CHAPTER

9

THE CARTILAGE AS THE ULTIMATE VICTIM OF LATERAL ANKLE INSTABILITY

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The cartilage as the ultimate victim of lateral ankle instability

Surgical Treatment Paradigms of Ankle Lateral Instability, Osteochondral Defects and Impingment

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ABSTRACT

Ankle sprain is amongst the most frequent musculoskeletal injuries, particularly during sports activities. Chronic ankle instability (CAI) resulting from an ankle sprain might have severe long-lasting consequences on the ankle joint.

Fact Box 1 – Ankle Injury Epidemiology

• Inversion ankle sprain most frequent mechanisms: often during landing on the lateral border of the foot, or if the foot gets locked on the ground, while the body continues to turn.
• Isolated lesions of the ATFL occur in 65% of all injuries, while combined rupture of the ATFL and CFL occurs in approximately 20%.
• Despite adequate conservative treatment, approximately 20% of patients develop chronic lateral ankle instability.
• Nonanatomic reconstruction techniques significantly change ankle and subtalar biomechanics.
• Upon failure of conservative treatment, anatomic repair or reconstruction techniques have achieved high percentage of good results.

Fact Box 2 – Surgical Options for Treatment of Lateral Ankle Instability

• The so-called anatomic techniques include isolated repair of ATFL remnant and combined ATFL and CFL repair, with or without Gould augmentation by pants-over-vest reinforcement with inferior extensor retinaculum.
• If the remnant tissues are considered as irreparable, or in revision surgeries, anatomic reconstruction by using a tendon graft (gracilis tendon) either open, percutaneous or arthroscopic has produced favorable outcome.
• Arthroscopic surgical techniques are under development with promising results (at least similar to open techniques while enabling treatment of comorbidities), but more studies are required, particularly in in high-level athletes.

Fact Box 3 – Most Frequent Risk Factors for Surgical Treatment of Lateral Ankle Instability

• Stiffness <5% (reduced ROM >5°)
• Re-rupture

• Nerve damage
• Complications with skin closure
• Risk factors for worst surgical outcome:
• Patients with hyperlaxity
• Very long-standing ligamentous injury (over 10 years)
• Previous surgery for ankle ligament repair

Fact Box 4 – Osteochondral Defects (OCDs) of the Ankle

• Traumatic and non-traumatic aetiologies have been described.
• Ankle sprain or chronic ankle instability might be implicated in the aetiology of OCD.
• Fixation of a large fragment shall be performed whenever possible.
• Microfracture is still the most popular treatment once it has favorable results, low aggression and low cost.
• Moreover, no surgical treatment has proven superiority over any other in this field so far.
• Tissue engineering and regenerative medicine approaches promise new options for the future.

Fact Box 5 – Ankle Anterior and Posterior Impingement

• Both are based on clinical diagnosis while imaging might be helpful in preoperative planning.
• Arthroscopic approach of bony or soft tissue impingement is the rule upon failure of conservative treatment.
• Both are treated in outpatient clinic with immediate range of motion and weightbearing. Full return to activity is usually achieved between 4 and 6 weeks.
• It is very important to start active dorsiflexion-plantarflexion exercises from day one to avoid stiffness.

INTRODUCTION

Ankle lateral instability is a very frequent injury which might cause functional limitations in both athletes and in the general population. It has been stated that ankle sprain is one of the most frequent injuries during sports activity; however, criteria for return to activity are under-reported[1]. The rapid direction and step's changes in addition to landings from falls, collisions and jumps

present players with high injury risk during sports. These manoeuvres, which are key elements of the sport at the top level, produce high loads to the hindfoot, frequently exceeding the mechanical resistance of the ankle joint[2,3]. An inversion ankle sprain is the most frequent cause of acute ankle injury in sports[4].
This typically occurs after a jump, when landing on the lateral border of the foot, but might also occur if the foot gets locked on the ground, while the body continues to turn.
This sudden increase in inversion and internal rotation forces, combined with either dorsi- or plantarflexion, produces sufficient strains to rupture the ankle lateral ligaments, causes concomitant osteochondral lesions or aggravates anterior or posterior joint impingement[5,6].

The anterior talofibular ligament (ATFL) is injured first; then with increased inversion and rotation, the calcaneofibular ligament (CFL) is also torn (Fig. 4.1)[7].

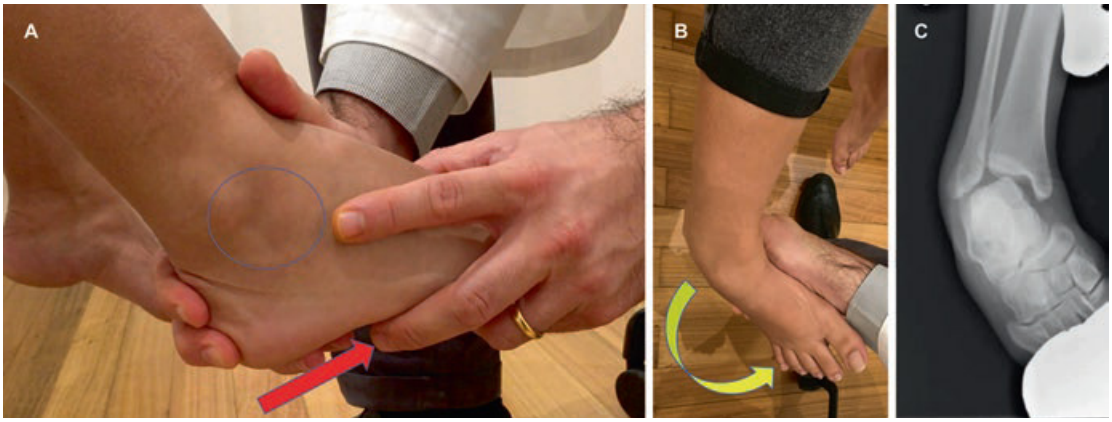

Fig. 4.1 (A) Anterior drawer test in which the surgeon induces anterior translation force (red arrow). The anterior dislocation of the talus makes visible a sulcus sign (blue circle). (B) Tilt test in which a rotational force (yellow arrow) is induced suggesting calcaneofibular ligament injury. (C) Varus stress X-ray reproducing the tilt test and demonstrating impingement of the talus within the ankle mortise.

In about 65% of cases, an isolated lesion of the ATFL will occur, while combined ruptures of the ATFL and CFL happen in around[8,9] 20%. The posterior talofibular ligament (PTFL) is rarely injured during inversion sprain[10,11]. In approximately 10–15% of all inversion injuries, there is a total rupture of the lateral ankle ligaments[12]. Moreover, 50% of these cases have concomitant other injuries in the joint (medial ligament injuries, syndesmotic injuries, loose bodies, osteochondral defects (OCDs))[13].

If not treated adequately and in due time, these injuries will lead to chronic ankle instability (CAI) and might have severe consequences such as

osteochondral defects, ankle impingement, synovitis and post-traumatic ankle arthrosis (given the recurrence of ankle sprains)[14-17]. Furthermore, patients with CAI have altered joint kinematics which in turn lead to an increased chance on recurrent ankle sprains[18]. These persistent "microtraumatisms" will increase the possibility for osteochondral injuries as well as anterior or posterior impingement.

In case of failure of conservative treatment, patients who suffer from recurrent ankle sprains can be effectively treated by means of surgical stabilization[19-21]. With the objective to minimize surgical aggression and enable immediate treatment of comorbidities, arthroscopic techniques have been developed and optimized, providing at least similar outcome as open techniques[20].
In order to preserve joint kinematics and optimize clinical results, present surgical techniques aim to restore the "normal" anatomy[22]. Use of peroneal tendons as used in the past is therefore not advised unless this is considered to be the last option[22].

The two most popular techniques include anatomic repair and anatomic reconstruction[22]. A third technique, receiving less attention in current literature, is capsular shrinkage[23]. By use of radiofrequency, the joint capsule is heated which induces shrinkage of collagenous structures aiming to tighten the ATFL (without any foreign or allogeneic material such as suture anchors or tendon grafts)[24]. Despite overall good results, de Vries et al.[23] reported the technique to be unable to modify objective ankle joint laxity.

From Ankle Sprain to Chronic Lateral Ankle Instability

Although the natural history of ankle sprains is not completely understood, the inherent stability of the ankle mortice and its congruency might contribute to the fact that complete but isolated ATFL ruptures have good prognosis. Most patients are successfully treated with functional treatment[25]. In some selected cases, especially in elite athletes, it has been proposed that early surgery can be considered as a first-line treatment to achieve a faster return to play[26,27].
If no ligament rupture occurs, functional rehabilitation treatment will enable to resume activities in few days/weeks. Pain is used as a guide for patients and doctors. Ruptured lateral ankle ligaments usually require a period of rigid/semi-rigid immobilization followed by soft brace protection or taping (taping has some risk of skin irritation)[28].
Despite adequate conservative treatment, around 20–30% of patients will develop CAI with persistent symptoms (fear of reinjury limiting activity, sense of

giving away, and recurrent sprains)[26,29,30]. Standardized and reproducible criteria for reporting return to play for athletes are scarce in literature, and there are no objective guidelines to assist us in this determinant decision[1].
CAI derives from several functional and mechanical factors[7,31,32]. These include lower-leg proprioceptive deficits, disturbance of normal reflexes and (peroneal) muscle weakness which are relevant contributors to the persistence of the symptoms[31]. Subsequently, a thorough rehabilitation program that emphasizes proprioceptive, neuromuscular control and balance training must always be followed.
Available data report success rates up to 80% after functional rehabilitation programs[10,26].

Principles of Surgical Treatment of Lateral Ankle Instability

Surgery is indicated to restore functional stability upon failure of conservative treatment[25,30]. The surgical options to treat CAI range from anatomic repair to Non-anatomic reconstructions. Currently, there is insufficient evidence to support any specific superior surgical intervention in the treatment of chronic ankle instability[29,33].
Nevertheless, non-anatomic reconstruction, as the classic Evans, Watson-Jones or Chrisman-Snook procedures, has been shown to significantly alter the normal biomechanics of the ankle complex, particularly the subtalar joint[8,9,34,35].
Given these concerns[33], and the favourable outcome of anatomic techniques, the former are currently the first line of surgical treatment[36-38].
Anatomic open repair was first described in 1966 by Bröstrom et al.[39]. This technique respects the original anatomy by tightening the torn ATFL and CFL to the distal fibula (Fig. 4.2).

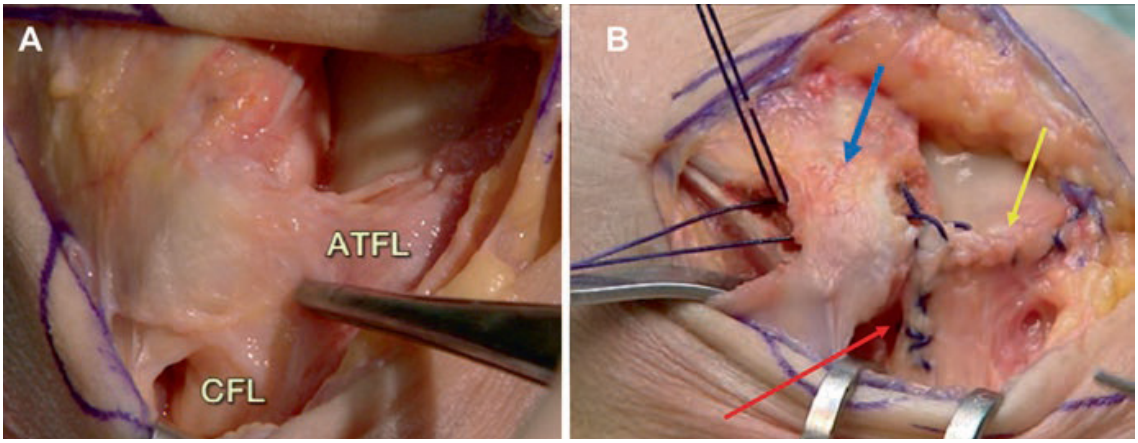

Fig. 4.2 (A) Open surgery where anterior tibiofibular (ATFL) and calcaneofibular ligament (CFL) are visible. (B) Open Brostrom repair with repair of the anterior tibiofibular (yellow arrow, ATFL) and calcaneofibular ligament (red arrow, CFL) is reattached to the fibula (blue arrow)

Two modifications were introduced over time by Gould et al.[40] that advises to suture the inferior retinaculum extensorum (RE) over the proximal ATFL end to augment the repair, and the modification by Karlsson et al.[41] advises to shorten the ligaments were often not disrupted but elongated.
The functional outcomes of these techniques in its many modifications have been excellent, with success rates reported as high as 87–95%[12,40,41].
Retrospective case series of arthroscopic repair techniques have shown successful postoperative results with a high rate of self-reported satisfaction (94.5%), with low rate of complications (0.5–3%)[42-45].

The rehabilitation protocol after anatomic repair of the lateral ligament follows the functional treatment for acute ligament rupture, with a lower-leg cast for 1 or 2 weeks, followed by 2–4 weeks in a functional brace[37]. To encourage earlier return to play, range of movement exercises and protected loading are recommended after 2 weeks as tolerated. Inversion and rotational exercises should be limited during the first 4–6 weeks. Return to sport is usually possible between 10 and 12 weeks; dynamic postural control tests are considered valuable functional assessment tools to progress in return to full activities[4,33,46].

Recent Advances in Surgery for Ankle Instability

All the anatomic repair techniques depend on the quality of the ligaments' remnant in order to achieve an effective repair[36]. Karlsson et al. determined risk factors for worst outcome: hyperlaxity, long-standing injuries and previous surgical treatment[41].
When the tissue remnant is considered inadequate for repair, then anatomic reconstruction using a free tendon graft (autograft or allograft), usually the gracilis tendon, has been proposed with favorable outcome[47,48]. Available clinical data suggest that these anatomic free graft-based reconstructions, either by arthroscopic, percutaneous or open techniques[49], enable favorable outcome in properly selected cases: inadequate remnant or as a salvage/revision procedure[47,48,50,51].
Graft-based reconstructions may lead to increased stiffness once the graft is much stronger than the native tissue[47]. Usually a more aggressive rehabilitation

is possible, depending on the intraoperative achieved tension and graft fixation[52].
Song et al. recently showed a midterm better ankle joint function in patients who received an ATFL reconstruction, compared with the Broström procedure[51], but this finding requires further research with larger series and uniform selection criteria followed by randomized studies.
The current trend is on the pursuit of minimally invasive arthroscopic techniques (Fig. 4.3). Based on the favorable outcome of open ligament repair, several authors have described repair techniques aiming to replicate what has been learnt with open surgery and achieve similar repairs with arthroscopic anchor-based approaches[36–38, 42, 49, 53]. This might lower the surgical morbidity and shorten the time of recovery[54, 55]. Arthroscopy also enables the treatment of concomitant intra-articular lesions in addition to ankle stabilization[14,56].
Considering the aforementioned retrospective series, comparative studies for open and arthroscopic anatomic lateral ligament repair have shown similar clinical and biomechanical outcome[20,54,55].

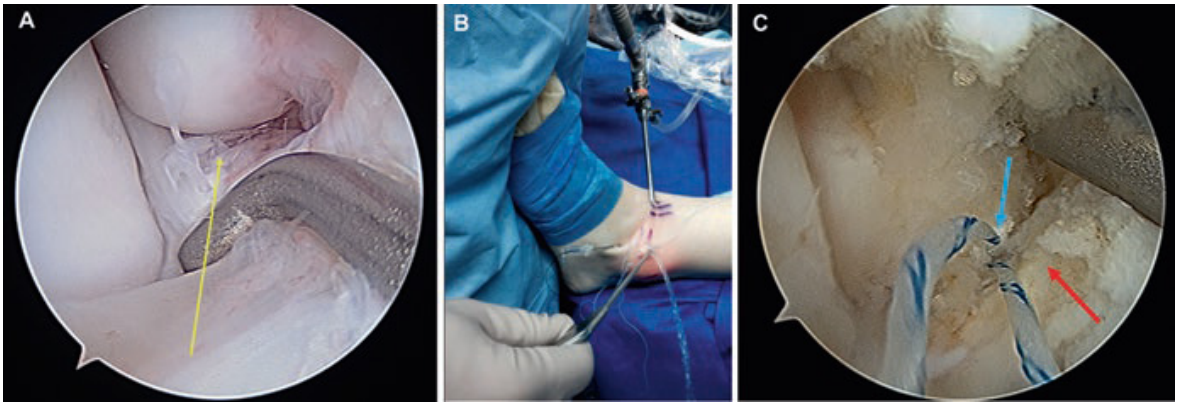

Fig. 4.3 (A) Arthroscopic view of the ATFL remnant detached from the fibula (yellow arrow); (B) outside view of arthroscopic ATFL repair; (C) arthroscopic view of reattachment of the ATFL remnant (red arrow) to the fibula and knot tying (light blue arrow)

Ankle Osteochondral Defects

An osteochondral defect (OCD) of the talus is a lesion involving the talar articular cartilage and its subchondral bone. Several classifications have been used over time, but the first comes from 1959 from Berndt and Harty[57]. OCDs are usually caused by a single or multiple traumatic events, but non-traumatic, idiopathic OCDs of the ankle have been described[58-61]. No classification fully addresses the problem, but the anatomic grid proposed by Raikin and Elias has proven to be useful both in the talus and the tibial plafond[62,63]. The defect

initially may involve only superficial cartilage damage caused by shearing stresses, without damage to the underlying subchondral bone, but a bony injury after a high-impact force also can cause a defect[64]. Ankle trauma associated with an OCD often develops leading to the formation of subchondral bone cysts. These cysts are related with persistent deep ankle pain thereby causing functional impairment. Most OCDs of the talus are found on the anterolateral or posteromedial talar dome[65]. Lateral lesions are usually shallow oval shaped, and a shear mechanism has been proposed to be more frequently implicated. This opposes to medial lesions which are usually deeper, and cup shaped, suggesting a mechanism of torsional impaction and axial loading[58,60]. Despite several theories and basic science studies concerning OCDs of the talus, its aetiology and pathogenesis are still not fully comprehended. An OCD might have an acute onset. However, the process leading to subchondral cyst formation requires some time, and it's a slower process[66]. The reason why some OCDs remain asymptomatic is still unclear, while others with apparently similar features cause pain on weightbearing (aggravated by effort), show persistent bone oedema on magnetic resonance imaging and ultimately lead to a subchondral cyst. Understanding this process would be critical in order to prevent progressive joint damage[66].

A traumatic event is commonly accepted as the most important aetiologic factor of an OCD of the talus. For lateral talar defects, trauma has been implicated in 93–98% and for medial defects in 61–70%[67]. OCD aetiology can be divided in non-traumatic and traumatic defects[60]. Vascular aetiology, ischemia, subsequent necrosis, and genetics have been accepted as aetiologic factors[58]. Moreover, OCDs have been found in identical twins and siblings[68]. OCDs are bilateral in 10% of patients[69]. Traumatic cartilage lesions include three categories: microdamage or blunt trauma, chondral fractures and osteochondral fractures[70].

Ankle sprains have a predominant role in the aetiology of traumatic OCDs, once these are probably the most frequent traumatic events leading to these injuries[13].
When a talus twists inside its "bony mortice" during an ankle sprain, the cartilage covering of the talus can be damaged by direct impactions causing a real OCD, bone bruise, cartilage crack or delamination. Shearing forces might cause separation in superficial layer of the cartilage[60]. Loose bodies can be created (and cause even more cartilage damage), or OCDs might remain partially stable in its position (Fig. 4.4).

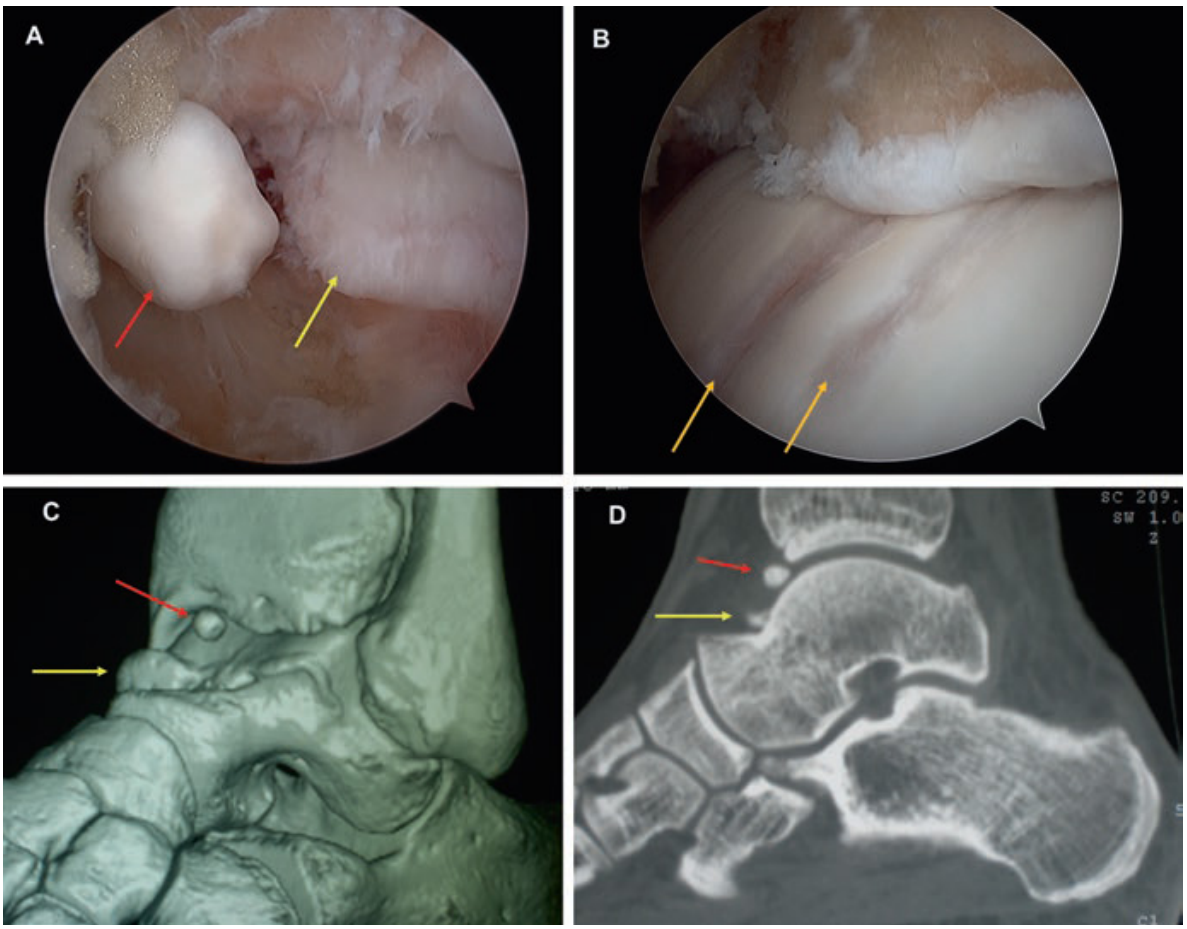

Fig. 4.4 (A, B) Arthroscopic view of loose body (red arrow) and talar spur (yellow arrow), causing osteochondral ridge defects (orange arrow on the talar dome). (C, D) CT view of the loose body (red arrow) and talar spur (yellow arrow)

The lesions can either heal and remain asymptomatic, or progress to deep ankle pain on weightbearing and form subchondral bone cysts. Berndt and Harty were able to reproduce lateral ankle OCDs under laboratory conditions by intensely inverting a dorsiflexed ankle. As the foot was inverted, the lateral border of the talar dome was compacted against the face of the fibula, and when the lateral ligament ruptured it lead to cartilage avulsion. During application of excessive inverting force, the talus rotated laterally in the frontal plane within the mortise, thus impacting and compressing the lateral talar margin against the articular surface of the fibula.

With this mechanism, a portion of the talar margin was sheared off from the main body of the talus, causing a lateral OCD. A medial lesion was reproduced by plantarflexing the ankle in combination with slight anterior displacement of the talus on the tibia and inversion and internal rotation of the talus on the tibia[57,60].

For this reason, one can assume a tight connection between most ankle OCDs and CAI which is the topic for reflection in the herein presented paper.

Principles of Surgical Treatment of Osteochondral Defects

Asymptomatic incidental findings of the ankle are not infrequent, including within athletic population[71].
Asymptomatic and/or low symptomatic OCDs can usually be treated conservatively, even if kept under clinical and/or image surveillance. Conservative treatment includes orthobiologics, physiotherapy, periods of rest or immobilization (e.g. Walker Boot)[59,65].
Regarding the symptomatic ankle OCDs, several approaches are possible depending on the characteristics of the lesion and patient profile.

There is no current consensus in literature of clear superiority of any surgical treatment over another either in primary or secondary ankle OCDs[65,72,73]. Preoperative planning is of paramount relevance, and it should always include X-rays for alignment assessment and global evaluation. The computed tomography (CT) is a critical method since it provides a relatively more reliable assessment of bone defects, which can be overestimated by the MRI oedema around the defect mainly in T2 sequences. However, the presence of such oedema in T2 suggests activity around the lesion. Moreover, CT lateral view in plantar flexion or dorsiflexion is helpful to determine if it's possibly an anterior or posterior arthroscopic approach or if an open approach is required (medial malleolar osteotomy for medial defects or lateral ligament detachment and afterwards reinsertion for lateral defects).

Arthroscopic approach is currently the preferred and most frequently used for both anterior and posterior compartments[74]. Moreover, when no fixed distraction is used, the percentage of complications is extremely low[75].
Given the lack of evidence of any superior treatment, the author's approach favors to prefer the less aggressive options. More aggressive, thus more prone to complications or higher cost procedures are considered for secondary or revision surgeries (Table 4.1).

Table 4.1 Practical algorithm for surgical treatment of osteochondral defects of the ankle

Type of osteochondral defect	Treatment option
Asymptomatic/low-symptomatic lesions	Conservative: periods of rest/walker boot
Symptomatic lesions ≤ 15 mm	Excision, curettage and bone marrow stimulation (ECBMS)
Symptomatic lesions ≥ 15 mm	Fixation* / OATS Consider ECBMS
Large talar cystic lesion	Retrograde drilling ± bone transplant Consider ECBMS
Secondary lesions	OATS/ACI/Hemicap ®/Osteotomy Consider ECBMS

ECBMS excision, curettage and bone marrow stimulation, *OATS* osteochondral autologous transplantation surgery, *ACI* autologous chondrocyte implantation (last generation); Hemicap®, metallic implant for partial replacement of the medial talar dome. ECBMS is considered in most cases given the outcome possibilities and lower aggression and cost. Lower percentage of good/excellent results is to be expected in larger lesions and revision surgery

\Whenever possible, an ankle OCD which is possible to fix in place (with sufficient size and preferably with some underlying bone) will constitute our first option
(Fig. 4.5).

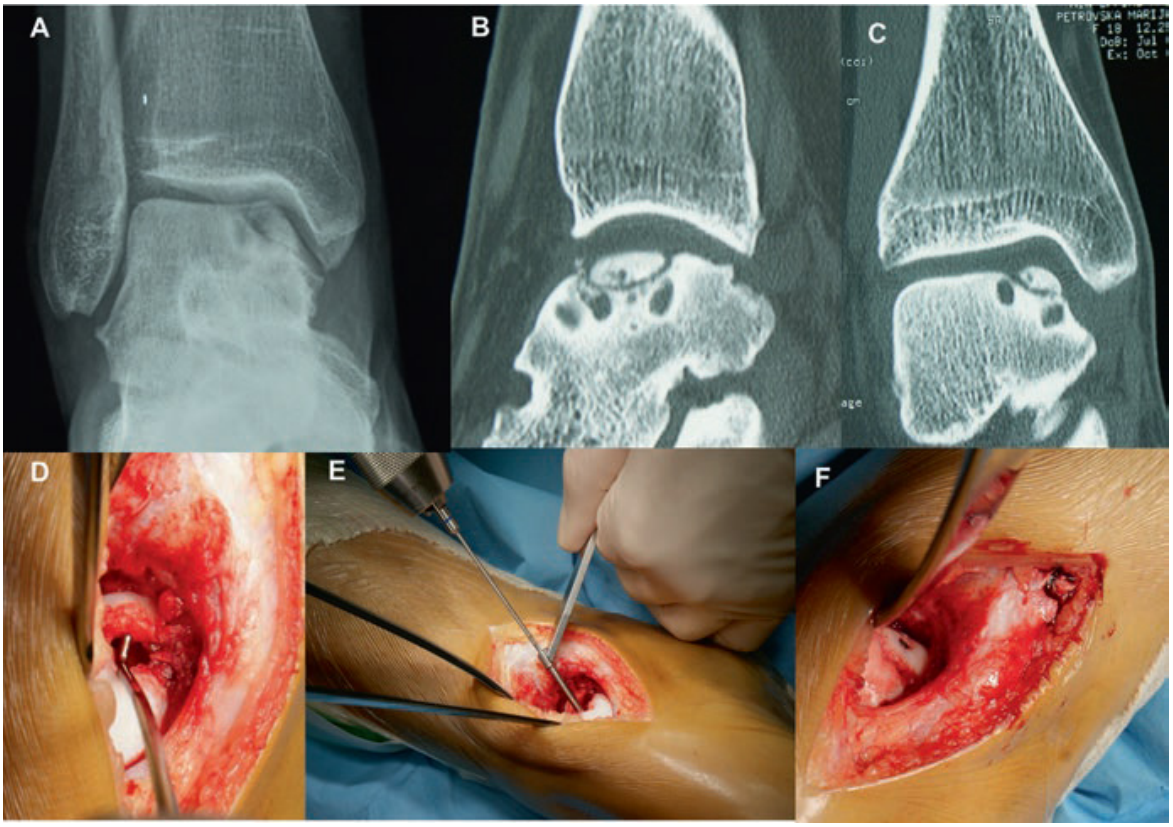

Fig. 4.5 (A) X-ray with visible medial OCD on the talar dome. (B, C) CT confirms OCD with underlying bone and cystic lesions around it. (D) After medial malleolus osteotomy, the OCD is lifted, submitted to bone marrow

stimulation and filled with bone autograft. (E) The fragment is fixed. (F) Final view with fixation with compression screw.

Either open or arthroscopic, the "lift, drill, fill, fix" technique should always be considered once it is the one who preserves the most of the native tissue and hyaline cartilage[76] (lift, the defect; drill, by making microfracture or bone marrow stimulation; fill, the defect with bone graft; and fix, the fragment with metallic or bio-absorbable screws or pins).

In OCDs smaller than 15 mm, excision, curettage and bone marrow stimulation, usually by microfractures (Fig. 4.6), aims to stimulate the underlying subchondral bone bringing "blood" containing growth factors (GFs) and mesenchymal stem cells (MSCs) which will promote fibrocartilage coverage of the defect and provide around 85% of successful outcome at a 5-year follow-up[77].

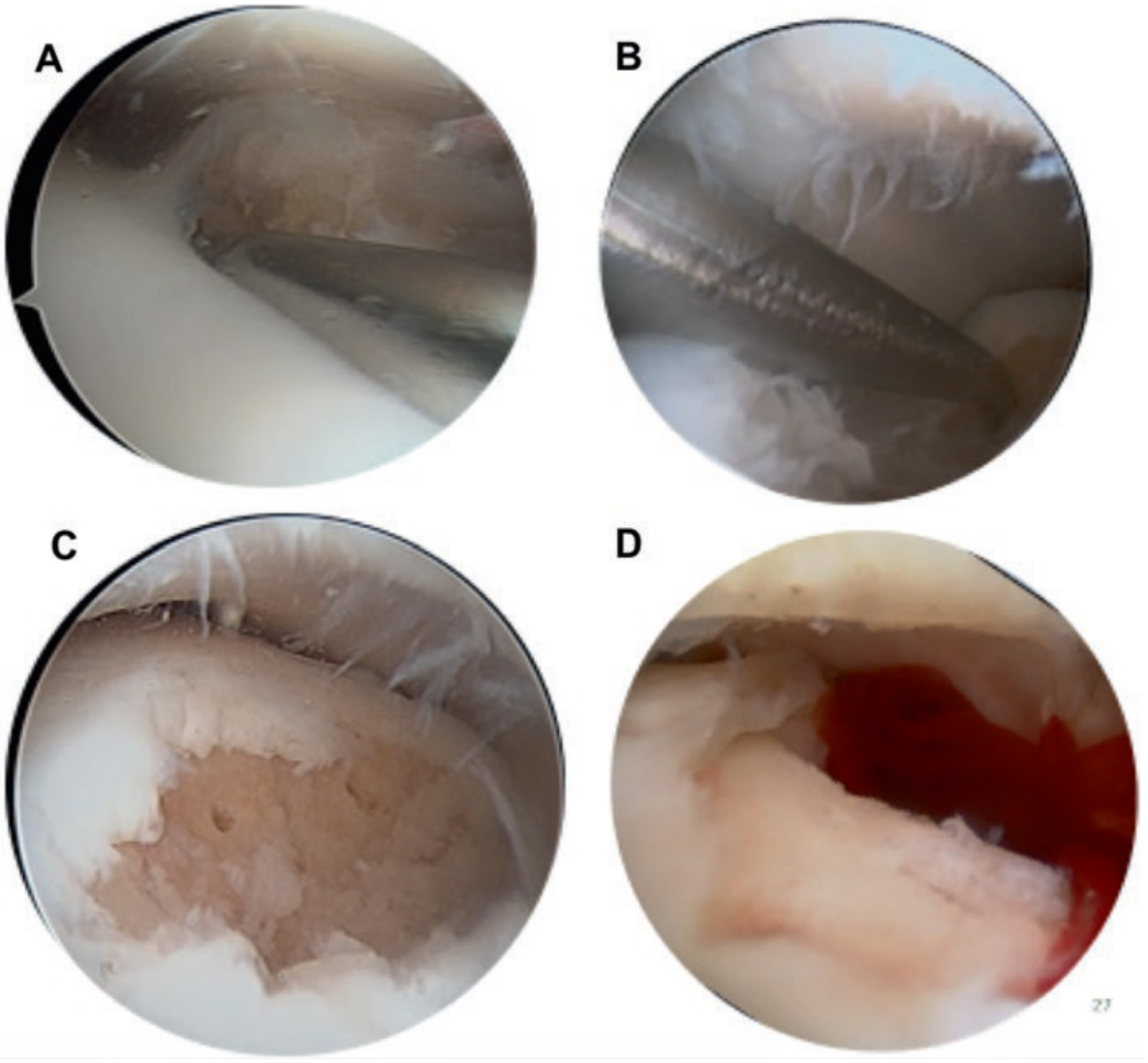

Fig. 4.6 (A) Ankle OCD arthroscopic view and removal of unstable fragment; (B) microfracture probe; (C) final look after microfractures; (D) blood coming from the microfracture holes after reliving the tourniquet.

Given the satisfactory results with minimal aggression, depending on the patient profile and injury characteristics, this approach can also be considered in bigger lesions unable for fixation or secondary injuries[65,72,73].
Large cystic lesions, including tibial OCDs, can be addressed by retrograde drilling to lower the pressure within the cyst and filling with bone graft when possible or required.
The osteochondral autologous transplantation surgery (OATS) consists in harvesting osteochondral cylinders from the knee to fill an ankle defect. Despite a high rate of successful outcome stated by the promoters, a systematic review has shown that this technique is linked to a high percentage of complication[78].

So, in our algorithm it remains a salvage procedure for large OCDs or secondary lesions (after failure of previous surgeries). Cell-based therapies, scaffolds and augmentation with hydrogels, despite being quite promising, have not been able to consistently present superiority to the previously described techniques on the clinical setting. For this reason, and considering their high cost, they remain options for revision surgeries or large injuries without possibility for fixation and not amenable by any of the previous techniques[79-95]. However, we strongly believe in advanced tissue engineering and regenerative medicine approaches for the future. When all biologic surgical treatments fail, a novel metallic implant designed for secondary defects of the medial talar dome (Hemicap®) has provided favorable outcome[96].

Finally, realignment by means of the osteotomy (calcaneal sliding (Fig. 4.7) or supramalleolar) is a powerful tool to provide a more favorable biomechanical environment for OCD healing by unloading the affected site[97,98].
As a last resource, ankle fusion or ankle arthroplasty in very selective cases might be the end line treatment[98].

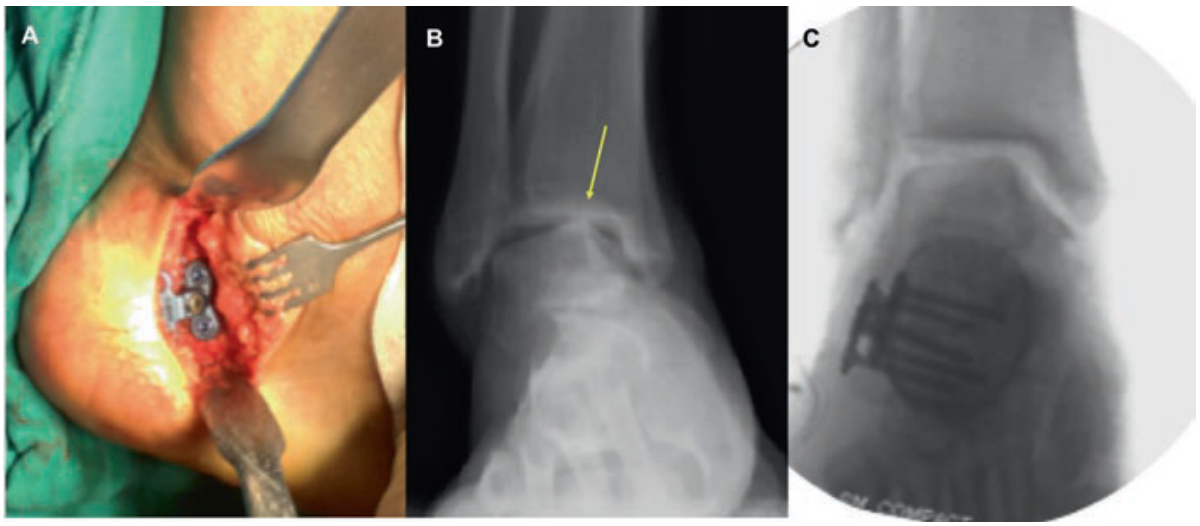

Fig. 4.7 (A) Surgical procedure of calcaneal sliding osteotomy; (B) preoperative X-ray demonstrating severe varus with impingement of the talus on the tibial plafond; (C) final position achieved with improved alignment enabling better load distribution.

Ankle Impingement Syndromes

Repetitive microtrauma to the anterior aspect of the ankle joint might lead to bony spur formation ultimately causing anterior impingement syndrome[99]. This microtrauma might be linked to CAI or repetitive direct impact force (e.g. kicking a ball)[100]. About one third of patients with CAI will experience pain related to ankle impingement. Injury of the anterior-inferior talofibular ligament might lead to the development of a "meniscoid lesion" which might cause soft tissue anterolateral impingement[99]. Impingement is considered as a syndrome, meaning that it is basically a clinical diagnosis in which the key sentence is superficial recognizable pain on palpation. Patients complain of persistent pain in walking, aggravated by climbing stairs (dorsiflexion or local pressure might cause entrapment of soft tissue/ synovitis between two hard surfaces).

Anterior or anteromedial impingement I usually caused by osteophytes, which are not enthesophytes (Fig. 4.8).

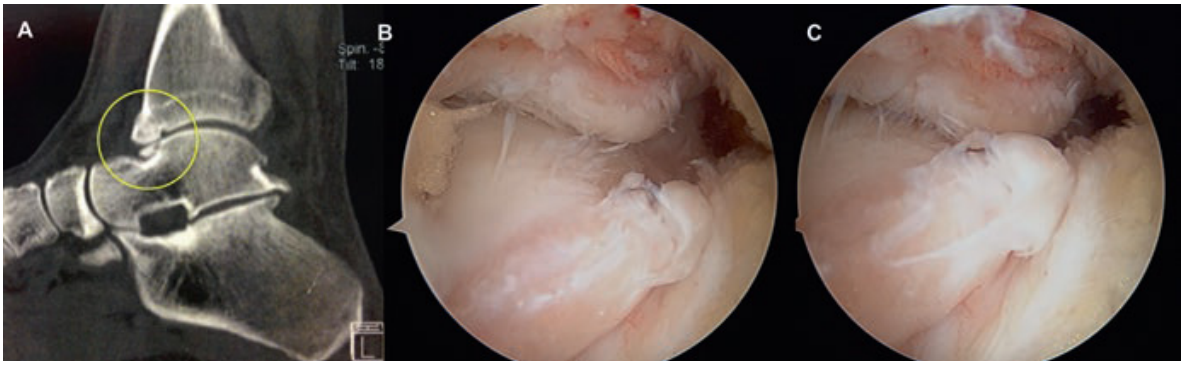

Fig. 4.8 (A) CT demonstrating anterior impingement (yellow circle); (B, C) arthroscopic view in neutral position and dorsiflexion where bony impingement is confirmed.

They do not result traction once they are included in the limits of the capsule[101]. X-ray (including the AMIC view –anteromedial oblique view)[102] or CT (less frequently MRI) can be useful for preoperative planning and identification of concomitant loose bodies or painful broken osteophytes.

Posterior impingement syndrome concerns a mechanical conflict due to hyperplantarflexion[103]. It can be either acute (os trigonum or Stieda process fracture or dislocation) after trauma[104] or chronic, caused by repetitive microtrauma (which might also be linked to CAI) (Fig. 4.9).

Fig. 4.9 CT 3D view of plantarflexion ankle with posterior impingement with os trigonum (yellow arrow).

Chronic cases can be linked to hypertrophic os trigonum or posterior talar process as well as related fractures or soft tissue impingement (cysts). It is often observed in footballers, cyclers, swimmers, acro-gymnasts and ballet dancers[105,106]. It is also a syndrome, where posterior impingement test is most helpful and imaging is used for preoperative planning in most cases[107]. Upon failure of conservative treatment (physiotherapy, injections, shoe wear), surgical treatment is recommended.

Principles of Surgical Treatment of Anterior Impingement

The treatment of anterior, anteromedial, anterolateral, bony or soft tissue ankle impingement is nowadays achieved mainly by arthroscopic approach. The medial portal is created in dorsiflexion, medial to the crossing line between the anterior tibialis tendon and the joint line[108]. This way the cartilage surface is protected under the tibial plafond, and the working space is "opened". The lateral portal is performed under transillumination and again in dorsiflexion to avoid nerve damage (the superficial peroneal nerve moves posteriorly). The tibial osteophyte shall be removed from superior to inferior and the talar osteophyte from distal to proximal to fully control the bone morphology [101,107].

It is recommended to minimize aggression which will ultimately lead to a faster recovery and avoid secondary instability due to loss of bony contact (if too much bone is removed)[101,107].
This is an outpatient procedure, and the patient can weight bear from day 1 if tolerated. It is very important to start active dorsiflexion-plantarflexion exercises from day 1 to avoid stiffness. Stiches are removed at 2 weeks, and full return to activity is possible within 4–6 weeks.
Satisfactory results have been published around 85–90% at a 5-year follow-up, and around 80% remain asymptomatic at an 8-year follow-up[101,107].

Principles of Surgical Treatment of Posterior Impingement

The two-portal endoscopic approach for the hindfoot described by Van Dijk et al. created a revolution in the treatment of these conditions[109], either bony or soft tissue impingement. It lowered dramatically the surgical aggression as it is an outpatient procedure, and the patient can weight bear from day 1 if tolerated.

Once more, it is very important to start active dorsiflexion-plantarflexion exercises from day 1. Stiches are removed at 2 weeks, and full return to activity is possible within 4–6 weeks for isolated procedures[103].
The flexor hallucis longus tendon is used as a medial landmark to define a safe working area to avoid the medial neurovascular bundle.

The knowledge of anatomy is fundamental, and the step-by-step technique has been described elsewhere[110]. Effort shall be made to remove the os trigonum in one piece to avoid living small loose bodies behind.

Final Remarks

• The majority of inversion ankle sprains are effectively managed with functional conservative treatment, even in the case of ligament rupture.
• There is increasing evidence on the effectiveness of arthroscopic approach for CAI treatment. So far, the reported outcomes are at least equivalent to open techniques. However, more high-level studies are still needed.
• When repair of the remnant tissue is no longer possible, anatomic reconstruction by using a free graft (auto- or allograft) has provided good results and is also suitable for revision cases. Moreover, replication of the anatomy may facilitate to overcome the limitations of previous nonanatomic techniques.
• Osteochondral defects can have traumatic and non-traumatic aetiology. CAI is a major cause of traumatic OCDs.
• Fixation of an OCD should be performed whenever possible. Besides this, the most frequent surgical treatment remains bone marrow stimulation (microfractures). This relies on the high percentage of satisfactory results and lower aggression, as well as the fact that no surgical procedure has, so far, demonstrated consistent advantage over the former.
• Tissue engineering and regenerative medicine promises to provide new more effective options for the future.
• Anterior and posterior impingement syndromes are based on clinical diagnosis while imaging is helpful in preoperative planning.
• Aetiology can be traumatic with the contribution of repeated microtrauma connected to CAI.
• Arthroscopic/endoscopic approaches for both these entities enable high percentage of good results with minimal complications and fast return to activity.

• CAI, as herein described, is a major entity which can cause further damage through time in the ankle joint. Effective and timely treatment will avoid further joint damage.

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Rehabilitation and return to sports after cartilage repair of the ankle - Proceedings from the 2017 International consensus meeting on cartilage repair of the ankle

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ABSTRACT

Background

The evidence supporting best practice guidelines in the field of cartilage repair of the ankle are based on both low quality and low levels of evidence. Therefore, an international consensus group of experts was convened to collaboratively advance toward consensus opinions based on the best available evidence on key topics within cartilage repair of the ankle.

Aim

The purpose of this article is to report the consensus statements on Rehabilitation and Return to Sports developed at the 2017 International Consensus Meeting on Cartilage Repair of the Ankle.

Methods

Seventy-five international experts in cartilage repair of the ankle representing 25 countries and 1 territory were convened and participated in a process based on the Delphi method of achieving consensus. Questions and statements were drafted within 11 working groups focusing on specific topics within cartilage repair of the ankle, after which a comprehensive literature review was performed and the available evidence for each statement was graded. Discussion and debate occurred in cases where statements were not agreed upon in unanimous fashion within the working groups. A final vote was then held, and the strength of consensus was characterized as follows: consensus, 51% to 74%; strong consensus, 75% to 99%; unanimous, 100%.

Results

A total of 9 statements on rehabilitation and return to sports reached consensus during the 2017 International Consensus Meeting on Cartilage Repair of the Ankle. All 9 statements reached strong consensus, with at least 86% agreement.

Conclusion

The rehabilitation process for an ankle cartilage injury requires a multidisciplinary and comprehensive approach. This international consensus derived from leaders in the field will assist clinicians with rehabilitation and return to sports after treatment of a cartilage injury of the ankle.

INTRODUCTION

Osteochondral lesions of the talus (OLT) can have a substantial impact on overall quality of life and on athletic performance, resulting in the delay or inability of an athlete to train or compete.[3,15,39] The primary goal of the process of the rehabilitation is to return the patient to his or her preinjury activity level without pain, which is particularly important for athletes. With respect to athletes, the time to return to high-impact sports after operative treatment of OLT ranges from 3 to 6 months and is dependent mainly on the type of lesion and specific treatment strategy employed.[23]

To our knowledge, no objective criteria exist to assist clinicians with progressing rehabilitation activities after cartilage repair of the ankle. Moreover, the optimal rehabilitation protocols and strategies for returning patients to work or sports after treatment of an OLT remain subjects of frequent debate.

As a whole, the current body of evidence regarding ankle cartilage repair is based on both low-level and low-quality of evidence.[32] In fact, the majority of studies are of level IV evidence and consist of short-term follow-up time periods.
Therefore, an international, multidisciplinary group of experts was assembled to develop expert- and evidence-based consensus statements to assist clinicians in managing this difficult pathology. The purpose of this article is to report the results of the working group on “Rehabilitation and Return to Sports” that were developed at the 2017 International Consensus Meeting on Cartilage Repair of the Ankle.

MATERIALS & METHODS

Seventy-five national and international multidisciplinary experts in cartilage repair of the ankle were convened to participate in a 1-year consensus building effort, which culminated with the International Consensus Meeting on Cartilage Repair of the Ankle on November 17 to 18, 2017 at the University of Pittsburgh and University of Pittsburgh Medical Center in Pittsburgh, Pennsylvania. Delegates from 25 countries and 1 territory encompassing 6 continents were represented in the initiative. Experts were assigned to one of 11 working groups defined by specific subtopics within cartilage repair of the ankle, including “Rehabilitation and Return to Sports.”

Specifically, this working group on “Rehabilitation and Return to Sports” consisted of 7 participants in total.
Each working group was assigned a liaison who served as the primary point of contact and dealt with communication and the distribution of surveys. In addition, liaisons were the responsible for writing the surveys, performing data analysis, and carrying out literature reviews. To reduce the potential for bias in the data analysis and/or literature review, liaisons did not submit answers to the questionnaires or partake in the voting process. One individual (C.D.M.) maintained oversight of the consensus process to ensure consistency across the working groups.

A list of questions for each working group was devised on the basis of a literature review and discussion with the expert participants. These were drafted with the aim of addressing areas of current controversy within cartilage repair of the ankle, leading to answers that may assist clinicians in the management of this difficult clinical pathology.
A total of 10 questions were formalized on “Rehabilitation and Return to Sports,” at which point the process to answer the questions and develop consensus statements was initiated.

A modification of the Delphi format described by Linstone and Turoff was used to pursue agreement among the experts on each question.[23] Blinded, electronic surveys were distributed, through which no identifying information was collected. Initially, participants were asked to provide their answer to each question in an open-ended format.
These initial open-ended answers then facilitated the development of a more structured questionnaire, with emphasis on identifying areas of common ground and resolving aspects of disagreement. Using the results of the second questionnaire, preliminary consensus statements were developed and a comprehensive literature review was performed to identify, where possible, whether each statement was supported or refuted by the best available evidence. In addition, the available evidence for each statement was graded (Table 1).

Table 1. Grades of Evidence.

A1	Multiple (2 or more) level I RCTs with similar findings, or a meta-analysis
A2	A single level I RCT
B1	Prospective cohort study
B2	Any comparison group that is not level I (eg, case control)
C	Case series
D	Case report
E	Expert opinion / basic science

After the literature review, each group had the opportunity to amend the preliminary statements. Thereafter, a third questionnaire requested that each participant "agree" or "disagree" with each preliminary statement.
For questions that were agreed upon unanimously within the working group, these were progressed to a final vote among all 75 members of the consensus group. For questions that did not achieve unanimous agreement within the working group, these were advanced to an in-person discussion among all participants at the meeting in Pittsburgh.

Five questions in this working group were not agreed upon unanimously and were therefore advanced to the full group, with in-person discussion based on a standardized format. Briefly, each question and proposed answer was presented to the group, after which an opportunity for amendments was provided. Each proposed amendment required 2 additional participants to second and third the motion. If the amendment was successfully furthered, an opportunity for rebuttal was provided, followed by a vote of agreement or disagreement. In cases where 66% (two-thirds supermajority) or greater of the total votes received were in favor of the proposed amendment, the statement was amended accordingly.

This process was repeated for any further amendments that were desired, after which a final vote on the entirety of the statement was undertaken. Voting was conducted using electronic keypads. Similar to the survey data that were collected, all votes were anonymous and of equal weight among participants. After the final votes for each question occurred, the degree of agreement was expressed using a percentage rounded to the nearest whole number. Consensus was defined as 51% to 74%, whereas strong consensus was defined

as 75% to 99%, and unanimous was indicated by receiving 100% of the votes in favor of a proposed statement.

RESULTS

Of the 10 total questions and consensus statements in this group, 9 achieved strong consensus, and 1 question was removed as a result of redundant information provided in a similar question and statement in this same working group.

Question: What are the general concepts and time points to consider in patients returning to activities of daily living, recreational and/or elite athletic activities after cartilage repair of the ankle?

Answer: The general concepts of rehabilitation to consider in returning patients to activities of daily living, recreational and/or elite athletic activities after cartilage repair of the ankle are:
(1) allowing biological healing by limiting shear forces
(2) progression of activities based on a clinical evaluation

The following aspects of the clinical evaluation can be used when deciding whether to progress rehabilitation activities:
(1) pain;
(2) proprioception;
(3) stability;
(4) swelling.

In general, shear forces should be limited for 3 months, at which time rehabilitation/training can be progressed. Sports-specific training is considered 3 to 6 months after surgery and is individualized depending on the type of procedure. Return to competition after cartilage repair of the ankle is considered 6 months to 1 year after surgery and is individualized depending on the type of procedure.
Vote: Agree: 92%; Disagree: 8% (Strong Consensus).
Grade of Evidence: E

Question: What procedure-specific advice can patients be given with regard to their likelihood of returning to sport at the previous level of athletic play after ankle cartilage repair?

Answer: There are no validated specific recommendations to consider for rehabilitation and return to sports after cartilage repair of the ankle. Advising patients with regards to their likelihood of returning to sports at the previous level of athletic play is individualized. It can be conveyed that pain and function are likely to improve with diligent rehabilitation. When available, data from a representative population should be provided to the patient in order to quantify likelihood of returning to sport at the previous level.

The following prognostic factors should be used to identify athletes MORE likely to return to the previous level of athletic play:
(1) biomechanics (stability, alignment);
(2) lesion size less than 1 cm^2;
(3) low fear of reinjury (psychological readiness to return to sports);
(4) patient compliance;
(5) previous involvement in a high level and frequency of competition with a strong desire to return;
(6) primary procedure;
(7) younger age.
Vote: Agree: 86%; Disagree: 14% (Strong Consensus).
Grade of Evidence: C for age and lesion size; E for others

Question: What effect(s) do concomitant procedures (osteotomy, lateral ligament reconstruction) have on the overall process of rehabilitation and return to sports after cartilage repair of the ankle?

Answer: The rate-limiting factor in the process of rehabilitation is limited by the procedure that requires the most protection, which is most often the cartilage repair procedure. Thus, concomitant procedures typically have no impact on return to sport after cartilage repair of the ankle, but procedure-specific impairments related to the concomitant procedure may need to be addressed in the rehabilitation program. In cases of osteotomy, weight-bearing may be delayed to allow time for bone healing. It is important for the surgeon and physical therapist to communicate such that both are fully aware of concomitant procedures performed and the potential surgery-specific implications on rehabilitation activities and associated precautions.
Vote: Agree: 86%; Disagree: 14% (Strong Consensus).

Grade of Evidence: E

Question: Is there a benefit(s) to early versus delayed weight bearing after cartilage repair of the ankle?

Answer: Early weightbearing is beneficial, so long as shear forces are minimized, and should be utilized after cartilage repair of the ankle. Early weightbearing is defined as beginning at 4 weeks postoperatively.
Vote: Agree: 87%; Disagree: 13% (Strong Consensus).
Grade of Evidence: A2

Question: Is there a benefit(s) to early versus delayed motion after cartilage repair of the ankle?

Answer: Early motion is beneficial and should be utilized after cartilage repair of the ankle. Early motion can begin within 1 week following surgery and should consist of free, active range of motion. Maneuvers such as forced passive movements that extend the patient beyond their available range of motion should be avoided.
Vote: Agree: 98%; Disagree: 2% (Strong Consensus).
Grade of Evidence: C

Question: What criteria can be utilized in the clinical decision- making process of clearing an athlete to return to play after cartilage repair of the ankle?

Answer: The following clinical criteria can be utilized in the clinical decision-making process of clearing an athlete to return to play after cartilage repair of the ankle:
(1) lack of negative effects with impact/loading;
(2) pain;
(3) physical function testing assessed in comparison to the contralateral (healthy) limb;
(4) sport-specific tasks at 100% in an unopposed setting;
(5) strength;
(6) swelling.

The following procedure-specific criteria should be utilized in the clinical decision-making process of clearing an athlete to return to play after cartilage repair of the ankle:
(1) size of lesion;

(2) type of lesion (chondral vs osteochondral);
(3) type of procedure.

It is not necessary to use imaging in the decision-making process of clearing athlete to return to play after cartilage repair of the ankle.
Vote: Agree: 88%; Disagree: 12% (Strong Consensus).
Grade of Evidence: E

Question: For how long after returning to play following cartilage repair of the ankle should an athlete be advised to follow up with the surgeon clinically?

Answer: An athlete can be advised to follow up with the surgeon clinically for a total of 2 years after cartilage repair of the ankle. Further follow-up beyond 2 years is ideal, but only necessary in cases where the patient is or becomes symptomatic.
Vote: Agree: 86%; Disagree: 14% (Strong Consensus).
Grade of Evidence: E

Question: Should psychological factors be considered in the process of rehabilitation and return to sport in athletes? If so, how?

Answer: Yes, psychological factors can be considered in the process of rehabilitation and return to sport in athletes and should be assessed by a trained sports psychologist and/or via the mental health/psychological components of the Short-Form 12 or 36 questionnaires. This should be assessed preoperatively for baseline, as well as at routine postoperative intervals in conjunction with posttreatment outcome scores.
Vote: Agree: 86%; Disagree: 14% (Strong Consensus).
Grade of Evidence: E

Question: Are there special considerations to be made in the process of rehabilitation and return to sports in elite athletes?

Answer: Close and frequent communication should occur between the surgeon, athlete, and support group around the athlete, with the team athletic trainer or physical therapist acting as the point person for these discussions given that they work most closely with the athlete on a daily basis. It is imperative that the athlete not be overly aggressive in the process of rehabilitation of cartilage

repair of the ankle, as biological healing must be allowed to occur. Elite athletes may proceed through the later phases of rehabilitation at an increased rate secondary to their body awareness and skilled movement patterns, but this should not be influenced by outside circumstances such as time of season, in addition to pressure from coaches, management, or agents.
Vote: Agree: 89%; Disagree: 11% (Strong Consensus).
Grade of Evidence: E

DISCUSSION

A total of 9 statements on "Rehabilitation and Return to Sports" reached consensus during the 2017 International Consensus Meeting on Cartilage Repair of the Ankle. All 9 statements reached strong consensus (greater than 75% agreement), and 1 question was removed as a result of redundancy in information. There is a deficiency in the literature pertaining to consistent, meaningful return to play (RTP) timelines following the treatment of cartilage lesions in the ankle.

Published studies vary considerably in the metrics that used for measuring patient-reported outcomes, and few actually track them. Therefore, it is suggested that rehabilitation be performed according to the biological phases of healing. Full range of motion (ROM), a normal running pattern without pain and a 90% preinjury score on functional tests are considered the minimal requirements for RTP.[24]

It was the consensus of the group that both early range of motion and early weightbearing protocols can be employed after treatment of a cartilage lesion of the ankle. To our knowledge, no clinical data exist to substantiate the superiority of a recommendation of early motion within 1 week after surgery. However, previous animal studies have demonstrated that continuous passive motion (CPM) demonstrated faster healing, as well as thicker cartilage with an increased concentration of proteoglycans as compared to cast immobilization.[12,30,35] With regard to weightbearing, it was previously common practice to unload patients for 6 weeks after arthroscopic bone marrow stimulation (BMS), but immediate partial weight-bearing is now encouraged.[4,9,14,19,20,24,29,36,37,40,41,44]

Allowing full weightbearing depends on the size and location of the lesion. In this regard, lesions measuring <1 cm can generally progress to full

weightbearing within 2 to 4 weeks, whereas larger lesions and anteriorly located lesions can benefit from partial weightbearing for up to 6 weeks.[13] Several studies exist to evaluate early weightbearing after ankle cartilage repair. Li et al performed a retrospective review of a cohort that was allowed to bear weight immediately postoperatively in a splint after microfracture for osteochondral lesions of the talus, and reported excellent results with the VAS and AOFAS scores.[22]

A separate study by Lee et al studied weightbearing after microfracture for osteochondral lesions of the talus.[20] The study compared early weightbearing at 2 weeks postoperatively versus delayed weightbearing at 6 weeks and found no overall differences in outcomes per AOFAS, VAS, and AAS. Therefore, early weightbearing can be used in postoperative protocols without causing apparent adverse effects in the setting of arthroscopic bone marrow stimulation. The course of rehabilitation in larger or secondary lesions depends on the specific operative technique, but generally involves longer periods of partial weightbearing.

In the case of fixation or procedures involving malleolar osteotomy, weightbearing can be modified such that 6 weeks of non-weightbearing is typically advised.[24,28] Before returning to activity and/or sports after debridement and bone marrow stimulation of an osteochondral injury, it is important to quantify patient activity level for arthroscopic bone marrow stimulation, a 4-level activity rehabilitation program has been proposed, with gradual progression to normal walking, running, noncontact sports, and contact sports, respectively.[42] A lesion up to 1 cm can commence partial weightbearing within 4 to 6 weeks, but larger and anteriorly located lesions require 6 to 8 weeks to start partial weightbearing. The consensus of this expert group was that weightbearing should commence early at 4 weeks posttreatment. Full return to noncontact sporting activities is advised at 20 to 24 weeks postoperatively, whereas contact sports are permitted from 24 weeks and beyond. Final training for speed, strength and endurance should begin with running on uneven ground, generating explosive force, changing direction(s), and other sport-specific movements.

Also, as ankle sprains are the major cause of cartilage injuries, the use of ankle injury prevention strategies (including neuromuscular training and the use of tape or brace) should be considered.

An average RTP length of 15 ± 4 weeks in athletes treated with bone marrow stimulation has been reported. With regard to elite athletes after bone marrow stimulation, a 94% RTP is described,[37] although studies in a mixed population generally report lower rates (63%-79%).[17] Increasing age may be a negative predictor for the ability to return to peak performance after surgery. In a study analyzing return to sport after microfracture in male professional soccer players with an average age of 27 (range, 18-32 years), [21] (95%) players returned to their previous level in the following season.[25] The one player who did not return was the oldest player of the cohort at the age of 32 years.
Increased years of age negatively correlated with continued play post injury. In a separate study evaluating 38 patients who underwent second-look arthroscopy 1 year after autologous chondrocyte implantation, both patient age and size of the lesion were found to be the statistically significant factors impacting RTP.[21] Larger lesion size is also well described as a factor for poorer patient outcomes after bone marrow stimulation and may similarly affect return to sport, as well.

Return to play in patients treated with autologous bone grafts is significantly longer than that of the bone marrow stimulation (19.6 ± 5.9 vs 15.1 ± 4 weeks, respectively).[37]
The addition of a concomitant medial malleolar osteotomy resulted in 2 weeks longer time to RTP. In a case series of athletes who underwent autologous bone grafting, 90% of the athletes were still competing at a mean of 6 years.[9] Moreover, approximately 90% of athletes can RTP after autologous graft procedures, which has been reported in both amateur and professional athletes.[11]

Recent studies have attempted to augment healing of cartilage lesions by injecting platelet-rich plasma[2,26,27] or hyaluronic acid[1,26,31,34] as an adjunct to arthroscopic microfracture.[16,38] Although functional improvement has been reported following injection, further double-blinded evaluation in greater numbers are necessary.[25]

Despite this, no studies suggest that the addition of a biologic will speed physiological healing. Nonetheless, potential factors reducing the rehabilitation time are a younger age[5-7,9,18,33] lower BMI,[9,20] smaller defect size,[8-10,14] mobilization, and treatment with bisphosphonates and pulsed electromagnetic field therapy.[42]

This consensus effort is not without limitations. By definition, consensus statements are considered level V data and represent a blend of expert-opinion and the best available evidence.[43] Nonetheless, the lack of high-quality clinical evidence to date in this field encouraged us to seek alternative methods for developing best practice guidelines in conjunction with leaders in the field. Further high-level studies should be required to substantiate the statements that have been developed as part of this initiative.
The consensus will be updated in the event that further evidence for or against a current statement becomes available. The questions that were developed were a potential source of bias in that there was no standardized process for soliciting questions from all members of the working groups at the same time and in a blinded fashion.

In future iterations, we will be adding an additional questionnaire to solicit questions from all members to ensure that the most comprehensive and clinically relevant topics are addressed.

CONCLUSION

This international consensus derived from leaders in the field will assist clinicians with rehabilitation and return to sports after treatment of a cartilage injury of the ankle.

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CHAPTER

10

INTERNATIONAL SURVEY ON THE MANAGEMENT OF SYNDESMOTIC INJURIES IN ATHLETES

CHAPTER 10:
International survey on the management of syndesmotic injuries in athletes

International Survey on the RTP in syndesmotic injuries in athletes.

(in preparation for peer-review, expected submission: November 2019)

Hunt K, D'Hooghe P

Study Title: Evolving and Innovative Treatments for Syndesmosis Injuries: Evaluating Current Practices

Principal Investigators:
Kenneth J. Hunt, MD, Pieter D'Hooghe, MD

COMIRB #17-0717

You are being asked to be in this research study because you are a trained, licensed orthopedic surgeon (i.e., MD, DO, etc.) who treats syndesmotic injuries.
If you join this study, you will need to complete a brief survey on treatment of ligamentous syndesmotic injuries. The survey is administered in English.
This study is designed to learn more about current international practices for treating syndesmotic injuries across different orthopedic specialities, including fixation techniques and post-operative treatment.

There are no risks or discomfort associated with this study.
No identifying information will be collected or maintained in this study, and every effort to maintain confidentiality will be maintained according to mandatory COMIRB regulations by the study team.
You have a choice about being in this study. You do not have to be in this study if you do not want to be.
You may have questions about your rights as someone in this study. If you have questions, you can call the COMIRB (the responsible Institutional Review Board). Their number is (+1/303) 724-1055.

Thank you for completing this brief survey on treatment of ligamentous syndesmotic injuries. The goal of this study is to learn more about current international practices for treating syndesmotic injuries across different orthopedic specialties, including fixation techniques and post-operative treatment.
This is meant to apply to athletic individuals with syndesmotic injuries that are NOT associated with ankle fractures (although Maisonneuve injuries are included). There are up to 27 questions and it should take less than 10 minutes to complete.

Please click on the below link to start the survey:

https://redcap.ucdenver.edu/surveys/?s=MMAWKD7AKK

CHAPTER

11

TEAMWORK

CHAPTER 11:
Teamwork

Thank you to our reviewers 2016

Journal of ISAKOS (2016)

D'Hooghe P et al

JISAKOS 2017;2:e1. doi:10.1136/jisakos-2017-reviewers

Thank you to our reviewers 2016. The Editor would like to publicly acknowledge the people listed below who served as reviewers on the journal during 2016. Without their efforts, the quality of the journal could not be sustained. TEAMWORK makes the Research DREAM WORK.

Abrams, Geoffrey
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Cohen, Steven B.
Condello, Vincenzo
Cucchiarini, Magali
D'Hooghe, Pieter
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Ekdahl, Max
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Farr, Jack
Farraro, Katie
Ficek, Krzysztof
Forster, Benjamin
Freehill, Michael
Fu, Freddie
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Karlsson, Jón
Keeney, James A.
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Kennedy, John G.
Koga, Hideyuki
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Kopf, Sebastian
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Lee, Myung Chul
Lee, Alan
Lee, Jin Woo
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van Bergen, Christiaan
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van der Made, Anne
van Heerwaarden, Ronald
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Vannini, Francesca
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Vuurberg, Gwendolyn
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Zacchilli, Michael
Zaffagnini, Stefano

GENERAL DISCUSSION

The main purpose of this thesis is to improve in the diagnosis, treatment and return to play of injuries to the lateral ligamentous complex of the athlete's ankle. Although there are a great number of research papers in general practice, sports medicine and orthopaedic surgery on these 3 topics, limited evidence is present for several athlete (low and high) ankle sprain-related conditions.

To provide new insights and cover the statement that "there's no such thing as a simple ankle sprain", a range of research modalities were used:

- A prospective cohort study on epidemiology and return to play following isolated syndesmotic injuries of the ankle of 3677 male professional footballers in the UEFA Elite Club Injury Study (Chapter 1).
- A cross-sectional MRI study on the ligamentous injuries and the risk of associated tissue damage in acute ankle sprains in athletes (Chapter 2).
- 3 literature reviews on low and high athlete ankle sprains and concomitant injuries in chronic ankle instability (Chapter 2 & 9).
- 2 controlled laboratory studies on the role of calcaneofibular ligament injury in ankle instability and its implications for surgical repair management (Chapter 3).
- A cadaveric laboratory study on quantifying the necessary forces applied during ankle arthroscopy to evaluate syndesmotic ankle instability (Chapter 4).
- The development and validation of a biomechanical device that can assist in the non-invasive clinical diagnosis of syndesmotic instability (Chapter 5).
- A current concepts review on the fixation techniques in lower extremity syndesmotic injuries (Chapter 6).
- A Level 1 meta-analysis on randomized controlled trials on the dynamic stabilization of syndesmosis injuries that reduces romplications and reoperations compared to screw fixation (Chapter 6).
- A cross sectional MRI study linking chronic ankle instability to posterior ankle impingment surgery and a current state of the art on posterior ankle arthroscopy (Chapter 7).
- A longitudinal observational cohort study on the return to play after isolated unstable syndesmotic ankle injuries in 110 male professional football players (Chapter 8).

- 2 systematic reviews on the return to play following lateral ankle ligament repair (Chapter 8).
- An international consensus on rehabilitation and return to sports after treatment of a cartilage injury in the ankle (Chapter 9).
- An international online survey on the management and return to play of syndesmotic ankle injuries in athletes (Chapter 10).

The results of these above mentioned research modalities and reflections on future research are discussed below.

Lateral ligament ankle injury

In Chapter 2, we present a comprehensive review of the literature highlighting the diagnosis, frequency, clinical significance and treatment options for all concomitant injuries associated with chronic ankle instability. We conclude that chronic ankle instability is associated with an extremely high prevalence of associated intra-articular pathology. Preoperative imaging and examination may identify some associated pathology, but a significant number of intra-articular lesions are missed without arthroscopic evaluation of the joint.
This evidence shows that arthroscopic evaluation of the ankle joint during lateral ligament reconstruction should be considered to identify intra-articular pathology.

Furthermore, the ATFL and CFL ligaments are both important lateral ankle stabilizers in internal rotation and inversion. While there is a trend towards worse outcomes in combined ATFL and CFL injuries, there is still a lack of knowledge concerning the implications of insufficiency of the CFL as well as the possible relevance of its respective repair in chronic ankle instability.
Additionally, there is no current consensus amongst the Orthopaedic community whether the CFL should be repaired in high grade ankle sprains. In Chapter 3, we present the first biomechanical study examining the influence of the ATFL and CFL during weight-bearing inversion injury conditions concerning both joint stability and kinematics. Our findings show that the stiffness and peak torque did not significantly decrease after sectioning the ATFL, but decreased significantly after sectioning the CFL. Peak pressures in the tibiotalar joint decreased and mean contact area increased significantly following CFL release. There was significantly more inversion of the talus and calcaneus as well as calcaneus medial displacement with weight-bearing inversion after sectioning the CFL.
The evidence in this study suggests that the CFL plays a more significant role in ankle joint stability and contact mechanics when compared to the ATFL and that repair of the CFL should be considered during lateral ligament reconstruction. We

also provide evidence that a CFL-deficient ankle has significantly different joint mechanics compared to the intact ankle and that there may be an important role for early (arthroscopic/endoscopic or open) repair of the CFL in high grade ankle sprains to avoid the intermediate and long-term consequences of a loose or incompetent CFL.

In Chapter 7, we examined the association between the injury to the lateral ligament complex of the ankle (acute and chronic) and the clinical os trigonum syndrome. Our study presents with evidence that professional athletes who have os trigonum syndrome and a combined chronic lateral ligament ankle injury have an approximate 10 times greater risk for surgery compared to athletes with os trigonum syndrome and an acute lateral ligament ankle injury. Consequently, this study offers new insights into the etiology and pathophysiology of posterior impingement in the athlete's ankle. It also provides new evidence-based diagnostic indications for os trigonum syndrome surgery and the need to rethink our preventative and rehabilitation guidelines around this posterior impingment pathology.
In line with these new findings, we also present a state of the art review on the indications and techniques in posterior ankle arthroscopy.

In Chapter 8, we present 2 systematic reviews that identify a clear deficiency in the literature pertaining to consistent, meaningful postoperative return to play timelines following lateral ankle ligament repair (with comparison of open versus arthroscopic techniques). Published studies vary considerably in the metrics used for measuring patient-reported outcomes and very few actually track them.
Our study findings suggest that future studies on outcomes following ankle ligament repair should include clear and consistent metrics for return to sport and level of play. These new findings warrant standardized and reproducible criteria for reporting return to play for athletes in order to improve the utility and applicability of outcome data as surgical and rehabilitative techniques continue to advance.

Chapter 9 reports on the effect of chronic ankle instability with the ankle cartilage as it's ultimate victim. This chapter also reports on the international ankle cartilage repair consensus meeting where seventy-five international experts in cartilage repair of the ankle representing 25 countries convened and participated in a process based on the Delphi method of achieving consensus. A

total of 9 specific statements on rehabilitation and return to sports reached strong consensus. This consensus concluded that the rehabilitation process for an ankle cartilage injury requires a multidisciplinary and comprehensive approach and it assists clinicians with rehabilitation and return to sports guidelines after treatment of a cartilage injury of the ankle.

Syndesmotic ligament ankle injury

There is a paucity of studies on the incidence of isolated syndesmotic ankle injuries in sports, especially in football.
Therefore, we performed a study on 3677 elite professional European football players (from the UEFA Injury Study Database) over the past 15 seasons. This study indicated that an isolated syndesmotic injury in professional football is a relatively rare event but that the injury incidence during match play seems to have increased over the past 15 seasons with a return to play after injury that exceeds 5 weeks. These findings may assist in making football players, coaches, referees and club medical staff aware of isolated syndesmotic ankle injuries and its consequences. They may also contribute to the development of injury prevention strategies as they demonstrate that isolated syndesmotic injuries are most commonly caused by player-tackling (Chapter 1).

In Chapter 2, we present a literature review describing the clinical features and return to play evidence of the so- called “low” and “high” ankle sprains. We also present a descriptive MRI study depicting that about 20% of athletes referred for MRI after suffering an acute ankle sprain have evidence of a syndesmotic injury regardless of lateral ligament involvement. Although the mechanism of injury of these “low” and “high” ankle sprains is very different, these findings suggest that both can be more connected in the overall ankle sprain pathology than previously considered.

Several clinical tests can be used in the evaluation of a syndesmotic injury. The external rotation test and the squeeze test are the most commonly described tests, but the Cotton test, the fibular-translation test and the cross-legged test can also be used. The combination of tenderness on palpation over the ATFL, a positive fibular translation test, and positive Cotton test is considered highly clinically suspicious. Although the squeeze test has been shown to be highly sensitive, there is no one pathognomonic test for the clinical diagnosis of syndesmotic instability. As presented in Chapter 5, we developed and validated

a non-invasive clinical “Syndhoo” device to dynamically evaluate the distal tibiofibular stability during external rotation of the ankle as an extension to the available clinical tests.

Although clinical testing and diagnostic imaging have added value, they currently remain limited in the detection of distal syndesmotic ankle instability. The “gold standard” is considered intra-operative testing through arthroscopic probing while externally stressing the ankle in a sagittal direction.
However, no validated arthroscopic guidelines have been established to distinguish a stable from an unstable syndesmotic ankle joint and current literature does not provide us with clear and reproducible guidelines on the amount of displacement or degree of diastasis that are required to indicate syndesmotic stabilization.
In Chapter 4, we present the results of our cadaveric study depicting anatomical and biomechanical data that can help surgeons correctly identify this isolated distal syndesmotic ankle instability. Our study also offers to bridge the gap to the development of arthroscopic tools that can identify the need for surgical fixation to the syndesmosis based on the laxity of specific ankle ligaments that contribute to subtle instability.

Considering surgical treatment, there is an ongoing discussion on postoperative malreduction and on how to fix the syndesmotic ankle instability (screws, suture buttons, etc.). In Chapter 6, we present an evidence-based review of current techniques, indications, complications and implants for syndesmotic fixation. Furthermore, we describe the results of our Level I meta-analysis on randomized controlled trials to investigate the complications, subjective outcomes and functional results after dynamic or static fixation of acute syndesmotic injuries.
We conclude that dynamic fixation of syndesmotic injuries is able to reduce the number of complications and improve clinical outcomes compared to static screw fixation, especially malreduction and clinical instability or diastasis, at a follow-up of 2 years. A lower risk of re-operation with dynamic fixation was found compared to static fixation with permanent screw.

In Chapter 8, we evaluated the typical time to return to play following surgical stabilization for isolated unstable ankle joint distal syndesmosis injuries amongst a cohort of professional male football players. This study establishes for the first time the average time required to start with on field rehabilitation, team training and official match play in professional football players who were surgically treated for isolated unstable ankle joint distal syndesmosis injuries.

We also identified 3 specific injury characteristics (a grade III injury, a combined cartilage lesion and young age) as predictors for a delayed return to match play.

Finally, in Chapter 10, we present the online link to the international survey that we build looking at global treatment strategies for ligamentous syndesmotic ankle injuries. The goal of this study is to learn more about current international practices for treating syndesmotic injuries across different orthopedic specialties (and continents), including fixation techniques and post-operative treatment. Preliminary data already shows a great geographic variety in treatment practices and indication settings.

Future Research

The major focus of this thesis' research is on the static modalities related to the lateral ligament ankle pathology in athletes and aims at putting forward new related insights on epidemiology, mechanism of injury, clinical features, imaging, treatment options and return to play.
However, these findings need to be challenged furthermore from a neuromotoric dynamic point of view. A close collaboration with rehabilitation, performance, neuro-motoric gait analysis, sports medicine and orthopaedic surgery experts is therefore mandatory to build further on the findings of the presented research in the benefit of the athlete's ankle.

Although the results of an open surgical anatomical repair report excellent outcomes, there is a current discours to address chronic ankle instability by means of arthroscopy. Our 2 laboratory studies show however that the CFL is key in stabilizing joint kinematics and optimizing the ankle biomechanics but the CFL is anatomically an extra-articular ligament that is not addressed during arthroscopy. In order to progress with minimal invasive arthroscopic techniques for chronic ankle instability, we need to step up in our current intra-articular techniques and combine them with endoscopic strategies that also address the extra-articular CFL.

The same accounts for the return to play after lateral ligament repair where the current arthroscopic techniques show a 1 month longer rehabilitation time compared to the open techniques. Our study shows that it will be key to incorporate the CFL in the treatment algorithm in order to achieve better and faster outcomes after arthroscopic/endoscopic lateral ligament ankle repair.

There is substantial evidence that chronic ankle instability leads to concomitant lesions such as anterior impingment and osteochondral defects. However, our study on posterior impingment suggests that there is also a link with posterior impingment. We hypothised that the combination of recurrent anterior talar translation and ankle hyperflexion in specific sports can trigger the os trigonum to become symptomatic and this was confirmed by our data. Further anatomical and biomechanical research is needed to evaluate and quantify the effect of chronic ankle instability on the os trigonum syndrome as part of the broader spectrum of posterior ankle impingment pathology.

The ultimate victim of chronic ankle instability is known to be the cartilage. After surgical cartilage repair techniques, many questions arise that currently have no evidence-based answer:

- "Is there a benefit(s) to early versus delayed motion after cartilage repair of the ankle?"
- "What criteria can be utilized in the clinical decision-making process of clearing an athlete to return to play after cartilage repair of the ankle?"
- "Is there a benefit(s) to early versus delayed weight bearing after cartilage repair of the ankle?"
- "What effect(s) do concomitant procedures (eg, osteotomy, lateral ligament reconstruction) have on the overall process of rehabilitation and return to sports after cartilage repair of the ankle?"

The international consensus meeting on cartilage repair of the ankle aimed at gathering the most credible expert opinions to answer these questions. However, the outcome remains a consensus. Further research is required to investigate the value of these consensus statements and to align the rehabilitation and return to play protocols with the best evidence.

Although the current thesis' work provides with new guidelines on the clinical diagnosis and surgical treatment of isolated syndesmotic ankle injuries, more research is required to validate these findings multicentrically.

The findings of the presented thesis' studies aimed at providing more insight in the complexity of the athlete's ankle lateral ligamentous complex injuries. However since "there is no such thing as a simple ankle sprain" our findings already instigated new questions and further research teamwork is required to keep delivering excellence to the athlete's ankle (Chapter 11).

AWARDS

- 2015, WINNER OF THE ISAKOS (International Society of Arthroscopy, Knee surgery and Orthopaedic Sportsmedicine) CONGRESS SCIENTIFIC GRANT:
  "The effect of arthroscopic lateral ligament repair on the subtalar ankle joint."
  (received by P. D'Hooghe, as Chairman of the Leg, Ankle and Foot ISAKOS Committee 2015 - 2019).
  Biomechanical cadaveric lab mechanical ankle testing performed at the University of Colorado (Anschlutz), Denver, USA.

- ISOKINETIC Conference " RETURN TO PLAY ", QE2 Conference Hall, Westminster, London, UK 2016.
  Awarded for 'Best 10 Conference Posters' with Case report: Talar body stress fracture (P. D'Hooghe, S. Tomoyuki).

- ISOKINETIC Conference " THE FUTURE OF FOOTBALL MEDICINE ", Camp Nou, Barcelona, Spain, 13-15 May 2017.
  Awarded for 'Best 10 Conference Posters' with Case report: Endoscopic surgery in athletes with calcaneal lipoma (P. D'Hooghe, B. Krivokapic).

- ISAKOS Conference 2017 Shanghai: Silver medal winner of the " JAN GILLCRIST SCIENTIFIC RESEARCH AWARD" with the paper:
  "The Role of Calcaneofibular Ligament (CFL) Injury in Ankle Instability: Implications for Surgical Management" (D'Hooghe P, Hunt K, Pereira H).

- Western Orthopaedic Association Conference 2017 Kauai:
  Winner of the " YOUNG INVESTIGATOR SCIENTIFIC RESEARCH AWARD" with the paper:
  "The Role of Calcaneofibular Ligament (CFL) Injury in Ankle Instability: Implications for Surgical Management" (D'Hooghe P, Hunt K, Pereira H).

- ISOKINETIC June 2018: Finalist within the Top 10 Case Report Finalists for the Conference Case Report: "
  Tibial Soft Tissue Avulsion in the knee of a 14 yr old football Player " (Cruz F, D'Hooghe P, Landreau P)

PRESENTATIONS

2015

- 23-24 JANUARY 2015. QATAR 2015 24th MEN'S HANDBALL WORLD CHAMPIONSHIP. CONFERENCE ON NEW SPORTS MEDICINE CONCEPTS IN HANDBALL. THE TORCH HOTEL BALLROOM, Doha, Qatar. "SURGICAL TREATMENT OPTIONS IN HANDBALL INJURIES"

- 11-12 APRIL 2015. 14 th INTERNATIONAL CONFERENCE ON SPORTS REHABILITATION AND TRAUMATOLOGY, QUEEN ELISABETH II CENTRE, LONDON, UNITED KINGDOM. " ANTERIOR ANKLE IMPINGMENT IN FOOTBALLERS (CHURCHILL ROOM)".

- 19 MAY 2015. INTERNATIONAL OLYMPIC COMMITTEE (IOC) ADVANCED TEAM PHYSICIAN COURSE, SHARQ HOTEL CONFERENCE HALL, DOHA, QATAR."
    - PRESENTER: "MANAGEMENT OF THE ELITE ATHLETE WITH PROBLEMATIC ANKLE INJURIES"
    - EDITOR: IOC ADVANCED TEAM PHYSICIAN WORKSHOP CASE BOOK

- 21-23 MAY 2015. 1st SERBIAN INTERNATIONAL SPORTS MEDICINE CONFERENCE, SAVA CENTER, BELGRADE, SERBIA.
    - PRESENTER: "ANKLE INJURIES AND SURGICAL TREATMENT IN SPORTS."
    - INSTRUCTOR OF THE WORKSHOP: "ANKLE AND FOOT EXAMINATION"

- 7-11 JUNE 2015. 10 th BIENNAL ISAKOS CONGRESS, LYON, FRANCE. "HOW TO MANAGE ANKLE AND FOOT FRACTURES IN FOOTBALL PLAYERS?"

- 7-11 JUNE 2015. 10 th BIENNAL ISAKOS CONGRESS, LYON, FRANCE. "ARE PROFESSIONAL FOOTBALL PLAYERS PART OF A SPECIFIC GROUP AT A HIGHER RISK OF SEPTIC ARTHRITIS AFTER ACL SURGERY?" (e-poster stage presentation) IN COLLEGE OF SPORT & EXERCISE PHYSICIANS. 7th

MUSCLE TECH NETWORK WORKSHOP AT NOU CAMP FOOTBALL STADIUM ARENA, BARCELONA, SPAIN.
Session: "SURGICAL TREATMENT OF PROXIMAL HAMSTRING AVULSIONS".

- 13-14 JUNE 2015. INTERNATIONAL CONGRESS ON CARTILAGE REPAIR OF THE ANKLE, KWA MARITANI, PILANESBERG, SOUTH AFRICA.
    - PRESENTER: " HOW SHOULD OUTCOMES BE ASSESSED FOR CHRONIC OSTEOCHONDRAL DEFECTS?
    - PRESENTER: "INSTABILITY OF THE ATHLETE'S ANKLE.
    - PRESENTER: "RETURN TO SPORT IN ANKLE FRACTURES"
    - MODERATOR: SYNDESMOSIS SESSION

- 30 NOVEMBER – 02 DECEMBER 2015. 5th ASIAN AFC MEDICAL CONFERENCE, NEW DELHI, INDIA.
    - PRESENTER: "ANKLE AND FOOT STRESS FRACTURES IN ATHLETES."
    - PRESENTER: "LATERAL LIGAMENT REPAIR IN THE ATHLETE'S ANKLE."
    - PRESENTER: " OSTEOCHONDRAL DEFECTS."
    - PRESENTER: " ACHILLES TENDINOPATHY, SURGICAL OPTIONS."
    - CHAIRMAN: " UEFA CHAMPIONS LEAGUE STUDY GROUP SESSION"
    - INSTRUCTOR: ANKLE & FOOT EXAMINATION WORKSHOP

- 12-13 December 2015. 2nd QATAR FOOT&ANKLE CONFERENCE. SHERATON CONVENTION CENTER, DOHA, QATAR.
  a/ " STRESS FRACTURES OF ANKLE IN THE ATHLETE".
  b/ " SURGICAL CONSIDERATIONS IN THE ATHLETE'S ANKLE" .

2016

- 11-12 FEBRUARY 2016, THE TORCH HOTEL BALLROOM, Doha, Qatar. CONFERENCE: "CHALLENGES IN FOOTBALL INJURIES". SURGERY AND SPORTSMEDICINE CONFERENCE (A3-HGI).
    - CHAIRMAN: ANKLE & FOOT SESSION

- PRESENTER: “ATHLETE ANKLE IMPINGMENT”

- 09-10 APRIL 2016. RETURN TO PLAY – MEDICAL STRATEGIES CONFERENCE, London, United Kingdom.
  - PRESENTER: “ TALAR BODY (STRESS) FRACTURES”
  - PRESENTER: “ METATARSAL AND NAVICULAR STRESS FRACTURES”

- 23 -24 APRIL 2016. 1st GCC – ASPETAR SPORTS MEDICINE CONFERENCE, THE TORCH HOTEL BALLROOM. “SURGICAL ATHLETE INJURIES IN THE ANKLE”.

- 4-7 MAY 2016, EUROPEAN SOCIETY OF SPORTS TRAUMATOLOGY, KNEE SURGERY AND ARTHROSCOPY (ESSKA) CONGRESS, Barcelona, Spain.
  - PRESENTER: “CHARACTERISTICS OF HANDBALL INJURIES”
  - PRESENTER: “PERONEAL TENDON PATHOLOGY”
  - PRESENTER: “ INSTRUCTIONAL COURSE LECTURE ON THE POSTERIOR COMPARTMENT OF THE ANKLE JOINT “
  - CHAIRMAN: “ BASIC SCIENCE SESSION “

- 9-12 JUNE 2016, ASIA-PACIFIC KNEE, ARTHROSCOPY & SPORTSMEDICINE SOCIETY (APKASS) & 13th INTERNATIONAL FORUM OF ORTHOPAEDIC SPORTSMEDICINE AND ARTHROSCOPY SURGERY (IFOSMA) CONGRESS,
  - PRESENTER: “ LIGAMENT INJURIES IN THE ANKLE”
  - PRESENTER: “ OSTEOCHONDRAL DEFECTS IN THE ANKLE.”

- 13-15 JUNE 2016, ASPETAR ORTHOPAEDIC AND SPORTSMEDICINE HOSPITAL, Doha, Qatar. 1st AFC ASIAN SPORTS PHYSIOTHERAPY COURSE.
  - PRESENTER: “SURGERY FOR ANKLE INJURIES IN THE FOOTBALL PLAYER.”
  - COURSE INSTRUCTOR.

- 24th JUNE 2016, ADVANCED FOOT AND ANKLE COURSE, ACADEMIC MEDICAL CENTER (AMC), Amsterdam, The Netherlands. “ ADVANCED POSTERIOR ARTHROSCOPY “

- 8 -10 SEPTEMBER 2016, 3rd SHANGHAI FORUM OF FOOT AND ANKLE SPORTS INJURY CONGRESS (SFFASI), Shanghai, China.
    - PRESENTER: “FOOT FRACTURES’ MANAGEMENT”
    - PRESENTER; “ARTHROSCOPIC LATERAL LIGAMENT REPAIR”

- 22 SEPTEMBER 2016, NEW DEVELOPMENTS IN SPORTS MEDICINE SYMPOSIUM, ASPIRE ACADEMY AUDITORIUM, Doha, Qatar. “SYNDESMOSIS INJURY, WHEN TO OPERATE?” (with the American College Of Sports Medicine –ACSM)

- 23 SEPTEMBER 2016, INTERNATIONAL CARTILAGE REPAIR OF THE ANKLE CONGRESS (ICRA - ICRS), Sorrento, Italy “RETURN TO SPORTS AFTER TREATMENT OF CHRONIC OSTEOCHONDRAL DEFECT.”

- 29 SEPTEMBER – 01 OCTOBER 2016, 6th NATIONAL CONGRESS OF THE SOCIETY OF ITALIAN ORTHOPAEDIC AND SPORTSMEDICAL SURGEONS (SIGASCOTT), Firenze, Italy. “THE VALUE OF ARTHROSCOPY IN ACUTE ANKLE INSTABILITY “.

- 13 -15 OCTOBER 2016, ISAKOS’ ORTHOPAEDIC AND SPORTSMEDICINE MASTER CLASS. Cadaveric Lab and Auditorium at the Aspetar Orthopaedic and Sportsmedicine Hospital, Doha, Qatar.
    - CADAVERIC LAB AND WORKSHOP INSTRUCTOR
    - PRESENTER: “ PATELLAR TENDON REPAIR – HOW I DO IT “

- 10-11 NOVEMBER 2016, SMITH & NEPHEW MASTERCLASS IN FOOT AND ANKLE at the Cadaveric Lab and Auditorium of Aspetar Orthopaedic and Sports medicine Hospital, Doha, Qatar.
    - INSTRUCTOR: “WORKSHOP AND CADAVERIC LAB”
    - PRESENTER: ”ANKLE TRAUMA FRACTURE FIXATION TECHNIQUES“

- 13 NOVEMBER 2016, Amsterdam, The Netherlands. NATIONAL DUTCH SOCIETY OF ORTHOPAEDIC AND SURGICAL RESIDENTS (VOCA). " RETURN TO PLAY AFTER SYNDESMOTIC INJURIES."

2017

- 21-22 February 2017, Caïro, Egypt. EGYPTIAN ARTHROSCOPY ASSOCIATION (EGAA). "Foot and Ankle injuries in the Middle East: What are the challenges?" (P. D'Hooghe)

- 25 March 2017, Abu Dhabi, UAE. Healthpoint Hospital in collaboration with Manchester City Football Club : "Syndesmotic ankle sprain in the elite athlete." (P. D'Hooghe)

- 4-8 June ISAKOS 2017 Congress in SHANGHAI, China.
    - Instructional Course nr. 3 Chair
    - Instructional Course nr.19 Presenter
    - Presenter of 4 free papers

- ISOKINETIC " THE FUTURE OF FOOTBALL MEDICINE ", Camp Nou, Barcelona, Spain
  13-15 May 2017.
  Presentation: " THE HIGH ANKLE SPRAIN " (P. D'Hooghe) on 13 May 2017

- BRUCOSPORT Congress, Bruges, Belgium, 11 March 2017:
  Presentation: "Ankle athlete injuries: From the lab, over the clinic to the pitch." (P. D'Hooghe)

- HONG KONG Sports Medicine Institute Keynote Lecture (30 September 2017, HKISMS 2017):
  Presentation: Current advances in the management of the athlete ankle sprain (P. D'Hooghe)

- 17 October 2017, University of Lyon, France. Presentation: How to manage the elite athlete ankle sprain – update anno 2017 (P. D'Hooghe)

- 21 October 2017, University of Liêge, Belgium. "The value of arthroscopy in the treatment of athlete ankle fractures". (P. D'Hooghe)

- November 2017, Pittsburgh University, USA in collaboration with Hospital of Special Surgery, New York (HSS). "Return to play consensus on chronic OLT's of the ankle." (P. D'Hooghe)

2018

- 10 and 11 February 2018, The Pearl Qatar in Doha Qatar. 3rd Qatar International Foot & Ankle Conference.
  Presentation: Current advances in the management of the Athlete's Ankle. (P. D'Hooghe) on 11 February 2018 at 14hoo.

- 2 March 2018. Presentation (20 min) on syndesmotic injuries in the ankle for the online FIFA team Physician diploma Module on ankle and foot injuries in football. Live broadcasted by Dr. Mark Fulcher with live question and answer.

- 5-10 March 2018, New Orleans, USA. AAOS meeting (American Academy of Orthopaedic Surgery). Invitation to present ICL 243: Land of the Ligaments.
  Presentation: Syndesmotic Injuries (P. D'Hooghe).

- 2018 ESSKA Congress, Glasgow, Scotland, UK. Instructional Course confirmed.
  Chair at this ICL named: "Small fractures around the ankle" (P.D'Hooghe)
- Presenter at this ICL: "Cedell fracture" (B. Krivokapic, P. D'Hooghe)

- Also presenting on a battle session on ankle CAI; Presentation on: “Open repair for chronic lateral ligament ankle instability” (P. D’Hooghe)

- Also presenting the book: “Return to play in Football” (co-editor P. D’Hooghe).

- ISOKINETIC 2018 “ARE WE WINNING” Conference in Barcelona, Nou Camp (Spain):

- Presentation on the 2nd of June 2018: Biomechanical analysis of football ankle sprains.

- Presentation on the 4th of June 2018 (FMCoE meeting): International Online Survey on Syndesmotic ankle injuries in Football.

- Texas Health Center (Dallas, USA), 17-19 July: Presentation on The management of Soccer Injuries (TCU Dome / FC Dallas stadium, Frisco, USA) – Chair: Dr. Steve Singleton.

- RUSSIAN FOOT and ANKLE CONGRESS 2018 (13 and 14 th of September 2018, Moscow, Russia, Prof. Andreij Korolev)

- Presentation on the 13th of September 2018: Advanced indications in Posterior Ankle Arthroscopy (P. D’Hooghe).

- Presentation on the 13th of September 2018: Syndesmosis Injuries in Athletes: “ When to refer to surgery ? “(P. D’Hooghe).

- Presentation on the 14th of September 2018: Stress Fractures of Foot and Ankle in Athletes (P. D’Hooghe).

- Live surgery (40 minutes session): OATS for big talar OCD lesions

- Live surgery (40 minutes session): Posterior Ankle Arthroscopy

- Chair in session on Ankle Cartilage treatment

- Chair in session on minimal invasive fracture treatment

- SIGASCOTT (Bologna, Italy) 4-5 October 2018 (Prof. S. Zaffagnini)

- Presentation on the 4th of October 2018 on: Surgical Treatment in Ankle Instabilities.

- Presentation on the 5th of October 2018 on: Treatment of syndesmotic Injuries in Athletes.

2019

- AFC Medical Conference Chengdu , China (March 3-8)

1. Presentation: The Footballers Ankle (20') - 4 March 2019
2. Presentation: Ankle Injuries in Football (20') - 4 March 2019
3. Workshop: Ankle Injuries (75') - 4 March 2019
4. Foot Injuries (75') - 4 March 2019
5. Presentation: MT 5 fractures (20') – 7 March 2019

- AAOS Las Vegas, USA (12-16 March)
  Presentation at the ICL (343) :" Land of the Ligaments" on Syndesmotic Injuries (30') 14th of March Room 3404 Marco Polo Room at the Venetian Sands Expo.

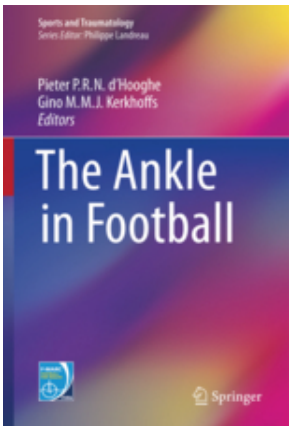
- International Conference on Sports Medicine in Athletics (4-6 May 2019, Aspire Zone Performance Center, Doha, Qatar).

- Presentation on : Peroneal Injuries in Athletics
- Cadaveric 3 hour workshop on : Functional Anatomy of the lower limb.

- ISOKINETIC 2019 Congress (Wembley, London, UK)
  Presentation on : Ankle arthroscopic surgery in specific Volleyball injuries

- ISAKOS 2019 Congress (Mexico)
  Chair and Faculty of 3 Instructional Course Lectures, Moderator of 2 symposia, 1 debate, 1 battle and 1 live surgery session

BOOKS



a. EDITOR OF THE BOOK: "THE ANKLE IN FOOTBALL" (D'Hooghe, Kerkhoffs)

2014, Springer-Verlag, 322 pages:

+ 8 ATHLETE RELATED INTERVIEWS
(Raul Gonzalez Blanco, Ricardo Pruna, Frank de Bleeckere, Jan Wouters, Velibor Milutinovic, Eva Blewanus, Ron Spelbos, Leonne Stentler)

+ CHAPTER 11: ANTERIOR IMPINGMENT (p.123-134) (P.D'Hooghe)

+ CHAPTER 13: POSTERIOR IMPINGMENT (p.141-154) (P.D'Hooghe)

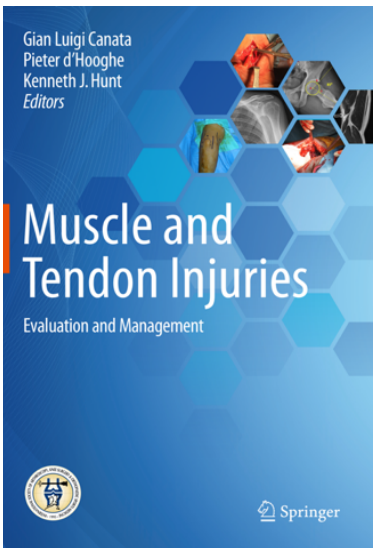
+ CHAPTER 15: ANKLE FRACTURES, INCLUDING AVULSION FRACTURES (p.159-186) (P.D'Hooghe)

+ CHAPTER 17: 5th METATARSAL STRESS FRACTURES IN FOOTBALL (p. 193-200)(P.D'Hooghe)

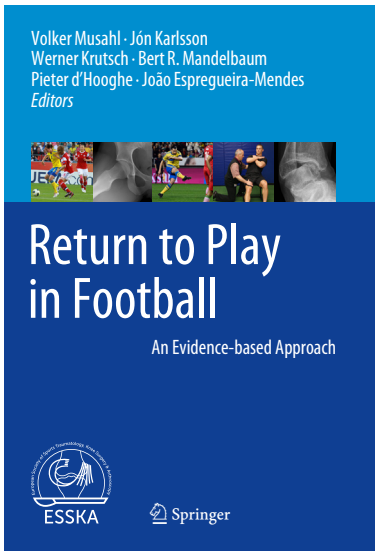
+ CHAPTER 19: ACHILLES TENDINOPATHY (p. 213 – 234, P.D'Hooghe)

+ CHAPTER 21: THE FOOTBALLER's INLAY SOLE: AN INDIVIDUALIZED APPROACH (p. 253 – 268) (P.D'Hooghe)

b. EDITOR OF THE ESSKA BOOK ICL 2016:
Posterior compartment of the ankle joint, a focus on the arthroscopic treatment (Haverkamp, D'Hooghe, Calder, Pereira)



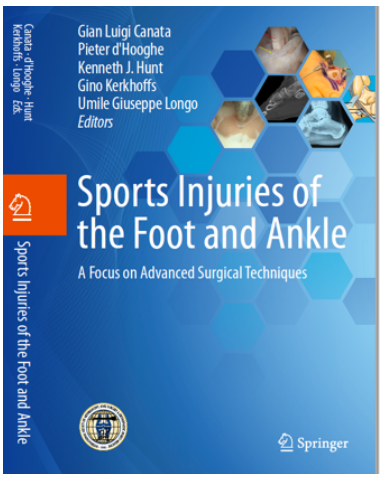
c. EDITOR OF THE BOOK:
"MUSCLE AND TENDON INJURIES" (Canata, D'Hooghe, Hunt) 2016, Springer-Verlag, 255 pages:



d. EDITOR OF THE BOOK:

"Return to Play in Football: An evidence based approach"

Editors: Volker Musahl, Jon Karlsson, Pieter D'Hooghe, Werner Krutsch, Bert Mandelbaum, and Joao Espregueira Mendes
Associate Editors: Christopher Murawski and Carola van Eck
Springer-Verlag book publisher
(publication: February 2018)



e. EDITOR OF THE BOOK:

"Foot and Ankle injuries in Sport, a focus on advanced techniques"
Editors: Gianluigi Canata, Pieter D'Hooghe, Kenneth Hunt, Umile Giuseppe Longo
Springer-Verlag book publisher
(publication: March 2019)

f. EDITOR of the BOOK (AAOS ICL 243, March 2018, New Orleans, USA)"Land of the Ligaments"

g. EDITOR of the book: FOOT and ANKLE INJURIES in ATHLETICS (coming 2021)
Authorship of 4 chapters in the future book confirmed.

BOOK CHAPTERS

a. Springer-Verlag Book : "Sports Injuries, 2nd Edition, 2015", edited by Mahmut N.D. and Karlsson J.
Book Chapter in the section: ANKLE
Chronic ligament injuries of the ankle joint (17 pages)
Pieter D'Hooghe, Jon Karlsson

b. Springer-Verlag Book : "Sports Injuries, 2nd Edition, 2015", edited by Mahmut N.D. and Karlsson J.
Book Chapter in the section: ANKLE
Total Achilles tendon Ruptures, Current Trends (14 pages)
Pieter D'Hooghe, Jon Karlsson

c. Springer-Verlag Book : "Nuclear Medicine and Radiologic Imaging in Sports Injuries ", 2015, edited by Glaudemans A.
Book Chapter 25: Sports Injury of the ankle (37 pages)
Johannes Tol, Pieter D'Hooghe, Gino Kerkhoffs

d. Springer-Verlag Book : "Football Traumatology, New Trends ", 2015, edited by Volpi P.
Book Chapter 25: Foot problems in Football (page 359 – 370)
Pieter D'Hooghe

e. Springer-Verlag Book: "ESSKA Arthroscopy Book", 2015, edited by Randelli P.
Book Chapter 94: Hindfoot endoscopy for posterior ankle impingement (16 pages)
Pieter D'Hooghe, Niek van Dijk

f. Springer-Verlag Book : THE MOST FREQUENT PROBLEMS AND INJURIES IN FOOTBALL. WHAT WE ALL SHOULD KNOW. ", edited by João Espregueira-Mendes and co-edited by Moisés Cohen, Stefano Della Villa, Niek van Dijk, Philippe Neyret, Joaquim Miguel Oliveira

and Hélder Pereira.
Book Chapter in the section: Ankle Injuries
Chapter – The value of arthroscopy on RTP in athlete ankle fractures.
Pieter D'Hooghe, Helder Pereira, Stefano Zaffagnini

g. Springer-Verlag Book (2016) :
"Acute and Chronic Muscular Pathology in the Athlete",
September 2014, edited by Dr. Ali Guermazi & Bernard Roger
Book Chapter in the section: Ankle
Chapter – Posterior Impingment
Author: Pieter D'Hooghe

h. Springer-Verlag Book :
" Intra-articular fractures – Minimally Invasive Surgery, Arthroscopy", May 2016.
Edited by Mahmut Nedim Doral & Jon Karlsson.
Book Chapter in the section:
Chapter – Talar Neck Fractures
Author: Pieter D'Hooghe

i. Elsevier Book: "CLINICAL SPORTSMEDICINE", edited by Karim Khan & Peter Brukhner (5th Edition, 2017):
BOOK CHAPTER 38: ACUTE ANKLE INJURIES
(D'Hooghe P, Weir A, Verhaegen E, Karlsson J)
2015, Elsevier, 955 pages : page 806 – 825.

j. FC Barcelona Muscle Tech Network Book chapter: "Muscle Injuries Clinical Guide 2.0, 2015"
Chapter : Surgical Treatment of Muscle Injuries.
Authors: Lempainen L, Orava S, Til L, Puigdellivol J, Pruna R, D'Hooghe P

k. AUTHOR OF THE 1st EDITION FOOTBALL MEDICINE MANUAL (F-

MARC, 2004)
Chapter on “sudden cardiac death on the field”. (P. D’Hooghe)

l. Springer-Verlag Book (2017) :
“Muscle and Tendon Injuries in the athlete” (May 2017).
Edited by Canata G, D’Hooghe P, Hunt K.
Book Chapter in the section: Ankle
Chapter – Posterior Impingment: Can there be a tendinous entity? (19 pages)
Author: Pieter D’Hooghe

m. ESSKA 2018 Book: HANDBALL SPORTS MEDICINE
(Editors: Laver, Popovic, Landreau, Seil)
CHAPTERS:

- Medical coverage of Handball events – from local competitions to world championships and Olympic games
  Nebojsa Popovic, Katharina Grim, Pieter D'Hooghe
- Foot and Ankle injuries in Handball
  Pieter D'Hooghe, Helder Pereira, Mike Carmont, Jon Karlsson
- Management of chronic instability in the handball player
  Helder Pereira, Pieter D'Hooghe, Mike Carmont, Jon Karlsson
- Management of cartilage injuries of the foot and ankle in Handball
  Mike Carmont, Helder Pereira, Pieter D'Hooghe, Jon Karlsson
- Rehabilitation of Foot and Ankle injuries in the handball player
  Ben Clarsen, Helder Pereira, Mike Carmont, Jon Karlsson, Pieter D'Hooghe

n. “Return to Play in Football: An evidence-based approach”
Editors: Volker Musahl, Jon Karlsson, Pieter D’Hooghe, Werner Krutsch, Bert Mandelbaum, and Joao Espregueira Mendes
Associate Editors: Christopher Murawski and Carola van Eck
Springer-Verlag book publisher
(publication: February 2018)
CHAPTER (P. D’Hooghe): “Foot stress Fractures in Football“.

o. “Foot and Ankle injuries in Sport, a focus on advanced techniques”
Editors: Gianluigi Canata, Pieter D’Hooghe, Kenneth Hunt, Umile Giuseppe Longo
Springer-Verlag book publisher
(publication: March 2019)

CHAPTER: Syndesmotic injuries (Pieter D’Hooghe)

CHAPTER: The role of arthroscopy in ankle fractures (Pieter D’Hooghe et al)

CHAPTER: Rehabilitation (Pieter D’Hooghe et al)

CHAPTER: Footwear and orthotics for the athlete (Craig Tanner, Pieter D’Hooghe)

p. Springer-Verlag Book (2018) :
“ Orthopaedic Research, A practical Guide “ (November 2017).
Edited by Volker Musahl et al.
Book Chapter in the section: Level 5 Evidence
Chapter – Level of Evidence 5
Author: Sean Mc Auliffe, Pieter D’Hooghe

q. Springer Book: “Osteochondral Tissue Engineering: Challenges, Current Strategies, and Technological Advances” to be published in 2018 (Series: Advances in Experimental Medicine and Biology) with editors: M. Oliveira, S. Pina, R.L. Reis and J.S. Roman