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Biological knee reconstruction: a case report of an Olympic athlete

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Abstract. – We report the case of a 31-year-old Olympic fencer, affected by complex degenerative lesions of the knee due to subtotal meniscal loss and patellar overload. The patient underwent a biological knee reconstruction including the treatment of the articular surface combined with lateral meniscal allograft transplantation and patellar realignment. This complex surgical approach significantly improved the knee function and reduced the pain. The athlete was able to get back to official competition 17 months after surgery.

Key Words:
Complex knee lesion, Osteochondral scaffold, Meniscal allograft, Patellar realignment, Biological reconstruction.

Background

Fencing competitions expose athletes to a peculiar, prolonged and asymmetrical biomechanical strain of the lower limb[1], possibly producing morphological changes[2] and leading to degenerative joint alterations, with a high prevalence of patellofemoral pain[3] that can markedly impair their performance. Symptomatic articular surface defects are a potential invalidating condition difficult to manage for the orthopaedic surgeon. The healing ability of cartilage is very poor and the situation is even more dramatic when the patient is relatively young and has high functional demands, such as professional sports players. Even small and focal defects can be heavily constraining and they can lay the joint open to the risk of more extensive damage and to the development of osteoarthritis (OA)[4-6]. Thus, surgical treatment is often unavoidable. Whereas there is consensus about avoiding, when possible, arthroplasty in young patients to maintain satisfactory physical activity, most of the biological options traditionally focus on the cartilage layer and offer a good outcome only in small and traumatic lesions, not in a more degenerated knee environment[7-13]. These considerations have drawn the attention of researchers to the subchondral bone, which may be involved primarily, for example in osteochondritis dissecans (OCD), osteonecrosis and trauma[14-16], or secondarily in large degenerative cartilage lesions. Treatment should always aim at restoring as anatomical a joint surface as possible, especially when approaching complex and degenerative knee lesions. Therefore, for articular defects involving the subchondral region, treatment addressing both cartilage and bone reconstruction might be more effective. Furthermore, the correction of all comorbidities is mandatory to restore a correct joint homeostasis and ensure good and long lasting results[14,15,17].

Case Reports

We report the case of a 31-year-old female Olympic fencer, who was treated for symptomatic osteochondral multifocal degenerative knee lesions, subtotal meniscal loss, and patellofemoral malalignment. The patient gave her informed consent to publish this case report.

The patient complained of anterior and lateral knee pain, combined with severe swelling, which forced her to interrupt competitions and sport activity completely. The patient had previously undergone several operations at the same knee: anterior cruciate ligament (ACL) reconstruction with patellar tendon graft (11 years earlier), arthroscopic debridement (4 years earlier), arthroscopic microfractures (2 years earlier), lateral meniscectomy, thermo-ablation and ACL shrinkage (4 months earlier).

Pre-op magnetic resonance imaging (MRI) showed a good appearance of the patellar graft used to reconstruct the ACL, and two osteochondral lesions, the bigger one located at the trochlea and the smaller one at the lateral patellar facet. The lateral meniscal tissue loss was estimated to be subtotal (> 80%) and was combined with chondropathy of the ipsilateral tibial plateau.

Objective findings were: normal femoro-tibial alignment, medial patellar tilt, limited and

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Figure 1. A lateral meniscus allograft, fixed by an all-inside suture, is implanted to protect the cartilage and increase the joint congruity.

painful (at 120°) range of movement (ROM). The grinding test was also positive.

Based upon the patient's age, clinical findings and functional demands, a complex reconstructive treatment was planned, involving a biological articular resurfacing in combination with lateral meniscal allograft transplantation (MAT) and patellar realignment to address the comorbidities. Surgery was performed by lateral parapatellar arthrotomy. A chondral grade III ICRS defect of the lateral tibial plateau was treated by microfracturing. The damaged remnant of the lateral meniscus was removed and subsequently a lateral meniscus allograft was prepared and implanted with all-inside sutures, as described by Marcacci et al[18] (Figure 1). The ICRS grade IV osteochondral lesion of the lateral throclea was treated with an autologous osteochondral plug (1 cm^2) from the supero-lateral aspect of the lateral condyle, with press-fit fixation[19]. The grade IV osteochondral defect of the lateral facet of the patella was treated by implanting a 3-layered osteochondral biomimetic scaffold measuring 2.5 cm^2 (Maioregen, Fin-Ceramica Faenza SpA, Italy; Figure 2)[20,21]. This scaffold was also used to fill the donor site on the supero-lateral aspect of the lateral condyle. Finally, the maltracking of the patella was corrected by performing a medial release and a lateral transposition of the lateral third of the patellar tendon and tibial tuberosity, adapting the technique originally described by Marcacci et al. to the specific needs[22] (Figure 3).

Postoperatively, the patient was placed into a full extension knee brace for 4 weeks. The brace immobilizer was removed 2 times a day to perform knee mobilization with motorized hardware. Starting the day after surgery, the patient began progressive range of motion from 0° to 45° over the first 2 weeks and 0° to 90° over the next 2 weeks, after which full motion was progressively allowed. At week 6 postoperatively, full bending of the knee was allowed. Over the first 4 weeks walking without weight-bearing with 2 crutches was allowed and 4 weeks postoperatively the patient started to bear weight as tolerated and weaned off one crutch. Eight weeks postoperatively, full weight-bearing was progressively started. In the following months a program of muscle strengthening and stretching was carried out to allow a gradual return to sport practice. Due to the high functional demand of the patient and her willingness to recover her elite-level of sports practice, she was constantly monitored in the rehabilitation center for up to one year.

Clinical evaluation was performed for up to 2 years of follow-up. The patient reported a clinical improvement in both knee functional status and pain. About one year after surgery she was able to run and a few months later she started her specific fencing training, that led to her getting

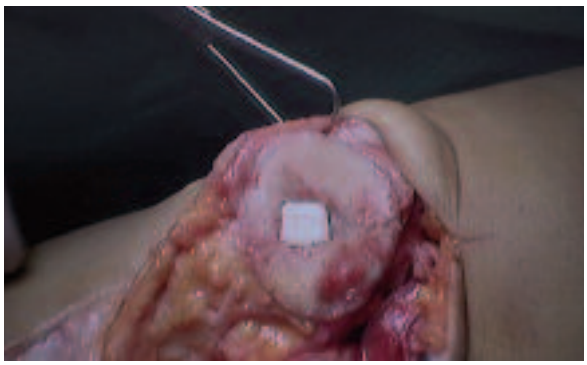

Figure 2. The 3-layered biomimetic osteochondral scaffold (Maioregen, Finceramica Faenza Spa, Italy) is used for the treatment of the osteochondral lesion of the patella.

back to competition at a National Fencing event 17 months after the operation.

Discussion

The main finding of this case report is that a complex approach with multiple combined surgical procedures is effective for the treatment of multifocal degenerative knee lesions at short-term follow-up, with a significant clinical improvement and the possibility of returning to professional sports activity.

Among the various procedures proposed over time to treat cartilage lesions, in very recent years the research has focused on biological and bioengineered resurfacing[9]. However, even the indication of these ambitious regenerative procedures has been limited to traumatic and focal lesions, whereas they cannot offer the same good results in degenerative ones. In fact, a compromised joint environment might influence the regenerative processes, probably due to the involvement of the subchondral bone as well[15], which is closely linked to the overlying articular cartilage: thus injuries of either adversely affect the entire joint mechanical environment. The resulting alterations limit the effects and outcome of cartilage treatments and can potentially contribute to the development of OA.

Nowadays, only a few articles deal with this challenging topic and report the management of "complex" knee cases. The case of a 15-year-old rugby player affected by a large OCD in his lateral femoral condyle combined with severe valgus deformity of the knee was reported by Vijayan et al[23]. The patient was treated with autologous chondrocyte implantation (ACI) and, 6 months later, by a closing wedge distal femoral osteotomy. Clinical results were encouraging at both the 12 months' and 24 months' evaluations and were confirmed at 8 years' follow-up, when a 2nd look arthroscopy documented the graft integrity. Another case report published by Ronga et al[24] described the management of a 40-year-old sport-active patient who suffered ACL rupture and medial meniscal tear combined with a large medial femoral condyle (MFC) chondral lesion. He was first treated with ACL reconstruction using bone-patellar tendon-bone graft and bio-engineered meniscal scaffold implant. After 6 months, due to persisting knee pain the patient underwent ACI on MFC: at 24 months' follow-up there was an increase in all the scores considered and even MRI showed integration of the collagen meniscus implant and good restoration of the articular surface. Farr et al[25] combined ACI and MAT with high tibial osteotomy, tibial tubercle osteotomy, and ACL reconstruction in 36 patients, and achieved good overall results, a marked decrease in pain and an increase in each clinical score at 2 years' follow-up. Bauer et al[26] used lateral closing wedge high tibial osteotomy and ACI for 18 patients with medial OA combined with varus mal-alignment of the knee. They reported a satisfactory clinical outcome; however, a clinical drop-off was reported between 36 months and 60 months and the graft tissue quality was considered unsatisfactory by MRI. Finally, Filardo et al[27] treated the knees of 33 patients affected by complex knee lesions by implanting an osteochondral scaffold and correcting all articular comorbidities, with good clinical results at 2 years. Moreover, the scores of patients who underwent osteochondral scaffold implantation were retrospectively compared with a homogeneous group of 23 complex patients treated with a purely chondral scaffold, showing significantly better results for the osteochondral treatment approach.

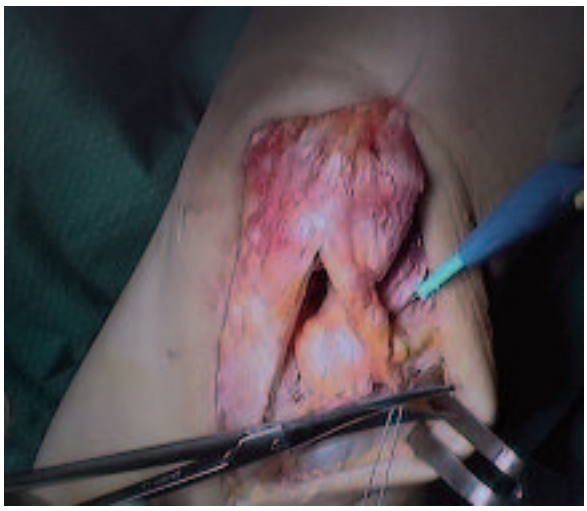

Figure 3. The lateral third of the patellar tendon is fixed laterally on the tibia with a metal staple in order to obtain a correct patello-trochlear tracking.

These studies confirmed and highlighted the importance of treating both the entire osteochondral unit and possible comorbidities such as axial mal-alignment, patellar mal-tracking, joint instability, and meniscus status. In fact, underestimating concurrent articular problems, either biological or biomechanical, can jeopardize even technically perfect cartilage procedures and affect the

final outcome[28,29]. Finally, also previous surgeries can influence the treatment: ACI has been shown to produce a poorer clinical outcome if performed in a site previously treated with microfractures[30], probably due to alterations of the underlying subchondral bone. The choice of an osteochondral treatment, such as osteochondral autograft or scaffolds may be a good solution, by allowing both the superficial chondral layer and the underlying bone layer to regenerate.

Following this experience, we approached this complex knee lesion with a comprehensive treatment to regenerate the damaged articular surface and address the comorbidities that might impair the healing process. In fact each of the single factors we dealt with might represent a potential predisposing factor in OA development: 1- degenerative and multifocal defects of the articular surface[17]; 2- presence of an injured or resected meniscus[17]; 3- patello-femoral overload due to mal-tracking[17]; 4- previous ACL lesion, even if reconstructed[17]; 5- previous surgeries in the same knee[31]. Moreover, Kujala et al[32] reported a five-fold increased risk of knee OA in former top-level athletes with previous knee injuries.

Thus, in this challenging case we performed an overall joint evaluation to tailor our treatment and increase the chances of clinical success. The stability was not addressed since the reconstructed ACL appeared to be still functional. The osteochondral lesions were treated by an osteochondral surgical approach and we also combined the implantation of a meniscal allograft and lateral patellar realignment, which were necessary to unload the tibio-femoral and patello-femoral compartments, respectively, and prevent overstress on the treated sites.

Such comorbidities required a patient-specific surgical approach with multiple treatments, accurately planned considering the patient's needs. The clinical and functional short-term results seem to confirm the validity of this type of approach, which led not only to a clinical improvement, but even allowed the return to the previous professional sport activity level.

Conclusions

This case report suggests that a regenerative procedure can be applied to challenging knee lesions, if accurately planned in a patient-specific manner: that is a sort of "surgery-on-demand" that might offer good results also in complex degenerative cases otherwise doomed to joint resurfacing, which should be preferably avoided especially in young active patients. The aim should always be to re-establish a joint surface as anatomically correct as possible by a repair targeted at both cartilage and bone reconstruction, and by concurrently considering and treating all the significant comorbidities, in order to restore a correct joint homeostasis and ensure good and stable results over time.

Authors' declaration of personal interests

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F. Perdisa, B. Di Matteo, G. Filardo and A. Di Martino declare no conflict of interests.

Declaration of funding interests

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