much information during a conversation – after all, they know where and how it hurts, and I build on that. I give myself plenty of time. I would highly recommend this to everyone. It builds trust. Symptoms vary quite a bit from one muscle injury to another. And if you've learned how to listen precisely, then the patient will basically lead you to the diagnosis. You hardly ever see that kind of dialog. They say that the average doctor takes just 18 seconds to go from the initial meeting to saying, Yup, let's get you to the MRI!

**“DON'T SHY AWAY FROM TOUCH.”**

One thing that's helped me a lot through all of these years is that I'm not shy about palpating and examining the patient. For me it started when I took massage courses when I was a student. No one forced me to, and, to be honest, I didn't really know why I did it.

Some friends just took me with them so that I could have a look and maybe even participate. And I'm grateful to them for that to this day. That was how I came to know and understand muscles. I could recognize deviations from the norm, especially when I compared the healthy, uninjured side with the injured side – which, by the way, is still what I do today. Those massage courses were really worth their weight in gold. I would even go so far as to say that, in my case, the massage courses served as a basis for palpation.

**“45 YEARS OF EXPERIENCE TREATING ELITE ATHLETES— THAT'S SOMETHING YOU HAVE TO SHARE AND PASS ON!”**

And just so no one later on can accuse me of keeping it all to myself, I also give people the chance to observe my work. A lot of physicians do come visit me in my practice—physicians from abroad too – I'm completely open to that. In addition to that, now I've also decided to host a weekend seminar once a month beginning in September. A certain number of doctors will also be admitted who can bring a patient with them; I'll examine the patient with no prior information and say what I feel, what I think. That's going to be exciting for everyone involved, and I'm already looking forward to the lively exchange with colleagues.

**Other treatment options  
“A LOT OF THINGS ARE GOOD AND HELPFUL, BUT YOU DON'T HAVE TO JUMP ON EVERY BANDWAGON EITHER.”**

**WHAT'S IMPORTANT IS THAT, IF YOU'RE GOING TO APPLY SOMETHING, YOU HAVE TO BE ABLE TO DO IT RIGHT!”**

With other treatment options and combination therapies, it's always a question of experience and dosage, depending on the injury or symptoms: laser therapy can be helpful for muscle injuries, intermittent vacuum therapy is a good option, and magnetic field therapy yields good results too. These treatments belong in the hands of experienced doctors and therapists. But with all of these additional technologies, you mustn't forget that palpation always has to be your starting point; only after that can you decide which type of physical therapy makes sense. I also really appreciate working with osteopaths, chiropractors, manual therapists, etc., and I know how fruitful collaboration between doctors and these therapists can be. That creates trust with the patient as well. I've been working with Hub Westhovens for several years now, for example, and I consider him to be the best osteopath I've ever met.

We first met through Arjen Robben, and Hub comes from Holland every week to visit my practice for 1 – 2 days. The collaboration is wonderful.

**“I DIDN'T JUST PULL THAT OUT OF THIN AIR – IT'S NOT HOKUS-POKUS! I'VE SPENT YEARS WORKING ON IT!”**

Development of Profelan ointment is another one of those stories. When I started out with Bayern München, I used a plant-based ointment called Spolera, as well as Enelbin paste and

Chomelanum ointment. In those days they were the three best products on the market for me. I would mix all three together, which was a lot of work of course and was particularly impractical in the treatment room. So I wanted to take the actives from each of the three products and combine them into one ointment. That was the beginning of Profelan. It was easier said than done. Ultimately we added arnica, zinc, vitamins A, C and E, mint and frankincense to this highly effective ointment for alleviating injuries, hardening or swelling.

**The back  
“I ALWAYS LIKE TO TELL ATHLETES: THIS IS THE COMMAND CENTER FOR YOUR LEG MUSCLES.**

**EVERYTHING IS CONTROLLED FROM HERE. EVERYBODY KNOWS THAT!”**

The lumbar spine plays an absolutely critical role in the musculature of the lower extremities. Take, for example, a herniated disk or a case of impingement syndrome in the lumbar spine area. What does a nerve do when it's irritated? It fires signals into the leg. In some cases that falls below the pain threshold, so that the player often doesn't even know or doesn't notice it at first. The muscle tenses up, and patients feel like their legs are “heavy.” If a player keeps on training, probably everything will feel fine, but then when the coach switches the focus to speed training and the muscle is pushed to its limits over and over, that tension will keep increasing, the muscle will grow rigid and end up completely inelastic. Then comes a scrimmage, a sprint, and suddenly it happens. Far too often, physicians fail to recognize this context and/or chain of cause and effect, and the treatment isn't adapted accordingly or the root cause of the injury goes untreated.

**“NEUROGENIC MUSCLE HARDENING? UM... OK. MUSCLE SHUT DOWN? THAT MAKES SENSE!”**

I have an anecdote from the 1980s that illustrates the point: at the Bayern München training facility in Bahrain, Lothar Matthäus was suddenly on the sidelines. He couldn't keep going, he wanted out. I took a look and examined him – nothing was torn, no hematoma, no structural damage. But I could feel that the muscle was severely contracted and hard. I found a thin line of fluid that had collected along the fascia surrounding the muscle bundle, and it felt weirdly soapy. One or two more sprints and the muscle fibers could tear. The painful muscle was no longer elastic – it was supplied by a motor nerve extending from the lower lumbar spine, and that nerve was sending it too many signals, to which the muscle was responding. For Lothar Matthäus, the question now was what to say to the media. Why wasn't he on the field? So to explain it to him, I told him that the muscle had “shut down” and that he had done the right thing. He understood that and told the media that “Mull” had told him his muscle had shut down. The phrase caught on, and ever since everybody can picture what that means. Neurogenic muscle hardening? Um... OK. Muscle shut down? That makes sense. A lot of muscle injuries are neurogenic in nature, and so it of course makes sense to examine and treat the back. Once we have eliminated the cause of the muscle overexcitation or, for instance, used Hub Westhovens' osteopathic methods to restore the desired function of the vertebral and/or iliosacral joints, then the neurogenic muscle hardening quickly recedes.

**Nutrition**

**“MY GOAL IS TO PREVENT DEFICIENCIES. YOU HAVE TO GET ENOUGH OF EVERYTHING!”**

We always have nutrition in our sights. People often have a vitamin D deficiency, for example. Research is still underway on how it behaves in combination with K2. Similarly, our magnesium and zinc levels are often too low, but never too high. We also monitor amino acids like arginine, lysine and proline. Glutamine too. These are fundamentally important for healthy connective tissue and for muscle and tendon regeneration. Enzymes like bromelain, which inhibit inflammation, represent another important area. In all of these cases, it isn't that I want to give particularly high doses. My goal is to prevent deficiencies. You simply have to get enough of everything! That's why I recommend regular lab testing.

**Mobility**

If possible, you should check the mobility of the vertebral joints, the iliosacral joints and the joints of the lower extremities and potentially mobilize them before every practice or competition. One example: dorsiflexion of the ankle is blocked all too often, which can lead to a stress situation in the Achilles tendon or increased muscle tone in the calf, which under certain circumstances can become rock hard and susceptible to injury. A second example: dysfunction in the lumbosacral transitional area. Generally speaking, when athletes come to me with muscle problems, I find there is a blockage of the 5th lumbar vertebra; most of the time I also see severe limitation or even a blockage of one or both iliosacral joints. This results in irritation to the root of the nerve (usually S1 or the obturator nerve) and along this nerve I see hypertonia that can become quite painful: neurogenic muscle hardening, in other words, that, if

left unaddressed, can lead to a structural muscle injury.

**“REGENERATION IS KEY AND IT SHOULD BE CONSIDERED ON A CASE-BY-CASE BASIS.”**

Thank you so much, Mr. Erbedinger, for helpfully reminding me to bring up regeneration. Regeneration gives the body a chance to take the time – both actively and passively – that it needs for repairs and cell renewal. During regeneration, the body “dials down” stress hormones (adrenaline, noradrenaline, dopamine and glucocorticoids), allow-

ing inner calm and relaxation to set in and guaranteeing a quiet, restful sleep. I think 7 hours of sleep are a must, 8 hours are good, and over 8 hours can be helpful, especially for elite athletes. Another issue: breathing. Conscious breathing without the distractions of TV or phones relaxes areas like the musculature of the shoulder girdle. All it takes is just a few minutes. You just need to make sure you’re breathing with your abdomen and avoiding shallow breaths as much as possible. It’s almost like meditation. I recommend James Nestor’s book “Breath” for reading material on this. I also feel strongly about

recommending conscious eating. Slowing things down, tasting consciously, being aware of what you’re eating and of the point when you become full. All the while seeking out conversations in a relaxed atmosphere and just generally gaining clarity on the many areas of our lives we should be experiencing more consciously.



After Dr. Müller-Wohlfahrt left Bayern München, a joint project on artificial intelligence came into being with researchers from the Klinikum rechts der Isar Hospital at the Technical University of Munich (TUM). As we talked, the subject sounded so exciting to us that we wanted more information, so we contacted TUM.

**...HOW DID COLLABORATION AND THE AI PROJECT COME ABOUT?**

Applying artificial intelligence means identifying complex correlations and patterns – potentially in multiple dimensions – studying them and applying them to new, future data. Apart from IT implementation, the key considerations are the quantity and quality of the data.

MRI testing is used throughout the world for diagnosing muscle injuries. It is exceptionally difficult with MRI, however, to distinguish, say, functional muscle injuries caused by neuromuscular disorders (type 2A; see consensus classification below) from circumscribed, structural muscle injuries (type 3A). If treated correctly, a competitive athlete who suffers a neurogenic injury can return to full performance after a few days. Inappropriate treatment and/or failure to recognize the injury, however, can keep the player off the field for several weeks. Precise diagnosis is therefore of the essence. Dr. Müller-Wohlfahrt gathers highly detailed palpa-

tory findings, which he compares to other important criteria (such as the circumstances surrounding the accident, etc.), allowing him to make these distinctions with considerable precision. In collaboration with international experts he has used this as a basis for developing a consensus classification system for muscle injuries (Müller-W. 2013). But because MRI classification does not take neurogenic-associated lesions into account, this imaging technique can lead to misdiagnoses. In response to this problem, Dr. Müller-Wohlfahrt approached our team of researchers, asking how diagnostic certainty could be improved here going forward. We have therefore proposed taking his outstanding palpatory skills in the form of his diagnosis, and feeding this into a specific AI algorithm along with MRI imaging data. The algorithm will then use neural networks to detect correlations between the image data and the corresponding diagnosis. Initial results

will be presented at the 2021 German Congress of Orthopaedics and Traumatology in Berlin in October. Even with very small amounts of data, the algorithm has already identified patterns that can be used for classifying injuries as functional/neuromuscular (type 2A) or structural (type 3A). Given our currently small number of cases, the results are merely preliminary and will have to be confirmed in large cohorts. The long-term idea is to develop a robust algorithm that will model the knowledge and skills of Dr. Müller-Wohlfahrt (as much as possible), serve as a supplementary diagnostic tool for (young) physicians and thus potentially benefit patients with muscle injuries.

**TUM researchers collaborating with Dr. Müller-Wohlfahrt on this joint project: Florian Hinterwimmer, Nikolas Wilhelm, Dr. Rüdiger von Eisenhart-Rothe MD, Dr. Rainer Burgkart MD**



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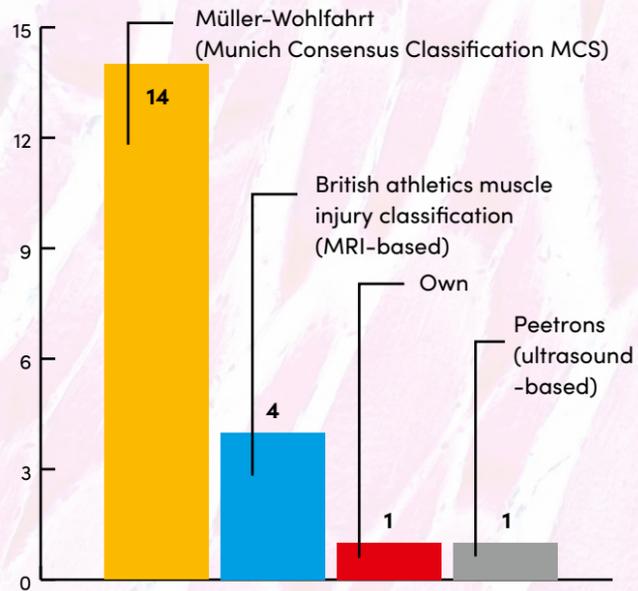
# SPORTS TEAM DOCTORS SURVEY ON MUSCLE INJURIES

According to the VBG-Sportreport 2020, muscle injuries account for up to 30 % of all football injuries. Concerning the body area, most injuries affected the thigh (25%). We, the Sportärztezeitung, have already addressed the topic of muscle injuries several times in the past. With this survey conducted among team doctors of the 1st and 2nd Football-Bundesliga, we mark the beginning of a more intensive and well-founded analysis of the topic. We

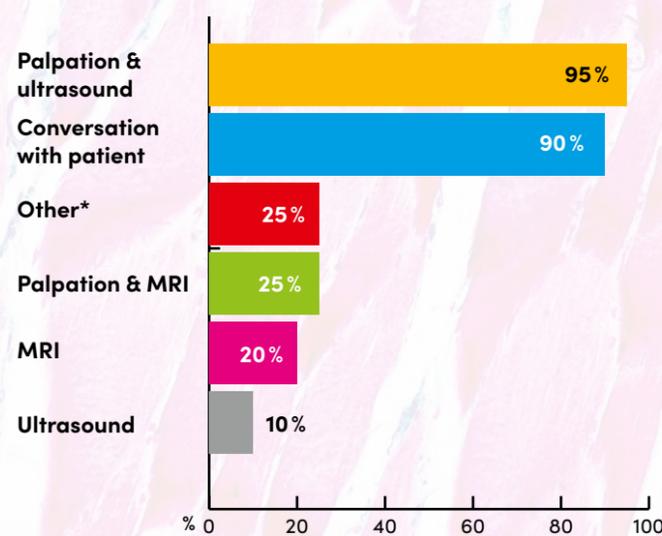
would like to thank a total of 19 participating team doctors, and want to present the results to you on the following pages. Multiple answers were possible for most of the questions. We will then present results and new food for thought in the sports medical newspaper, on our online portal [www.sportaerztezeitung.com](http://www.sportaerztezeitung.com) and at our training courses. At the same time, we would like to announce that we will work on and discuss the mentioned

aspects and further points together with our experts in a "working group for muscle injuries", also at our symposium on the 13th November 2021 in Kreuzlingen am Bodensee (Switzerland). We will present the results and new thought-provoking insight in the Sportärztezeitung, at our online portal [www.sportaerztezeitung.com](http://www.sportaerztezeitung.com), and at our educational events.

## » Anamnesis & Diagnostics – Which classification system do you follow when beginning a therapy?



## » Anamnesis & Diagnostics – What must a clinical examination always include?



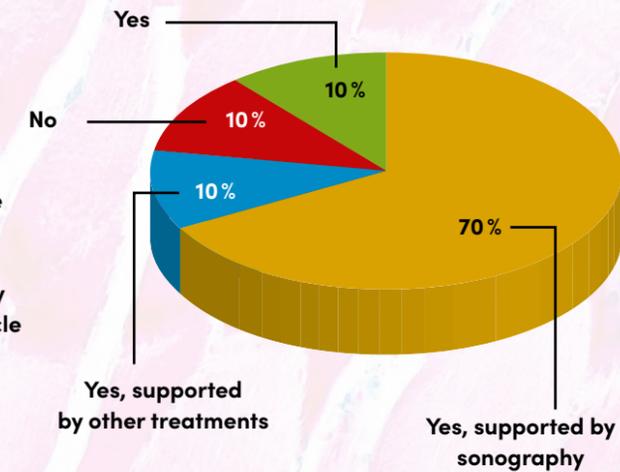
\* Functional tests, anamnesis with focus on initial pain characteristics, feedback from physiotherapy, stretching, strength test with manual resistance

## » Which therapeutic options do you frequently use to treat muscle injuries (in acute situations)?

Enzyme therapy (Wobenzym)	18	Taping	11	NSAID	6
Professional physiotherapy	18	Cold therapy	11	Osteopathy	6
RICE	16	Extracorporeal shockwave therapy (ESWT)	11	Injections PRP	4
Lymphatic drainage	15	Plant-based alternatives	10	Injection Actovegin	4
Compression	14	Nutritional supplements	9	Laser therapy	4
Injection of Traumeel	13	Injection ACP	9	Flossing	4
Cryotherapy	13	Local anesthetics	8		
Kinesiotherapy taping	13	Magnetic field therapy	7		
Dry needling	13	Electrotherapy	7		
Early & quick rehabilitation	13	Intermittent vacuum therapy	6		
Traumeel (oral)	12				

**1–3 mentions**  
acupuncture, protein shakes, transverse friction, Gameready, Physiokey, bandages / orthesis, nuclear magnetic resonance therapy, percutaneous electrolysis

## » In your opinion, does the puncture of intramuscular hematoma play a role in the therapy of structural muscle injuries?



## » Which analgesics or other medication (alternative, plant-based) do you apply, and what do you use to minimize the inflammatory reaction?

Wobenzym	13	Reparil	3	Local anesthetics	2
Traumeel	10	PRP/ACP	3		
Ibuprofen / NSAID	10	Turmeric	3		
		Vitamin C	2		

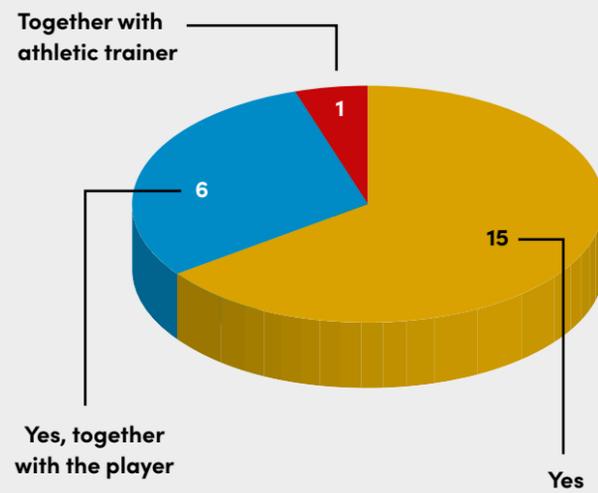
**One mention** local muscle relaxants, bicarbonate, Boswellia, Bromelain, zinc, incense, BCS, Arnica, Omega-3 fatty acids, Vitamin A, Vitamin E, Ortofon, Actovegin, Venostasin, Montmorency cherry, no analgesics

## » Which individual regeneration option do you use?

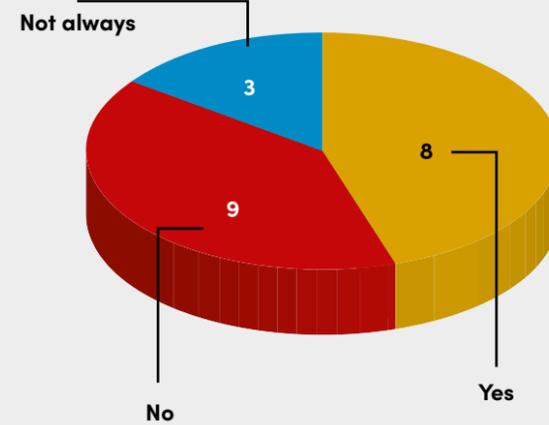
Cold therapy (Gameready, Eissauna, cold pool, „ice bin“, cryotherapy)	8
Physiotherapy	5
Lymphatic drainage	3

**1–2 mentions** AlterG treatment in water, athletic training, active regeneration, hypoxia, physiotherapy, magnetic field therapy, laser, PRP, ESWT, enzymes, Traumeel, Lymphomat, regenerative drinks/nutritional supplements, compression wear, underwater massage, sleep, emFieldPro

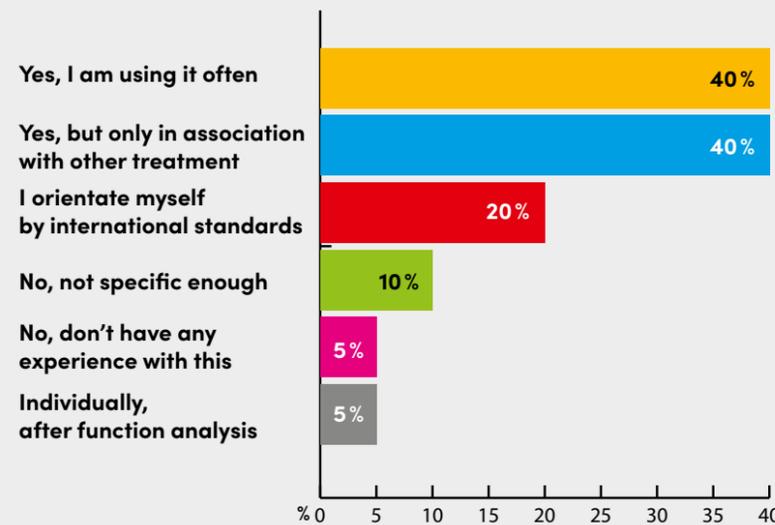
» In competitive sports, is the trainer (training) a fundamentally significant factor for the occurrence or the prophylaxis of muscle injuries?



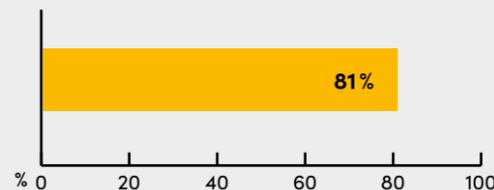
» In your opinion, for minor muscle injuries type 1–2B and up to 3a, a professional physiotherapy and natural therapies are a sufficient treatment? (in high-performance sports / football)?



» The Nordic Hamstring exercise is widely used as an effective prevention and rehabilitation of injuries of the ischiocrural musculature. Do you have any experience with this?



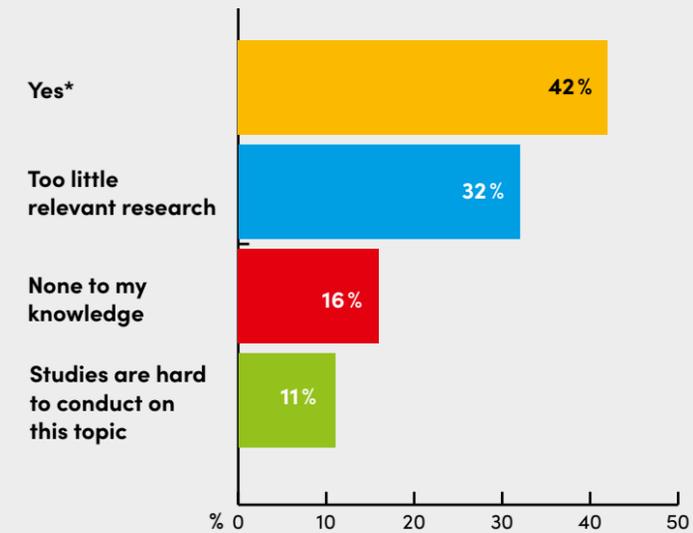
» Do you treat the back as well?



» In your opinion, what is the best – most innovative and effective – form of prophylaxis?

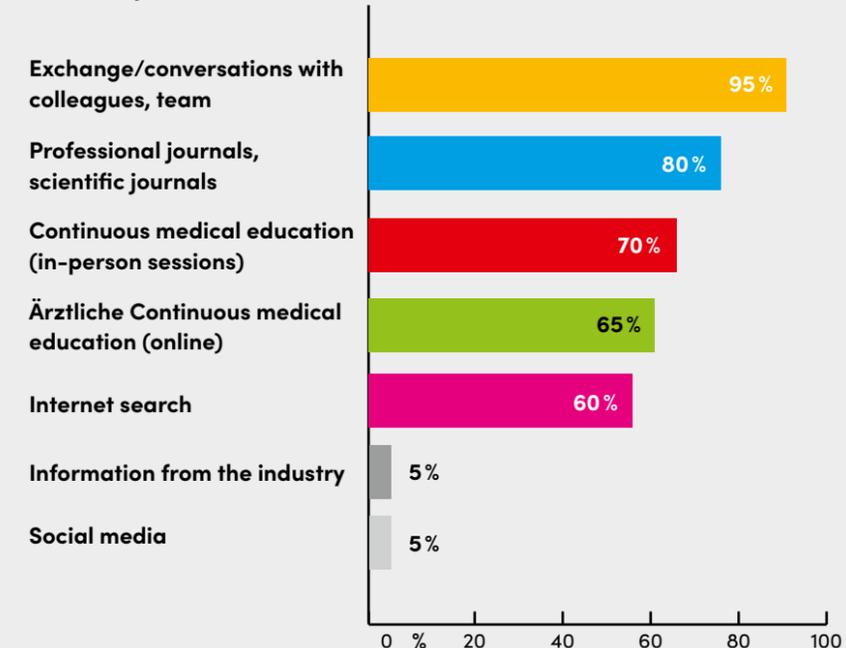
- |   |  |   |
|---|--|---|
| » Nordic Hamstring  | » Individual biomechanic analysis (marker and EMG-based)   | » Strength and coordination training  |
| » Individual training load exercises  | » Strengthening existing weak points/previous injuries; individual stability programs; training load | » Strain control  |
| » Good specific physical condition  | » Regular functional tests and individual training programs as well as regeneration                  | » Sprint training, hamstring prevention training such as Nordic Hamstring, strengthening of trunk-pelvic musculature, stretching, |
| » Lifestyle specific to type of sport   | » EMG  | » Balancing front and back femoral musculature  |
| » Osteopathic, chiropractic alignment of the pelvis and the lower lumbar spine before each training session | » Mobilization (esp. ankle joints)   | » Fitness   |
| » Compensated imbalances  |  |   |
| » Nutrition / Hydration   |  |   |

» In your opinion, are there to date any innovative studies on the topic of muscle injuries?



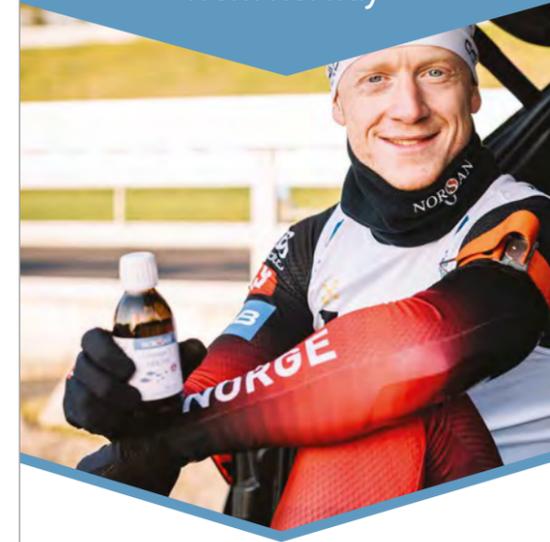
\* Specifically, 4 studies were named, which you can find at <https://sportaerztezeitung.com/rubriken/therapie/7733/studien-muskelerletzung/>.

» What is your main source of knowledge on muscle injuries?



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# INTRA-ARTICULAR INJECTION THERAPY

Hyaluronic acid and PRP for gonarthrosis

PROF. DR. MED. CHRISTOPH BECHER /  
INTERNATIONAL CENTER FOR ORTHOPEDICS, ATOS CLINIC HEIDELBERG

**Gonarthrosis is of high epidemiological significance, and its multi-factorial genesis results in a progressive alteration of joint structures involving painful functional restrictions. Arthrosis is maintained in its progress by a vicious cycle marked by the production of inflammatory cytokines and the resulting progressive degenerative metabolic processes in the joint. This vicious cycle needs to be interrupted if possible.**

## INJECTION THERAPY WITH HYALURONIC ACID

Hyaluronic acids are an important component of the articular cartilage and occur in high concentrations in synovial fluid. They are an essential factor in the viscoelastic (lubricating and shock-absorbing) properties of human synovial fluid. Healthy joints have a concentration of approx. 2.5 to 4 mg/ml [1]. Hyaluronic acid therapy to supplement viscosity has been a firmly established component in the orthopaedic treatment of gonarthrosis for many years. The therapy is applied on the assumption that it substitutes as a viscosity supplement for the physiological hyaluronic acid (HA) of the synovial fluid, which is reduced in terms of concentration and molecule size during arthrotic processes [5]. The S2k lead article “Gonarthrose”, published by the German Society of Orthopaedics and Traumatology (DGOU) in 2018, views intra-articular hyaluronic acid therapy as an

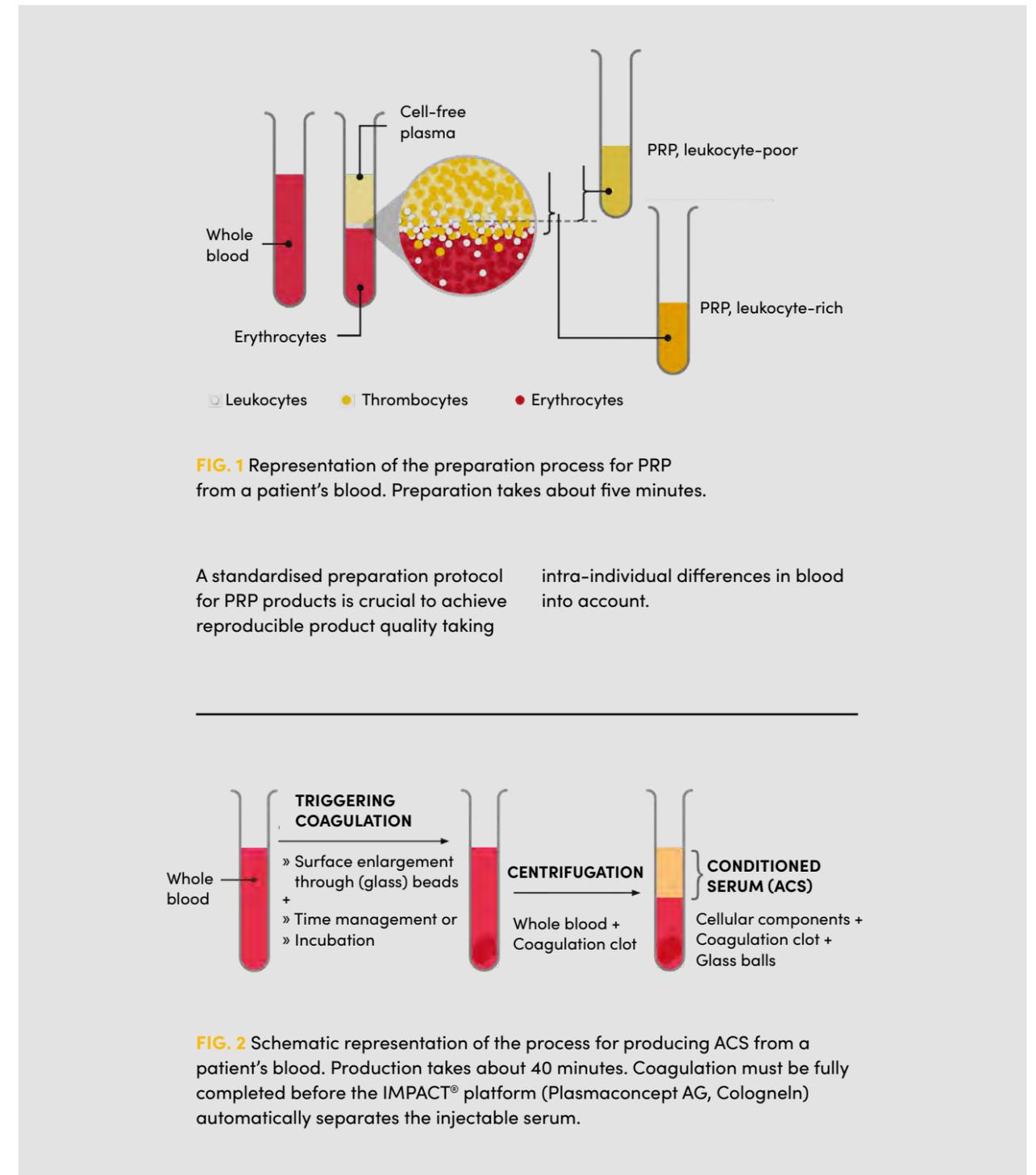
important therapeutic component for patients where NSAIDs are contraindicated or insufficiently effective [2].

There is currently a wide range of hyaluronic acid products on the global market. These preparations differ widely, both in terms of their origin and processing, and in terms of their characteristics and effects, which result from different molecule sizes and the different ways the molecules bond and link to each other [2]. Crosslinks improve the physical characteristics of HA by increasing molecule size and delaying enzyme degradation. As a result, it remains in the joint for longer [3]. A systematic overview of the available evidence was able to demonstrate that crosslinked HA has a statistically significant stronger therapeutic effect ( $p=0.003$ ) than non-crosslinked HA [4]. The recommended frequency of application depends on these characteristics. Hyaluronic acid preparations

that need to be applied only once (e.g. Monovisc®, Plasmaconcept AG, Cologne) generally consist of high-molecular crosslinked HA with high concentration. Correspondingly, preparations that need to be applied 3–5 x do not have these characteristics, or only to a lesser extent.

## INJECTION THERAPY WITH PLATELET-RICH PLASMA (PRP)

Autologous cell therapies with platelet-rich plasma (PRP) have become increasingly important as an intra-articular therapy option for treating gonarthrosis in recent years, and is now one of the most intensively studied regenerative treatment concepts. PRP is an example of autologous concentrated thrombocyte suspension. Thrombocytes are responsible for haemostasis and provide the basis for the first phase of wound healing. During this phase, the platelets aggregate and form the coagulation clot. In addition, by degranulation of thrombocytes growth factors are released (e.g. TGF- $\beta$ , IGF, PDGF). In short, PRP therapy can release local growth factors that attract the cells required for healing and stimulate these cells to greater activity. PRP is prepared by separating the components of previously drawn and anti-coagulated whole blood by means of centrifugation (Fig. 1). Gonarthrosis should ideally be treated with leukocyte poor PRP [5].



According to the DGOU guideline, the as-yet low number of well-designed studies is limiting the evidence assessment, and it is not possible to provide a final statement on PRP at this time [2]. However, the situation has improved

considerably since then. Just last year, several meta-analyses were published, involving up to 26 randomised control studies and comparing the effectiveness of PRP and HA. In summary, all the authors concluded that, over an exami-

nation period of one year, PRP was superior to HA in terms of its WOMAC score while offering the same product safety [6–8]. However, this was not true for a subgroup analysis involving the use of high-molecular and crosslinked

PROF. DR. MED.  
CHRISTOPH BECHER



is a specialist physician in orthopaedics and trauma surgery who additionally specialises in special orthopaedic surgery and sports medicine. He is the head physician in the field of orthopaedics and trauma surgery at the International Center for Orthopedics at ATOS Clinic Heidelberg. He is also a member of the editorial board of the Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA) journal and the Advisory Board of Archives of Orthopaedic and Trauma Surgery (AOTS).

to be treated. ACS, for example, is a form of PRP where the leukocytes in the whole blood are stimulated and produce increased levels of anti-inflammatory regenerating cytokines. Subsequent centrifugation automatically isolates and separates a serum free from cellular components and rich in anti-inflammatory cytokines as well as growth factors (Fig. 2). ACS is therefore especially suitable for treating inflammatory activated OA.

**A COMBINATION OF PRP AND HA TO TREAT GONARTHROSIS?**

Combining PRP and HA seems an attractive concept. Two current meta-analyses and systematic overview studies from 2021, which included 8 and 4 studies (including non-randomised studies) respectively, demonstrated that a combination of PRP and HA is superior to the application of HA alone [9, 10]. However, it was not possible to demonstrate that a combination of PRP and HA is superior to the application of PRP on its own [9]. This may beg the question of whether the combination therapy is suitable while not being superior to application of PRP alone. For a definitive answer it is certainly still too early.

**CONCLUSION**

The application of HA and PRP is a firmly established element in the treatment of gonarthrosis. Current literature appears to show that PRP is more effective than low-molecular HA, but not than high-molecular crosslinked HA. Combining PRP and HA does not provide a clear advantage over the use of PRP on its own, so the separate application of PRP or ACS with 3–5 injections and a single injection of high-molecular crosslinked HA seem the most sensible option.

HA. While PRP was superior to low-molecular non-crosslinked HA, there was no statistically significant difference between the application of PRP and the application of high-molecular crosslinked HA [7].

**INJECTION THERAPY WITH AUTOLOGOUS CONDITIONED SERUM (ACS)**

Depending on the preparation protocol, different autologous cell therapies can be obtained from the patient's blood to suit the pathology

*References*

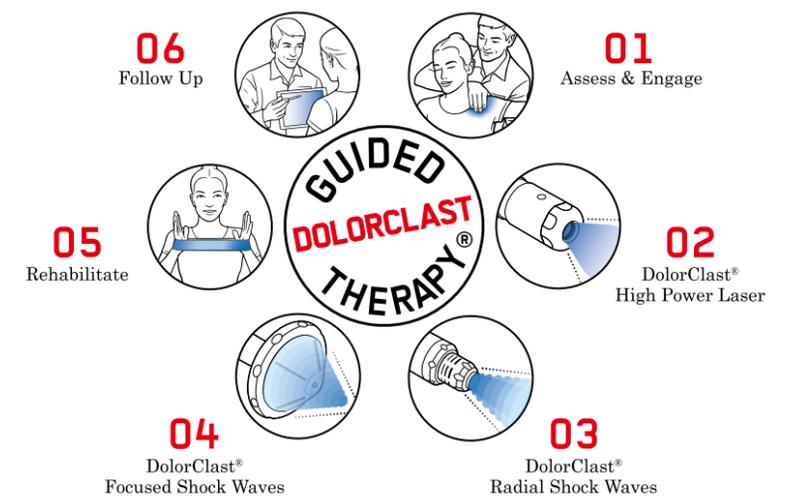
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# INJECTABLE BLOOD DERIVATIVES

Practical use and combinations for sports injuries

RALF DOYSCHER MD<sup>1</sup> AND MARTIN BARTSCH MD<sup>2</sup>  
<sup>1</sup>BORUSSIA MÖNCHENGLADBACH, <sup>2</sup>MEVIVA MEDICAL CENTRE BERLIN

The use of injection therapies for sports injuries has had a well-established place in sports orthopaedic practice for many decades. In particular, the use of blood derivatives such as PRP (platelet rich plasma) and BCS (blood clot secretome, formerly ACS, autologous conditioned serum), which has increased in popularity in recent years, is now becoming more common and attracting more scientific attention.

Whereas in our previous article we provided an overview of the main available manufacturing methods and products, it is of course equally important and of interest that we share our experiences with specific use in practice, possible treatment combinations and treatment plans with colleagues and patients.

## PIN-POINT APPLICATION, IDEALLY IMAGE-GUIDED

Unlike synthetic products such as corticosteroids, which can also be injected in the area surrounding the target structure but which can still achieve an adequate effect via diffusion and blood circulation (in case of doubt, also via a

systemic effect), biological substances have to be injected with a high degree of accuracy at the target site. Thus, it is important not only to establish the correct indication but also to administer the injection using the appropriate technique. While there is no doubting the expertise of many colleagues in also using palpation alone to locate the target structure when administering injections, the nagging question nonetheless remains how often it then turns out in the follow-up imaging procedure that the injection has been misdirected after all. Studies have reported misdirection in up to 50% of cases even in readily palpable structures such as the AC joint and with experienced users [1]. This is why image-guided infiltration procedures such as ultrasound-guided injection (particularly for muscles, tendons and peripheral joints) and image converter, CT or MRI-guided injections (particularly on the spine, such as PRT) became established early on. Some manufacturers now provide high-quality courses with hands-on workshops using models and human specimens.

The ideal treatment of patients directly after injection is also largely unresearched. In daily clinical practice we have observed that allowing patients to lie or sit for 10–15 minutes with no loading of the treated area immediately after BCS or PRP injection in muscles or tendons can help increase tolerance and efficacy. This, in our view, may be due to the conversion of fibrin in the

tissue, which continues for a short time after administration and may help retain the infiltrate at the administration site. If, on the other hand, the tissue is loaded immediately after injection, movement and tissue tension may squeeze the still completely liquid infiltrate out of the tissue or distribute it widely.

## THE CORRECT INDICATION FOR THE CORRECT PROCEDURE – EMPIRICAL DATA/CLINICAL EXPERIENCE

Unfortunately, there are virtually no substantive comparative studies of the use of different blood derivatives in sports orthopaedic injection therapy. Only the outcome of different studies on individual products can be compared. This, unfortunately, does not allow any comparative recommendations to be made as to what procedure is preferable for what indication – for the time being at least we must rely on our own or shared clinical experience. For example, in the experience of the authors the use of PRP with a high proportion of platelets and fibrin has proved to be of value particularly in the treatment of cases where the aim is to induce connective tissue synthesis, such as in fascia and tendon injuries, and to heal degenerative defects, e.g. in the central tendon area in advanced patellar tip syndrome and achillodynia. We have also observed in clinical practice that combined treatment with Traumeel or Zeel appears to alleviate tissue reactions particularly in muscle injuries and may therefore be a useful adjunct, e.g. when placing injection cannulas. The anti-inflammatory effect of BCS is also apparently of particular clinical value in more minor injuries and irritation in the tendon bed and in joints, e.g. secondary to arthritic changes. In this instance, initial deterioration with swelling, erythema and increased pain have been found to be less common than with platelet-rich blood derivatives. We have also time and again observed the same with facet joint infiltration and periradicular therapy (PRT) on the spine.

## COMBINING TREATMENTS TO ACHIEVE SUCCESS

However careful one might be in establishing the indication and the appropriate injection technique, one thing is still clear – injection therapy alone generally does not result in the healing and resolution of underlying causes in injuries and overuse damage. It must be integrated as a useful and essential element in a multimodal treatment concept. Concomitant physiotherapy with manual therapy and physical exercises as well as local physical treatments such as heat therapy, ultrasound, deep heat treatment, electrotherapy etc. have become virtually indispensable in competitive sport. It is also important to perform functional analysis of statics problems and of hypomobility in the function of ascending and descending joint and muscle chains and to assess potential visceral and segmental components. One specific treatment combination that has proved to be of value in clinical practice is the alternating use of extracorporeal shock wave therapy (ESWT – focused and/or radial, depending on the indication) and/or high energy laser with injection therapy (see illustration). Just as important, but equally little researched, is the sequencing and timing of the individual treatment elements. For example, in our clinical experience an alternating approach has proved to be of value, with initial shockwave and laser treatment followed three or four days later by injection, once the treated tissue has recovered a little. After a further four to five days, the next session of shock wave and/or laser therapy can be given. The cycle should be repeated three to five times, depending on the indication. However, with such intensive treatment, a noticeable improvement is often already evident after the second cycle. It is essential that the timing and number of repeat sessions are individually adjusted to the indication, patient acceptance and any local reactions. It is particularly important that the patient is fully informed about the treat-

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**RALF DOYSCHER MD**



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

**MARTIN BARTSCH MD**

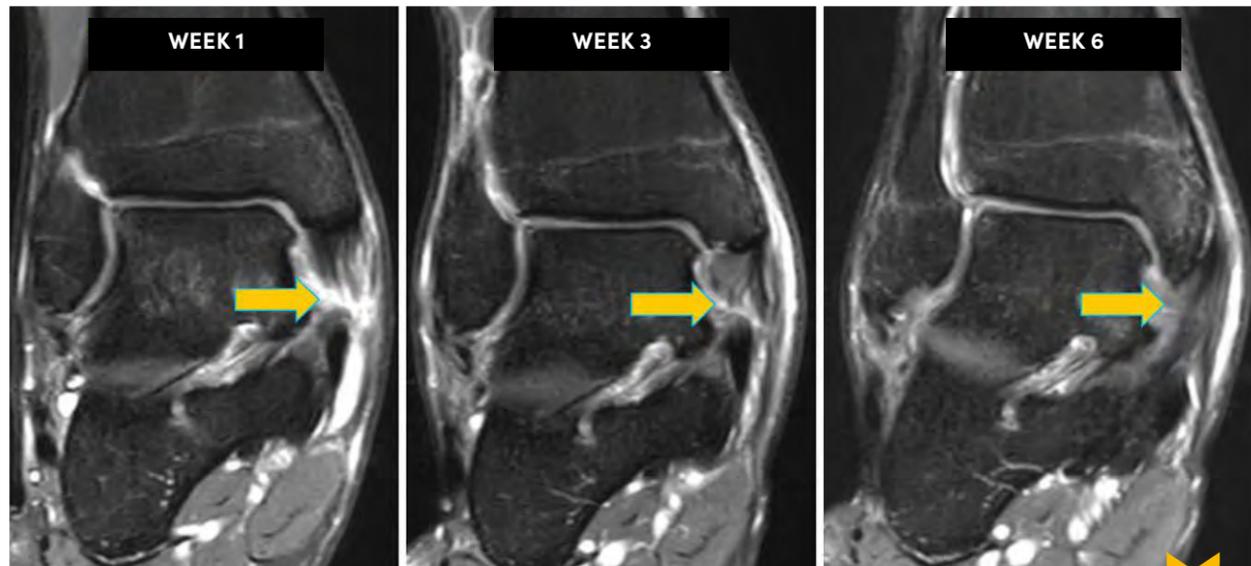


initially trained as a specialist in orthopaedics and trauma surgery at the Charité University Hospital Berlin before then further qualifying as a specialist in sports medicine in the Department of Sports Medicine of the same hospital. He has acquired extensive experience in the support of top-level athletes through working with several Berlin sports associations and also as team doctor of the German Olympic team at the 2018 Winter Olympic Games. He is now resident orthopaedic consultant at meviva. His work covers all aspects of conservative orthopaedics and sports medicine.

ment course, possible symptoms such as pain during and after injection, potential tissue irritation (initial deterioration), the need for multiple sessions and concomitant physiotherapy and guidance on exercise activities.

**CONCLUSION**

- » Advice for the use of BCS and PRP in clinical practice:
- » reliable injection technique, ideally ultrasound or MRI-guided
- » no loading of the treated area, e.g. with the patient lying or sitting for 15 minutes after
- » the injection (to allow fibrin clots to form)
- » where applicable, cool the injection site when symptoms are severe; where possible,
- » avoid using NSAIDs and local anaesthetics
- » always use as one element of multimodal treatment with local applications and
- » exercise activities to ensure long-term success
- » combined ESWT and physical procedures such as high energy laser have proved
- » effective in clinical practice



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(1) McFarlin, B. K., Henning, A. L., & Venable, A. S. (2017). Oral Consumption of Vitamin K2 for 8 Weeks Associated With Increased Maximal Cardiac Output During Exercise. *Alternative Therapies in Health & Medicine, 23*(4).

# BONE MARROW OEDEMA

PD DR. MED. PHILIP CATALÁ-LEHNEN /  
ÄRZTLICHER DIREKTOR, LANS MEDICUM HAMBURG

UNIV. PROF. DR. MED. CHRISTOPH SCHMITZ / INHABER DES LEHRSTUHL FÜR ANATOMIE II  
AN DER LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

**Bone marrow edema occurs when fluid builds up in the bone marrow and is typically a response to an injury, such as a fracture or conditions such as osteoarthritis. Although pain is the major symptom, bone marrow edema differs in terms of its causal mechanisms, underlying disease, as well as treatment and prognosis.**

## PATHOLOGY

Bone marrow edema (BME) is typically identified via MRI or ultrasound when a patient has another condition or pain in or around the bone. Most frequently, they occur in the hip, knee, ankle, or foot but can occur in all bones.

It's a relatively frequent disease, although its prevalence has yet to be examined further. In a recent study of patients with foot and/or ankle pain the prevalence of bone edema in MRI was 23%. There, the average patient was male, aged approximately 50, with traumatic or degenerative origin talus bone edema. [1]

In many cases, the liquid inside the bone will go away with time, therapy, and pain medication, such as nonsteroidal anti-inflammatory drugs (NSAIDs). However, waiting for the edema to go away by itself can take a long time, which is especially concerning for professional athletes, but also frustrating for regular patients. From practical cases, we know that exclusively focusing on avoiding load and exercises, unfortunately only brings limited success. Therefore, a better approach is needed and has been investigated in recent research groups.

## CAUSES

Painful bone marrow edema can occur

spontaneously or secondary to various, underlying diseases. Therefore, the detection of edema in the bone marrow is important in managing symptoms of arthritis, stress fracture, cancer, or infection. It can indicate where the pain started and how strong the bones are, which in turn will affect the treatment choice. Common causes of bone marrow edema include:

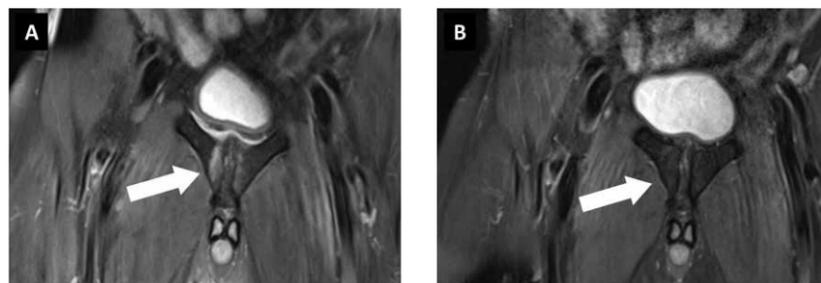
- » **Injuries:** such as plantar fasciitis or tendinitis
- » **Stress fractures:** Stress fractures occur with repetitive stress on the bones. This can occur due to physical activity such as running, competitive dancing, or weightlifting. The fractures are characterized by bone edema and fracture lines.
- » **Arthritis:** Bone edemas are relatively common in those who have both inflammatory and noninflammatory

arthritis. It's usually due to a cellular infiltrate within the bone which compromises bone cell function and appears as the disease gets worse together with loss of cartilage

- » **Cancer:** Metastatic tumors can produce a higher water production in bone. This edema will appear in ultrasound or MRI. Radiation treatment can also cause edemas to occur.
- » **Infection:** Swollen tissues can cause increased water in the bone. The edema will typically go away after the infection is treated.

## TREATMENT

The most important therapeutic measure is the research into the cause of the bone marrow edema or the stress reaction / stress fracture of the bone. Thus, triggering events, unaccustomed stress or incorrect stress should be investigated. Initial treatment is symptomatic with restricted weight bearing, analgesics, and physiotherapy. In addition, corticosteroids, bisphosphonates, and prostaglandin inhibitors are used. Although



**ABB. 1** MRI pubic bone branch football player 1st German Bundesliga.  
(A) Findings before start of therapy with focused ESWT,  
(B) findings 6 weeks later with no pain under stress.

BME is usually self-limiting, previous conservative therapy has not been successful in shortening the course of the disease. To research more effective approaches, recent publications have highlighted more holistic approaches. For example, an interdisciplinary task force was set up within our large osteology center at the Ludwig Maximilian University in Munich, Germany, consisting of specialists from internal medicine, endocrinology / diabetology, hematology/oncology, orthopedics, pediatrics, physical medicine, radiology, rheumatology, and trauma surgery to develop a consensus paper.

Extracorporeal shock wave therapy (ESWT) has also shown to be a promising addition for a conservative treatment approach. Practical evidence shows its effectiveness in various orthopaedic diseases (Kienböck's disease, plantar fasciitis, osteitis pubis, osteonecrosis of the femoral head). In general, shock wave therapy promotes the self-healing powers of the tissue and can therefore be a useful tool in managing underlying diseases or other, relevant symptoms.

Specifically, in bone tissue, this means the stimulation of osteoblasts and periosteum cells and the differentiation of stem cells. It is assumed that there is an increased secretion of nitric oxide synthase and vascular endothelial growth factor, which could lead to increased angiogenesis. In addition, the periosteum is stimulated and the activity of osteoclasts is reduced. To summarize, shock wave therapy promotes the treatment of the underlying causes around the pathology of bone marrow edema, to activate the bone structure to heal itself.

## EVIDENCE

The first evidence that ESWT can support the treatment of a bone marrow edema was established in a study by Steinborn et. al. in 2000: Extracorporeal shock wave application for chronic

plantar fasciitis associated with heel spurs: prediction of outcome by magnetic resonance imaging. There, in a group of patients with chronic plantar fasciitis who also had a confirmed calcaneal bone marrow edema on pretherapeutic MRI, ESWT delivered positive, satisfactory clinical outcomes. [2]

In addition, a systematic review by Häußer et al. provided a summary of the history of the treatment of osteonecrosis of the femoral head, showing bone bruises, with focused shock wave therapy. [3] Further information on this study can be found via our partner Sportärztezeitung.

Further relevant studies demonstrate that the Swiss DolorClast® is useful in a treatment protocol for bone bruise was published by Duan et. al. from Chongqing, China. [4, 5]

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READ FOR YOU BY THOMAS MAIER

## IMPROVING EXTRACORPOREAL SHOCK WAVE THERAPY WITH 904 OR 905 NM PULSED, HIGH POWER LASER PRETREATMENT

Preprints 2021, 2021010138 (doi: 10.20944/preprints202101.0138.v1)



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### IMPROVING EXTRACORPOREAL SHOCK WAVE THERAPY WITH 905 NM PULSED HIGH POWER LASER PRETREATMENT

Excellent treatment outcomes have been achieved to date in routine clinical practice with extracorporeal shock wave therapy (ESWT), a well-studied and widely used conservative treatment method for a variety of disorders of the musculoskeletal system. To date, the applicability and thus effectiveness of ESWT has often been limited by the painfulness of the therapy at high energy flux densities (EFD).

### MECHANISM OF ACTION OF EXTRACORPOREAL SHOCK WAVES ON MUSCULOSKELETAL TISSUE

Proven mechanisms of action of ESWT are the release of substance P, immediate pain reduction, the blockade of neurogenic inflammation, stronger expression of growth factors and activation of mesenchymal stem cells. To date, to circumvent the limitations imposed by the pain experienced at high EFD, either the individual maximum EFD has been reduced or local anaesthetics have also been used during application of the therapy. However, it has now been established that local anaesthetics block the effect of ESTW on substance P nerve fibres and thus adversely affect the outcome.

The problem that high EFD is either not possible or only to a limited extent due to the painfulness of the treatment has remained unresolved.

### WHAT CAN BE FOUND ABOUT LASER TREATMENTS IN THE LITERATURE TO DATE

In the literature search conducted by Prof. Christoph Schmitz MD, two studies were presented that show relevant mechanisms of action of 904/905 nm pulsed high power laser treatments to treat disorders of the musculoskeletal system. In the one study conducted as long ago as 1988, Mezawa et al. recorded that treatment with 904 nm pulsed laser is able to influence nociceptors on a cat's tongue and thus deduced an analgesic effect. In the other study in 2006, Bjordal et al. proved that 904 nm pulsed laser treatment reduces peritendinous prostaglandin E2 (PGE2) concentrations in humans. Laser pretreatment reduced relative PGE2 concentrations in peritendinous tissue after 45 minutes compared to baseline and sham laser pretreatment. Comparable to the way in which NSAID medication, with all the associated adverse effects, acts on the whole body, an effect can therefore be deduced, which is generated completely locally in the treated area. In the further search, 23 RCTs listed in the PEDro database were also investigated that describe treatment of disorders of the musculoskeletal system using 904/905 nm pulsed high power laser therapy alone and demonstrate its use for various diseases of the musculoskeletal system. 20 of these 23 studies (87%) reported that laser therapy was superior to sham treatment or another treatment modality. One striking fact is that both the total number of treatment

sessions and the frequency of treatments per week were substantially higher than the total number with equivalent outcomes for ESWT. To date, these outcomes have made 904/905 nm pulsed laser monotherapy less appealing. However, they also indicate that the two treatment modalities in combination may have positive synergistic effects, which have currently not yet been investigated together.

### USE IN CLINICAL PRACTICE

A team of doctors and physiotherapists from Germany, Switzerland and Spain developed a treatment protocol in which 905 nm pulsed high power laser pretreatment was performed to begin with (duration 3-5 minutes) prior to ESWT. The observed outcomes to date are that the EFD of ESWT can be increased by up to 50% compared to ESWT without laser pretreatment when there is a delay of 5 minutes between laser pretreatment and ESWT, and by up to 100% when there is a delay of one hour. These outcomes were achieved using the DolorClast high power laser (wavelength 905 nm, peak power 300 W, pulse width 100 ns, frequency 40 kHz) (Electro Medical Systems, Nyon, Switzerland) and the DolorClast ESWT machine (Electro Medical Systems, Nyon, Switzerland). This GDT treatment protocol can significantly reduce the limitation imposed on EFD in ESWT in routine clinical practice. It is now possible, e.g. in treatment of the hand, to treat at intensities of up to 3.1 bar and 20 kHz that were previously inconceivable. During development of the protocol, it also became clear that patients who waited for both 5 minutes and one hour between the two treatments preferred to wait for one hour, as they subjectively reported a better and more sustained positive treatment outcome. This initially required changes to the clinical practice routine, but these were made without any great inconvenience and were positively received as they resulted in improved treatment outcomes. These outcomes require further investigative study and indicate that the combined therapy can be raised to a new, previously unattainable level in the treatment of disorders of the musculoskeletal system.



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# SEVERE BILATERAL OSTEITIS PUBIS

Case: 18-year-old tennis professional – an extremely complex case

PETER STILLER, MEDWORKS AUGSBURG

**Medical history:** The present case concerns severe bilateral osteitis pubis that slowly developed in an 18-year-old professional tennis player in the summer of 2018. The patient presented to me here on the recommendation of his osteopath. He had not been able to train for the previous seven weeks, and had had to discontinue the Wimbledon Junior Championship, and the US Open had also been cancelled as a precaution.

The initial MRI showed severe bilateral osteitis pubis and symphysisitis, and the follow-up scan after seven weeks' rest showed even further progression of the known bone marrow oedema on both sides. His pain had actually increased due to normal everyday activities without sport. Until then, the player had only been treated cautiously with physiotherapy and analgesics. The player and his parents had refused the topical application of cortisone to the origins of the pubic rami. Since he did not respond to the osteopathic treatment either, the osteopath treating him referred the player to me.

**A METICULOUS CLINICAL EXAMINATION AT HIS FIRST PRESENTATION TO ME PRODUCED THE FOLLOWING FINDINGS:**

Pronounced pain in both pubic rami on pressure, stretching, and muscle tension, with the pain radiating into both groins and the adductors. In comparison between the two sides the left side was always more severely affected. Furthermore – which was surprising for the patient – there was pronounced pain on pressure on the distal insertion of the rectus abdominis, left > right, as well as the origin of the left iliac muscle on the

iliac crest, marked pain in the sacroiliac joints left > right and in the region of the paravertebral musculature on both sides as well as both quadratus lumborum muscles! With the patient lying down, but even more clearly when standing, the muscularly well trained body unfortunately showed massive myogeloses in the whole spinal and neck region and scolioses in the dorsal and lumbar spine. An exact assessment of whether these were primarily verte-brogenic or muscular was not possible at such an early stage.

**DIAGNOSTIC INVESTIGATIONS & TREATMENT**

MRI findings on 31.07.2018 (Fig. 1a+b): Unchanged findings of intensive left-sided osteitis pubis over the course of seven weeks with possible initial infraction near the left pubic symphysis. The hyperintensity of the proximal tendon of the left adductor longus indicates a possible cause of the problems.... No secondary cleft sign. Under normal circumstances further treatment would have been suggested with a combination of anti-inflammatory drugs (NSAID), absolute rest from sport, magnetic field therapy, topical cortisone and/or Traumeel injections and, with medical

advice, even intravenous bisphosphonate therapy. However, since these measures are not only associated with many side effects, but would also have been extremely questionable due to the patient's age and the indication. Since the immobilisation and physiotherapy to date had not shown any success, we decided on a combination of radial extracorporeal shockwave therapy (rESWT) of the pubic bone, the adductors and his whole back, gentle chirotherapy and specific physiotherapy for his back. Furthermore, high-power laser and hyperbaric CO2 cryotherapy with Cryolight were used to ease the pain more rapidly and inhibit the inflammation. At home he additionally used MediVid Cryo cooling bandages. Pharmacotherapy consisted of a combination of Wobenzym (1st and 2nd weeks 4 x 5 tablets, 3rd to 6th weeks 4 x 4 tablets, 7th to 10th weeks 3 x 3 tablets), Traumeel, vitamin D + K2 + magnesium, vitamin E, omega 3 and beetroot. From a large number of treatments, including for other indications, we know that this combination very often leads to quick pain relief, relatively more rapid regeneration, and full exercise tolerance even with other cases that do not respond to treatment. However, descriptions of the combined use of rESWT, laser, hyperbaric CO2 cryotherapy and chiro-/physiotherapy for this clinical picture, and above all for this severity, were not referenced in the literature when this treatment was given.

rESWT was given with a Swiss Dolor-Clast device (Electro Medical Systems; Nyon, Switzerland) and the EvoBlue handpiece (15- and 36-mm applicator.)

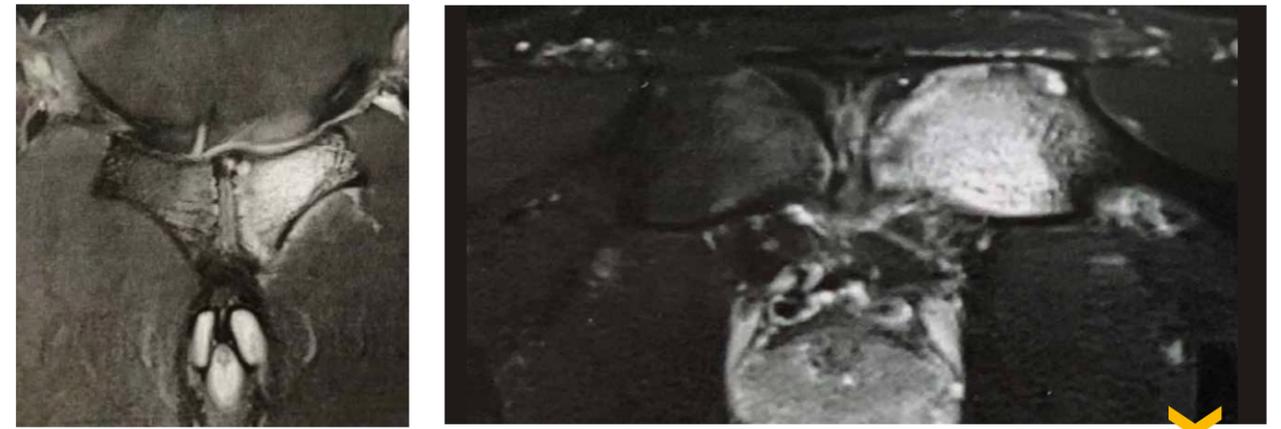


FIG. 1 A+B MRI on 31.07.2018 after seven weeks' break from training, still with massive pain

First a single dose of 5000 radial extracorporeal shockwaves (rESW) in the region of both pubic rami and the lower rectus abdominis insertions was applied using the 36-mm applicator with a working pressure of only 0.9–1.3 bar due to the strong pain (the large applicator is less painful). After the pain improved, he was given another 4000 rESW with 1.0 bar using the 15-mm applicator. This was followed by approximately 4000 rESW in the region of the adductor muscles on both sides (with the 36-mm applicator) and a working pressure of 1.3 – 1.7 bar which is also very little in this region. The pain thresh-

old was already reached at the pressure given here. Then complete additional treatment of the muscles of the lumbar spine (paravertebral autochthonous, sacroiliac joints, gluteal muscles, quadratus lumborum (with the 36-mm applicator). The rESW was always applied at 20 Hz, i.e. 20 rESW per second. At the next treatment sessions, which were initially held every three days, the pubic bone was always only treated with the 15-mm applicator, approximately 6000 – 7500 rESW per treatment. The other areas were still as described above. After the ESWT treatment the high-power laser was applied for 8:45 minutes with

the pain program (pre-installed), and for 4:30 minutes with the anti-oedematous program. The hyperbaric CO2 cryotherapy was given with Cryolight after the treatment, 3x down to a temperature of 2 – 4 degrees in the treated region. Of course the patient was still asked to abstain from all sports, but from the outset he was allowed to do special pain-free exercises to improve his posture, and was prescribed special orthopaedic insoles. Due to the muscular postural imbalance over his entire back we conducted precise tests with the EMG specialist Simon Roth from Mainz to specifically diagnose and treat

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PETER STILLER



is a specialist in general practice and accident and emergency medicine at the general medicine practice Lechhausen & MedWorks – private medical practice, Augsburg. He is the former team doctor of the FC Augsburg professional team.

faulty muscular control, i.e. to incorporate these findings into specific training to stabilise his torso.

These procedures resulted in rapid improvement of his symptoms; after only four treatments the patient could already cycle pain-free with relaxed jogging, and the treatment interval was extended to five days. After seven treatments normal jogging and the first stretching exercises were possible without any symptoms. The treatment interval here at my practice was now reduced to 1x weekly, and the physiotherapy and athletics training were intensified. On



FIG. 2 Scan on 01.10.2018

21.09.2018 (after seven weeks) a 90-minute pain-free full tennis training session was possible and rESWT was given at 3.6 bar without any problems.

OUTCOME

MRI 01.10.2018 (Fig. 2): In comparison with the previous examination there is clear regression of the cancellous bone oedema in the superior and inferior rami of the left pubic bone as an expression of the osteitis. Today there was a distinguishable secondary cleft sign for the first time at the origin of the left adductor longus muscle at the junction with the aponeurosis (arrows). Thus the result of the follow-up MRI scan showed an improvement. The secondary cleft sign that was now visible was not an indication of a new injury, but rather has only now become visible due to the marked improvement in the findings in the pubic area. After this result, and in view of the good clinical situation, the treatment with rESWT (20 Hz, 3.6 bar, 15 and 36 mm) was continued once a week for several weeks even after he had achieved full loading and was fit for competitive tennis to prevent recurrence. The specific stability training for his back and torso was adapted in the course of his progress and continued until today with great success. Compared with the previous situation the young professional has made astonishing progress. Only four days after the follow-up examination (MRI) the young patient was able to win his first world ranking points in his first Men's Challenger tournament. He has been symptom-free in the pubic area ever since then.

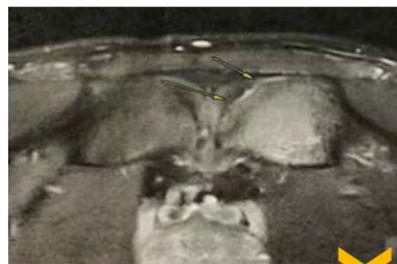


FIG. 3 Follow-up three days before the first match

SUMMARY

The combination of radial shockwave therapy, laser therapy and modern, intensive cryotherapy enables a very satisfactory, rapid outcome to be achieved that remains stable under pressure with regard to freedom from pain, regression of oedema and return to sports/competition despite such pronounced findings of symphysisitis and at such an advanced stage. For details of anti-inflammatory oral treatment with plant-based substances, please see the article by Klaus Pöttgen MD "Entzündungshemmung & Regenerationsoptimierung", pages 92 – 96 in the 01/20 issue of the sportärztezeitung.

Especially the combination of the new DolorClast highpower laser from EMS and their new DolorClast radial shockwave device is a real game changer on the market. We were able to gain a lot of experience from more than 1000 treatments this way and it is still astonishing with how much more pressure you can do the shockwave treatment 1 h after a 5 Minute laser session and so the very good results of shockwave treatment that we were used to, are now definitely extraordinary. EMS calls it GDT (=Guided DolorClast Therapy).

OUTLOOK

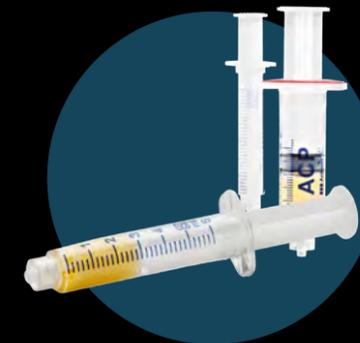
In my opinion, in the future also MBST magnetic resonance therapy should play an important role in the treatment of symphysisitis in professional athletes. I also see a future for testing such athletes by EMG in isokinetics laboratories to enable us to offer more comprehensive treatment and, at the same time, prevention, to heal more quickly and avoid injuries in the long term.

# Personalized Injection Therapies

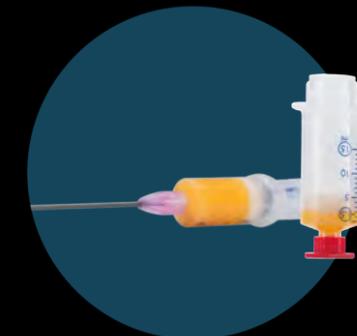
Regenerative Treatment Options Tailored to Patients' Needs



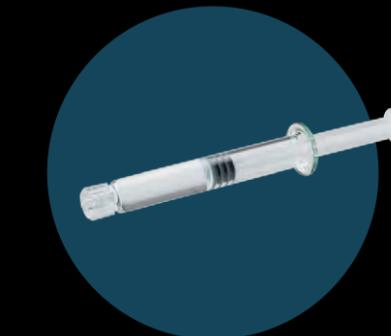
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# BIOREGENERATIVE TREATMENT METHOD

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

DR. MORITZ DAU /  
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.

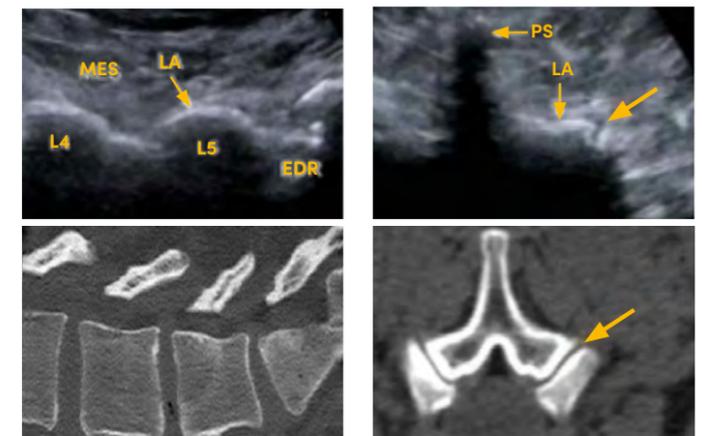
In exactly the same way as throughout the entire locomotor apparatus, chronic inflammatory and degenerative changes play a decisive role as the cause of the relevant symptoms here, too. The now extensive relevant literature contains a high level of evidence in favour of treating osteoarthritis (e.g. 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 costovertebral 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

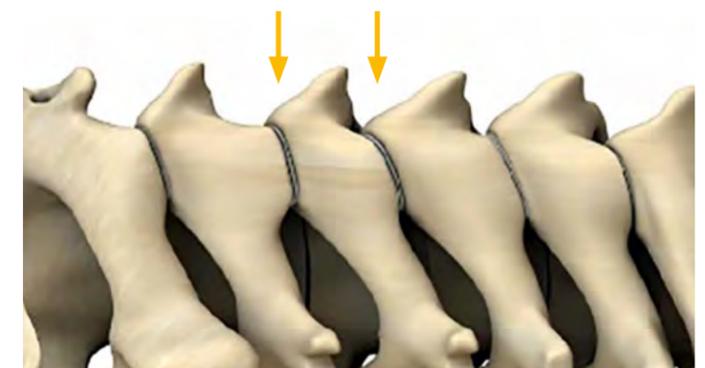
Activated facet joint osteoarthritis is the most common indication for the use of PRP in the spine. This can be imaged well using a linear transponder (e.g. 9 to 12 MHz) in slender, athletic patients. A convex probe is used for deeper imaging (Fig. 1).

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 →

**DR. MED.  
MORITZ DAU**



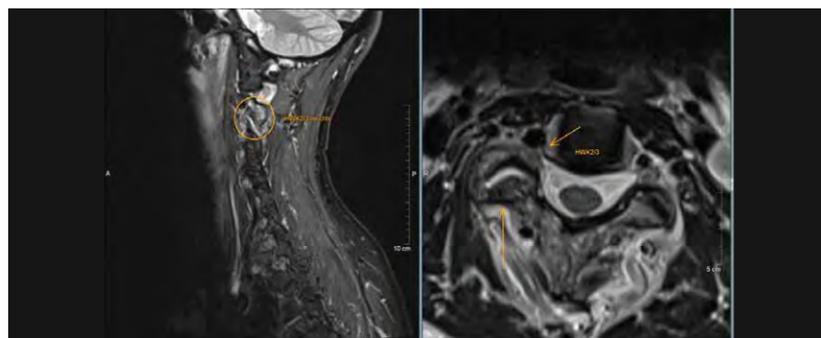
runs the Praxis Orthopädie am Rhy in Rheinfelden, and specialises in conservative and interventional treatment methods on the whole locomotor apparatus. He has additional qualifications in sports medicine, ultrasound and interventional pain treatment as well as manual medicine and accident and emergency medicine. Dr Dau has cared for various sports teams in Switzerland and has many years' experience in treating professional and top-class athletes.

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- $\alpha$  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**

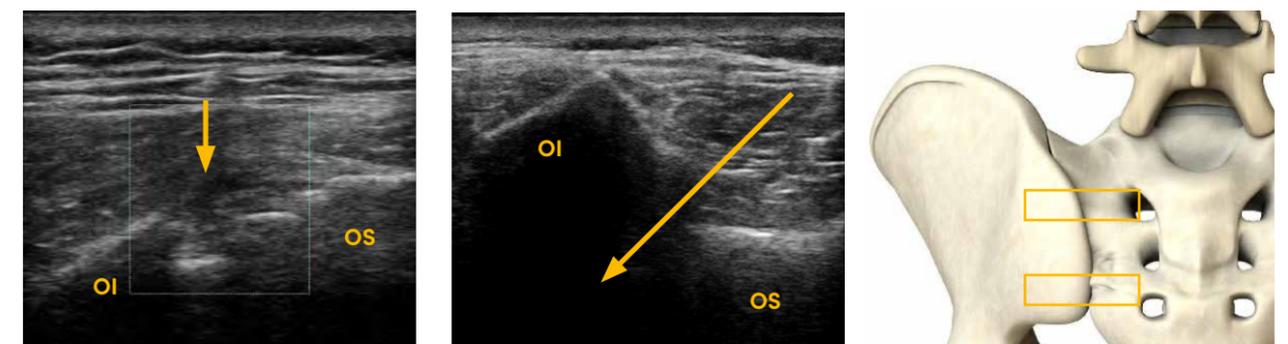
Due to the very promising results, both in daily use and in the literature, the focus is turning increasingly to treatment with platelet-rich plasma for spinal symptoms. Activated osteoarthritis of the lumbar and cervical facet joints,

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](http://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 = iliolumbar, OS = sacroiliac

# BREATHING, STRESS & A STRONG IMMUNE SYSTEM

Self-efficacy – a healthy and effective tool

MATTHIAS WITTFOTH MD /  
PSYCHOTHERAPY SCHÖNBERG

Strengthening the immune system has become an important focus for many people these days. In the current global pandemic, many are rightly asking themselves how they can build up their resistance to pathogens. They have no wish to face the looming danger passively and helplessly but wish instead to take active steps to ward off the danger themselves. Self-efficacy is a healthy and effective solution.



Sadly, one specific and relatively simple way of strengthening the immune defences has been largely ignored in favour of other options. Why has it still not caught on everywhere? Use your breathing!

## BREATHING AS A DIRECT PATH TO THE IMMUNE SYSTEM

But perhaps this is overstating the case. In recent years in particular, certain breathing techniques (notably the Wim Hof breathing technique) and new knowledge about paths and strategies to healthy breathing have become more widespread. Quite rightly in my opinion, and I dare to predict that this is just the beginning. Following a wave of knowledge about meditation, mindfulness, stress reduction and the importance of an individualised, healthy diet and optimal sleep, one of our essential basic functions – our breathing – is now being accorded the importance it deserves. If, on the one hand, it is true that new findings about breathing have recently come to light as a result of much research, on the other hand, it is also true that there are some that are anything but new. Rather, they have been rediscovered – locked away in a drawer for some inexplicable reason. Old knowledge about breathing.

## THE WIM HOF METHOD IN THE SCIENTIFIC SPOTLIGHT

In January 2014, an article was published in the renowned PNAS Journal [Proceedings of the National Academy of Sciences of the United States of America] under the title “Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans” [1]. This study is based on a single case study of the Dutchman Wim Hof [2]. This man has broken over 20 world records for cold endurance and has very successfully spread his very own method, the Wim Hof method, around the world. At that time, Wim Hof was still relatively unknown and was “The Iceman” just in Holland itself – mad and mocked. A few

years after the study on Wim Hof by Dutch doctors at the Radboud University Medical Centre in Nijmegen, the results of which were published as a single case study, the same doctors conducted a second study but this time with a group of young people, who were then compared with a control group. Normally, the fundamental purpose of the work of this group is to find appropriate measures and mechanisms of action to counter the increasing incidence of sepsis. Both the study on Wim Hof himself and the group study published in PNAS investigated the human immune response to injections of lipopolysaccharides (LPS). LPS are found in the outer membrane of Gram-negative bacteria. They are released when the microorganisms die. They act in the host as endotoxins and induce inter alia the release of IL-1 and TNF- $\alpha$  by macrophages. This is a process that can be relatively easily monitored, and which allows investigators to, as it were, watch the immune system in action by taking regular blood samples during the first 4–6 hours after the endotoxin injection.

The 2014 study showed that it is possible to modulate the immune system with something as simple as a breathing technique, the result in this case being that there were hardly any reports of the otherwise observed severe malaise from the study subjects who had trained in the Wim Hof method for just 10 days. Objective parameters showed a marked difference in the cytokine levels in the two groups. In those who had received training, there was a dramatic increase in IL-10 following LPS administration, which correlated with an increase in adrenaline. Pro-inflammatory mediators such as IL-6, IL-8 and TNF- $\alpha$  were lower in number and correlated with IL-10. The sympathetic nervous system was activated by this method of breathing, resulting in an increase in adrenaline\* but without any corresponding increase in noradrenaline and cortisol. The breathing method is no secret and can be learnt from the many instruction

videos now available [3]. The results generated a great deal of interest, and several renowned universities are now studying the Wim Hof method. Shortly after the publication of the results, an incredibly positive and informative article appeared in Nature, which optimistically concluded that we were well on the way to finding the connection between the immune response and neural regulation [4]. To have an idea of how the study subjects breathed following endotoxin administration, the following video from the additional files in the journal provide fascinating footage [5]. The researchers themselves were extremely sceptical and reluctant at first. The first author Matthijs Kox told me in an interview that Wim Hof had come to them himself, claiming that he knew a way of influencing the autonomic system and thus also his immune response [6]. This was considered medically impossible. Now, scientists are starting to think otherwise. Over-inflated expectations and hypercritical reporting aside, the essence and applicability of breathing techniques will become apparent in the future.

## OTHER STUDIES

Several other studies on the Wim Hof method have been published since the PNAS study in 2014, but all with a different focus. For example, researchers at the University of Michigan in Detroit studied Wim Hof using fMRI (functional magnetic resonance imaging) and PET (positron emission tomography) to examine the metabolic and neural links to cold [7]. The study of the Dutch group published in 2019 showed a significant fall in the ESR (erythrocyte sedimentation rate) in patients with the chronic autoimmune disease axial spondyloarthritis following an 8-week intervention (Wim Hof method) [8].

## BE SELECTIVE IN THE USE OF ADRENALINE

It is very often incomprehensible to many why activation of the sympathetic nervous system and modulation of the

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has a doctorate in neurosciences and is a certified Wim Hof method instructor. After almost two decades of research work (Bremen, Hanover, Boston) using functional imaging of the brain, he has been giving breathing and cold training workshops around Europe for several years.

immune system should be something positive. In many cases that is not necessarily true, this being the case when it is not just short-term but becomes chronic, such as in permanent stress. On the other hand, as Matthijs Kox pointed out to me, activation of the sympathetic nervous system and the corresponding increase in adrenaline levels are desirable in autoimmune disease. Adrenaline appears to have acquired a bad reputation. This is completely unjustified, as adrenaline is very beneficial for the function of the immune system. In this context it is helpful to refer to McEwen's model of allostasis [9]. It describes the effect of overload after repeated and chronic exposure to stress. To put it very simply and briefly, our brain is constantly seeking to predict future events. To regulate to some degree the uncertainty of life, we scan our environment and continuously make predictions about changes

to our environment and their effect on us. We feel secure in a predictable environment. On the other hand, if we find ourselves in an environment that constantly threatens us and in which we must always be on our guard, we are in a permanent state of stress. We are constantly trying, and above all expending much energy in doing so, to act predictively and to minimise the risk of any unpleasant surprises. And this is precisely what is associated with an increased allostasis load, which in the long term ultimately turns initially helpful short-term adjustment processes into the exact opposite. We pay for the chronic activation of neuroendocrine, cardiovascular and emotional alarm systems with pathophysiological changes.

But let us now turn back to short-term activation of the sympathetic nervous system. When we use the opportunity to increase adrenaline levels in the short term, our stress and immune systems are activated, and this is associated with two crucial factors: firstly, the activation is not prolonged but limited to a short period of time and secondly, our state of mind is playful, curious and relaxed, but not characterised by helplessness or anxiety. Breathing techniques that can trigger these effects can thus be used to control stress and be beneficial for oneself and one's immune system. It remains to be seen to what extent these techniques are a specific or just one possible path to strengthening the immune system (alongside, for example, controlled states of stress such as sport, ice baths and sauna).

**CONCLUSION:  
ADRENALINE AND LEARNING**

It may be a surprise to learn that these short-term positive effects can even directly result in improved learning and memory consolidation. For both factual memory and in sport the all-important motor memory, specific activation of the sympathetic nervous system at the end of a learning unit, or more pre-

cisely an increase in adrenaline levels induced by breathing techniques or other paths, results in a marked improvement in mnemonic retention. A further important point is that regular activation of adrenaline while in a calm state of mind helps strengthen both. This means that in situations that are stressful and likely to be beyond our control, as is certainly the case in many competitive situations in sport, we are more likely to achieve a trained mental balance and to possess, despite the activation of the sympathetic nervous system, more cognitive and emotional capacity to manage the situations to our advantage. Short-term stress training therefore has effects that transfer to areas that cannot be fully controlled.

*\*The terms adrenaline and epinephrine are synonymous. There is an incredibly interesting scientific story behind the two terms, with partly racist aspects. For more information, see Brian B. Hoffman: "Adrenaline", Harvard University Press, Cambridge and London 2013.*

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# OSTEOPOROSIS

Nutrition as prevention in sport

**PROF. NADINE BERLING, DOCTOR OF MEDICAL SCIENCES, NUTRITIONAL MANAGEMENT, APOLLON HOCHSCHULE DER GESUNDHEITSWIRTSCHAFT GMBH, BREMEN**

**Osteoporosis is one of the most common disorders in Germany in which nutrition plays a contributory role. Its pathogenesis often spans decades. Under certain conditions athletes are also at risk. Regular monitoring of the dietary intake and the state of nutritional health help reveal possible deficits and imbalances, and contribute toward the prevention of osteoporosis by the application of suitable nutritional measures [1, 2].**

Osteoporosis is a systemic disease of the skeleton. The low bone mass and the microarchitectural deterioration of the bone tissue lead to increased bone fragility and susceptibility to fractures. The peak age in men and women is over 70, which is explained by multifactorial influences and the insidious pathogenesis. A basic distinction is drawn between primary and secondary osteoporosis. Primary osteoporosis does not develop on the basis of an underlying disease [2].

## RISKS OF OSTEOPOROSIS IN SPORTS

All physical activities and sports contribute towards the prevention of osteoporosis. Athletes are at a higher risk of osteoporosis if they are subject to long-term malnutrition and dietary deficiency. This primarily affects athletes with a BMI <20, and/or those whose restrictive nutritional intake supplies insufficient nutrients [1, 3]. One-sided nutrition or an overlooked increased requirement can favour a deficiency of certain nutrients in the long term and promote the onset of osteoporosis [4]. From the ae-

tiological viewpoint, the consequences of malnutrition and deficiencies of certain nutrients (e.g. calcium, vitamin D) during adolescence and young adulthood often only become apparent decades later. This is compounded by the fact that some athletes have increased requirements of certain nutrients, e.g. protein, iron, depending on the type of sport and the degree of exertion [3].

A nutritional expert can calculate the early indications of athletes' nutrient intake and the status of nutritional supply by conducting a nutrient analysis. Possible deficits can be remedied successively by initiating individual interventions. Among others, these involve changing the choice of foodstuffs and, if necessary, taking supplements for deficient nutrients (after consulting a doctor). Medical examinations, e.g. of the blood during osteoporosis screening, give sound information about the supply of nutrients. If a long-term inadequate calcium supply is suspected the examination can be augmented by osteodensitometry. In case of inadequate supply, or with early or existing osteoporosis, medical interventions are initiated and supplemented by individual nutritional measures if necessary [5].

## KEY NUTRIENTS AND STIMULANTS

An adequate supply of calcium and vitamin D are important elements in the prevention of osteoporosis [1, 6]. Vitamin K2 also plays an important role in preventing osteoporosis. However, recommendations for supply and supplementation are not yet anchored in the

German Association of the Scientific Medical Societies (AWMF) guideline "Prophylaxis, diagnosis and treatment of osteoporosis". There is strong evidence that permanent calcium and vitamin D deficiencies influence the onset of osteoporosis [1]. While calcium is one of the components of bone, vitamin D promotes the absorption of calcium from the gastrointestinal tract and helps harden the bone. Vitamin D also regulates calcium and phosphate metabolism [7]. However, 74% of female adolescents aged between 14 and 18 fall short of the recommended calcium intake. In elderly men and women aged 65–80 these figures are 61% and 65% respectively [8]. With regard to the supply of vitamin D, the recommended intake is below the reference level in 91% of women, and in men this figure is 82% [8]. Since the substance is synthesised in the skin exposed to UVB radiation, humans do not depend solely on the supply of dietary vitamin D. Theoretically, UVB radiation is sufficient to ensure an adequate supply between April and October in Germany. Nevertheless, approx. 60% of the German population is considered to have an inadequate intake [5]. Consequently, athletes can also be affected.

An excessive supply of certain nutrients in sports can also favour the onset of osteoporosis. For instance, excessive protein intake also boosts the excretion of calcium in the urine. The same applies to the excessive consumption of coffee containing caffeine, although 3–4 cups a day are still considered safe. Immo-

derate alcohol consumption (men >20 g/day, women >10 g/day) has negative effects on osteoblast function and, as a result, increases the risk of osteoporosis [9–11]. While an excessive intake of protein promotes the excretion of calcium, a deficit should also be avoided: too little protein in the long term inhibits the collagen structure of the bones and, due to loss of muscle mass, increases the risk of falling [12]. More recent findings show that a protein intake of 1.2–2.0 g per kg bodyweight for athletes who do more than five hours of endurance sports per week provides a useful contribution to protein biosynthesis [13]. The study situation for other micronutrients is less well researched: folate, vitamin B6, vitamin B12, vitamin K, potassium, fluoride and silicon are examples of micronutrients that contribute towards the normal function of bone metabolism. Glucosamine and chondroitin sulphate are endogenous substances. They are components of the connective and cartilaginous tissues. The substances can be used at a sufficiently high dosage to treat existing osteoarthritis. The same applies to the omega-3 fatty acid eicosapentaenoic acid (EPA). The outcome of a cross-sectional study shows that the adequate intake of potassium and magnesium correlates positively. The following applies to athletes and everybody else: a high intake of fruit and vegetables in childhood contributes towards higher bone density of the femoral neck [14].

## VEGETARIAN AND VEGAN NUTRITION

Although vegetarians and vegans are often claimed to have an inadequate calcium intake, vegetarians are more rarely affected by increased loss of bone mass than omnivores. It is thought that a vegetarian diet, in part high in calcium and, at the same time, low in dietary phosphate, exerts beneficial properties in retaining bone mass. At the same time, the reduction in animal protein can exert a calcium-sparing effect. According to current understanding vegans

too, who eat more than 525 mg calcium daily, are not at higher risk of osteoporosis [5].

## CASE STUDY

Lisa A.: triathlete, 32-years-old, BMI 19.1, 12 hours of endurance sports per week, vegan lifestyle. Lisa A. refuses vegetarian foodstuffs that have been enriched with calcium, Vitamin B12 and other micronutrients. A BMI of <20 is principally a risk factor for the danger of osteoporosis. From a BMI of 18.4 adult women are classified as underweight. A nutritional behaviour of avoiding enriched milk substitutes can be a problem. It can lead to deficits of calcium and Vitamin B12 among others. Saltwater fish is the best dietary source for supplying vitamin D. This nutritional source is not available on a vegan diet. Possible nutritional measures: if the review of the supply of nutrients as part of a nutritional analysis shows that there are deficits, the following recommendations are conceivable:

- » Bodyweight: increase daily energy supply by about 300 kcal, e.g. 1–2 slices of wholemeal bread with humus and one portion of vegetables.
- » Calcium supply: eat calcium-rich vegetables and pulses daily, e.g. broccoli, kale, tofu and mung beans, and drink calcium-rich mineral water (>150 mg/ calcium per litre).
- » Vitamin B12 supply: ensure a supply of Vitamin B12 with alcohol-free wheat beers, bread drink, enriched toothpaste, and possibly with supplements.
- » Vitamin D supply: regular medical tests of the supply of vitamin D in the blood, if necessary take supplements, above all in winter.
- » Vitamin K2 supply: ensure the supply with fermented foodstuffs such as sauerkraut and with supplements if necessary, perhaps in combination with vitamin D3. Regular medical checks on the supply are recommended.

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Recommended intake of relevant nutrients (excerpts)

**Calcium [15]**

Age	mg / day
7 to under 10 years	900
10 to under 13 years	1100
13 to under 19 years	1200
19 years and older	1000
Nursing and pregnant women	1000

**Vitamin D (if there is no endogenous synthesis) [16]**

Age	µg* / day
0 to under 12 months	10
From the first year of life	20
Nursing and pregnant women	20

\*1µg is equivalent to 40 IU (International Units)

**SUMMARY**

Osteoporosis is a disease in which nutrition plays a contributory role. It can often be prevented by an adequate supply of nutrients in combination with sport. Nevertheless, athletes are also exposed to an increased risk of the disease, not only due to their low body weight, but also to inadequate/erroneous eating habits. An adequate supply of calcium and vitamin D is vital for preventing osteoporosis. Furthermore, other macro- and micronutrients influence bone metabolism. Athletes should always have their supply of nutrients checked by nutritional experts using nutrient analysis and by doctors testing laboratory parameters. In this manner possible deficits or imbalances can be revealed early and remedied with suitable interventions.

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# SUDDEN CARDIAC ARREST

## IN FOOTBALL

FIFA Sudden Death Registry,  
Screening & Prevention

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MEDICAL DEPARTMENT FIFA

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**Sudden Cardiac Arrest (SCA) is the leading cause of sudden death in footballers on the field-of-play. The actual mechanism that leads to SCA, though, is largely unknown [1]. In footballers below 35 years, SCA is believed to be mostly arrhythmogenic and often on the background of an underlying structural or electrical pathological heart condition [2, 3].**

Among athletes above 35 years, coronary atherosclerosis is the most frequent aetiology of SCA [1 – 4]. Exercise can be a trigger for arrhythmias in players with an underlying cardiac pathology. While physical activity has proven benefits for cardiovascular health, the risk of sudden death is increased during bouts of exercise, thus the majority of SCA in footballers occurs during training or competition. The frequency of SCA in footballers (and athletes in general) is unknown, largely due to the absence of mandatory reporting. Data collection systems and methods for examining the incidences of SCA have traditionally been quite limited. There are a number of populations (and sub sections of populations) who have mandated reporting systems, and it is from these that we derive our incidence data. Current estimates of the incidence of sudden cardiac death in athletes range from almost one in a million [5] to 1:23.000 [6] athletes per year, while some subpopulations of athletes are reported at even higher risk with an incidence of 1 in 3.000 [7]. The most commonly acknowledged incidence of SCD in athletes is 1 in 200.000, although later studies and a closer examination of methodologies have challenged this estimate as too low [7 – 9].

FIFA exists to govern football and to develop the game around the world. Recently the organisation has been fast evolving into a body that can more effectively serve football for the benefit of the entire world, and this includes the health and welfare of all players. In 2020 FIFA Medical made Cardiovascular health one of their 4 core pillars in their strategy to improve the health benefits for the entire footballing population.

Within this strategy, FIFA Medical looked to:

- » Identify the incidence of SCA
- » Produce policies to mitigate the risk of SCA
- » Produce guidance and education and research on the best practice when dealing with a SCA

### IDENTIFY THE INCIDENCE OF SCA

To establish the true incidence of SCA in football the FIFA Sudden Death Registry was established (FIFA-SDR). The Registry was developed in conjunction with Universität des Saarlandes in Germany. The FIFA-SDR (<http://www.uni-saarland.de/page/fifa/en/registry.html>) project offers the opportunity to examine SCA in football players and therefore, to improve our knowledge and understanding of sudden deaths and sudden cardiac arrest (including cases of SCA in which the patient survives) in apparently healthy athletes. A first report was published after five years of data collection [10]. It is envisaged that further data will help to detect possible regional or national differences, and to improve preventive measures which may be adapted to specific regional or national circumstances and conditions to further help prevent SCD/SCA in athletes. FIFA funding for this has been guaranteed over the 10-year project. Persons or associations who are interested in the FIFA-SDR and would like to cooperate are warmly welcome to contact FIFA-SDR by [sportscardiology@uni-saarland.de](mailto:sportscardiology@uni-saarland.de).

### PRODUCE POLICIES TO MITIGATE THE RISK OF SCA

Methods to reduce the occurrence of SCA during football include thorough

cardiovascular screening, and effective emergency planning of protocols and procedures to treat any cardiac emergencies. Before players start participating in any sport, they should be medically examined to ensure that they are sufficiently healthy to cope with the demands of training and playing. The FIFA pre-competition medical assessment (PCMA) is mandatory for all FIFA affiliated competitions. It aims to prevent harm and to identify potentially significant medical conditions that might make playing football dangerous. The FIFA PCMA involves a focused cardiac section, consisting of medical history, family medical history, physical examination, resting 12-lead ECG and an Echocardiography. Performing an ECG, in addition to taking a history and performing a clinical examination, increases the likelihood of identifying any pre-existing cardiac abnormality. Abnormalities for which indications may be identified on a screening ECG include hypertrophic cardiomyopathy (HCM) and arrhythmogenic right ventricular dysplasia. For conduction anomalies like long QT and WPW syndromes, the resting ECG is the decisive diagnostic tool. Genetic testing can be used afterwards to provide a definitive diagnosis. It is important to recognise that, for most cardiac diseases, ECG abnormalities may be present. The Two-dimensional transthoracic echocardiography is the principal diagnostic tool for clinical recognition of many cardiac pathologies. While being a cornerstone in the diagnosis and follow-up of HCM, it can also detect other relevant abnormalities possibly responsible for SCD in young athletes, such as left ventricular dysfunction e.g. due to myocarditis or dilated cardiomyopathy, valvular heart disease

**DR. ANDY MASSEY**



joined FIFA in 2020, having worked at Liverpool Football Club for the previous 7 years as Head of Medical Services. After a Masters in Sports Physiotherapy in Australia, he completed an MSc in Sports Medicine and was awarded a Fellowship of the Faculty of Sport and Exercise Medicine. At FIFA he has been tasked with leading the Medical Subdivision. His current projects are looking at strategies to improve the physical and mental health of footballers globally and providing frameworks for clubs, member associations and confederations to deliver the optimal medical care for all, and to encourage football participation.

and aortic root dilatation. Arrhythmogenic right ventricular cardiomyopathy is often difficult to diagnose by echocardiography alone. If this condition is suspected, a cardiac MRI is generally considered to be a better investigation tool. Although echocardiography may raise strong suspicion of congenital coronary anomalies, mainly the left main coronary artery originating from the right sinus of Valsalva in selected young athletes, CT angiography, magnetic resonance imaging (MRI) or even coronary arteriography are usually necessary to diagnose this entity.

**PRODUCE GUIDANCE AND EDUCATION AND RESEARCH ON THE BEST PRACTICE WHEN DEALING WITH A SCA**

The FIFA Medical department has developed a number of initiatives to assist clinicians working in football with the following aims:

- » To appropriately identify SCA on the field of play and manage

it appropriately

- » To train team officials, players and medical staff to respond effectively to a case of SCA
- » To train team officials, players and medical staff to understand how to deliver CPR on the field of play and use an AED appropriately in this setting
- » To develop an action plan for the management of SCA

The FIFA Emergency Medicine Courses are bespoke courses for clinicians working at all levels of football. The two principle courses are a one day foundation course and a two day advanced life support course, with assessments throughout the courses. Further, there are separate recertification courses and dissemination courses where participants learn the skills to pass on the formal teaching in their own environments.

Other education material include a specific SCA online interactive module and

exam that must be passed in order for clinicians to gain accreditation to work at a FIFA tournament, and the revised FIFA Emergency Medicine Manual that is planned for release in Summer 2021. The Pre-Match Emergency Action Plan (PEAP) is a new initiative that formalises the responses, should a cardiac (or other medical) emergency occur on a pitch. The PEAP is an opportunity to formalise agreed roles and responsibilities of all clinicians prior to a match, in response to an emergency, and offers a chance to rehearse the medical response to emergencies via various moulages conducted in the time prior to kick off.

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