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Use of Mesh Plate for the Treatment of Comminuted Patellar Fractures: Case Report

Uso de placa malla en el manejo de fracturas conminutas de patela: Reporte de caso

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Abstract

Objective To describe the surgical technique for the use of a mesh plate in a case of comminuted patellar fracture and the mid-term follow up outcomes.

Materials and Methods We present a case of comminuted patella fracture managed with the use of a mesh plate and an associated cannulated screw, thus avoiding partial patellectomy and its possible complications.

Results Four months postoperatively, the patient presented full knee range of motion and could be discharged to return to work, with no complications or reinterventions.

Discussion The use of mesh plates enables the management of comminuted patellar fractures preserving bone stock and restoring the extensor mechanism with a stable and little prominent osteosynthesis. Cases which previously would only have been treated by partial patellectomy and patellar tendon reinsertion can be treated with these plates.

Conclusion The use of mesh plates for comminuted patellar fractures is an attractive option due to their stability, their ability to preserve bone stock, and the low rates of reintervention.

Level of evidence V.

Keywords
- patella
- comminuted fracture
- mesh plate
- difficult patellar fracture

Resumen

Objetivos Describir la técnica quirúrgica para el uso de placa malla en un caso de fractura conminuta de patela y sus resultados en el seguimiento a mediano plazo.

Materiales y Métodos Presentamos un caso de fractura conminuta de patela manejada con el uso de una placa malla y un tornillo canulado asociado, evitando de esta forma la patelectomía parcial y sus posibles complicaciones.

Resultados El paciente presentó una evolución satisfactoria, con rango de movimiento de rodilla completo y en condiciones de alta laboral a los cuatro meses desde la cirugía, sin complicaciones ni reintervenciones.

Palabras Clave
- patela
- fractura conminuta
- placa de malla
- fractura patelar difícil

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Discusión El uso de placas de malla permite el manejo de fracturas conminutas de patela preservando *stock* óseo y restaurando la indemnidad del aparato extensor, con una osteosíntesis estable y poco prominente. Casos en que antiguamente la única alternativa era la patelectomía parcial y reinserción del tendón patelar ahora tienen etas placas como opción de manejo.

Conclusión El uso de placas de malla en fracturas conminutas de patela es una alternativa atractiva por la estabilidad que brindan, la capacidad de preservar *stock* óseo, y la baja tasa de reintervenciones.

Nivel de evidencia V.

Introduction

Patellar fractures represent between 0.7% and 1% of all fractures.[1,2] Comminuted fractures correspond to type C3 on the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification.[3] This subtype is the most frequent, representing 25% of the total.[3]

The treatment of patellar fractures seeks to restore the function of the extensor apparatus and obtain an anatomical joint reduction together with stable fixation that enables early rehabilitation. Achieving these objectives is more complex in the case of comminuted patellar fractures,[4] for which there is still no consensus regarding the surgical management.[5] Total or partial patellectomy is an alternative that has been used in the past for the management of these fractures;[6–9] however, it can result in loss of up to 49% of quadriceps strength,[10,11] and poor outcomes have been reported with its use.[10,12] Currently, the objective is to preserve the entire patella and, to do so, various surgical techniques and combinations of implants have emerged that seek to achieve better clinical results and a lower rate of complications.

Many authors have reported their results using various techniques for the management of type-C3 patellar fractures, highlighting the use of tension band wiring with cerclage,[13–18] the nitinol patellar concentrator,[19–21] tension band wiring with minifragment plates (measuring 1.5 mm to 2.0 mm),[22–25] and the use of mesh plates.

The objective of the present article is to report a case of comminuted patellar fracture managed by reduction and osteosynthesis using a mesh plate, describing the surgical technique and ending with a review of the current literature on this type of implant.

Written informed consent was obtained from the patient for the publication of this case and the accompanying images.

Clinical case

A 26-years-old healthy male patient who was run over by a car at low speed, which caused a fall with support on the right upper extremity and a direct impact on the front of the left knee.

After an evaluation in the Emergency Room of our center, he was admitted in a wheelchair, unable to walk. The physical examination revealed increased volume, pain on patellar palpation, and no active extension of the left knee. Through radiographs and computed tomography (CT) scans, a comminuted left patellar fracture, type C3 on the to the AO/OTA classification, and a Rolando fracture-dislocation of the right thumb were diagnosed. Preoperative planning is complemented with a three-dimensional (3D) reconstruction of the left knee CT scan (►**Figure 1**). One week after the accident, the reduction and osteosynthesis of both fractures were performed in a single procedure.

Surgical technique

With the patient in supine position, a longitudinal incision is made in the midline from the proximal edge to the distal edge of the patella. After a careful dissection by planes, a medial traumatic retinaculotomy and a comminuted patellar fracture are identified. Then, cleaning and careful curettage of the fracture site with a spoon and saline solution are performed. A small non-synthesizable fragment of the medial facet is resected, followed by fracture reduction using a forceps and three temporary Kirschner wires. Adequate

Fig. 1 Preoperative study with 3D reconstruction of a CT scan of the left knee.

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Fig. 2 Placement of mesh plate on reduced fracture for subsequent performance of cuts and final molding.

Fig. 3 Transient fixation of mesh plate using olive-shaped needles.

reduction is verified by direct palpation through the present traumatic retinaculotomy and by fluoroscopy.

At the same time, on an accessory table, the 2.4 mm/2.7 mm mesh plates from the LCP Compact Foot box set (DePuy Synthes, Raynham, MA, United States) are prepared. A plate is placed on the reduced fracture (►**Figure 2**); then, cuts and the definitive mold are made. Once its cephalocaudal size is defined, curvatures are made at its medial and lateral ends, thus enabling the placement of screws in the coronal plane. For the positioning of the definitive plate, temporary olive-shaped needles are used, which enable the placement of the plate face to face against the bone (►**Figure 3**). After verifying once more the reduction and proper positioning of the mesh plate under fluoroscopy, definitive fixation is selectively performed with screws, achieving fixation of the comminuted fragments. After the placement of the screws, it is essential to verify the integrity of the articular surface without the passage of the screws by direct palpation and radioscopy. Finally, in order to optimize stability, the distal fragment is synthesized with a 3.5-mm cannulated screw from distal to proximal. Osteosynthesis is tested by achieving flexion of up to 30° without loss of reduction, and the procedure is finished with cleaning and closure by tissue planes.

Results

The patient evolved favorably without complications in the immediate postoperative period. Gait rehabilitation was initiated with load bearing as tolerated with a cane on the left side and an adapted crutch on the right side together with a passive range of motion (ROM) of 0° to 30° for 2 weeks; then, progressive ROM was started. In the follow-up at 3 months, the patient presented a ROM of 0° to 115° with an intact extensor apparatus, achieving elevation of the leg in extension without difficulty (►**Figures 4(A**, B)). The control X-ray and CT scan showed adequate joint reduction and signs of advanced consolidation (►**Figures 5**, **6(A**,B)). The patient was discharged 26 months after the accident.

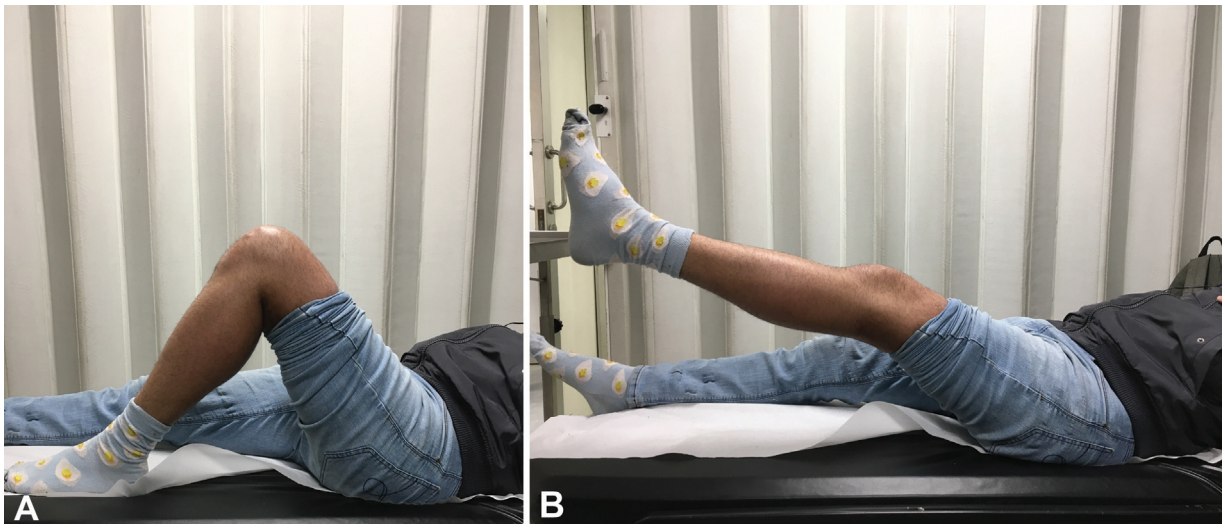

Fig. 4 (**A**,**B**) In the follow-up at 3 months, the patient presented a ROM of 0° to 119°, with an intact extensor apparatus, achieving elevation of the leg in extension without difficulty.

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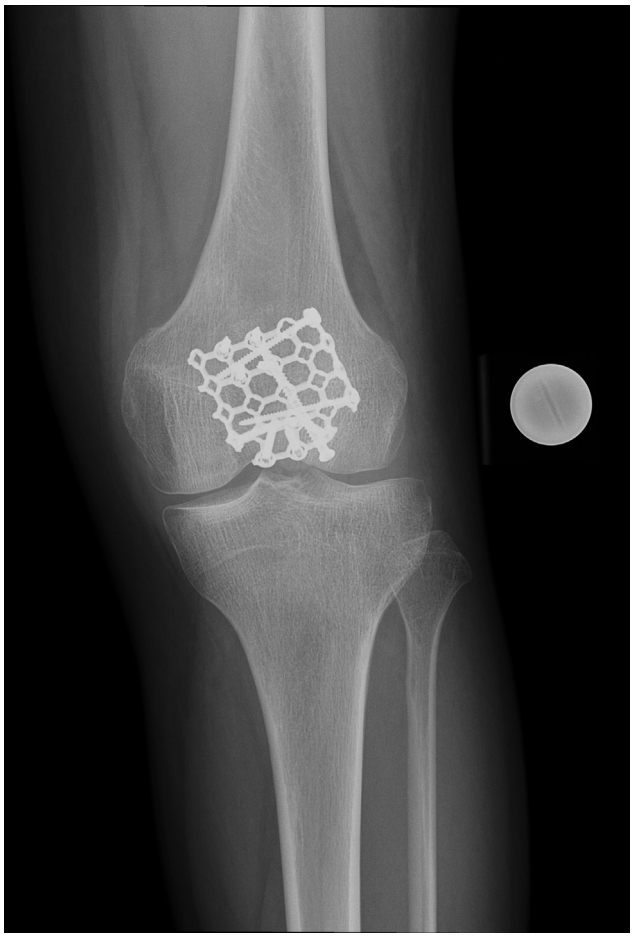

Fig. 5 Anteroposterior radiograph of the knee exemplifying the positioning of the plate, which is molded according to the patella with the reduced comminuted fracture.

Discussion

Comminuted fractures of the patella are a challenge for the surgeon; as they are joint fractures, the objective of the treatment is anatomical reduction with a stable construct that enables early rehabilitation. As treatment alternatives, there are options such as the use of tension band wiring with cerclage, individual screws for each fragment, and anatomical and non-anatomical plates, among others.

Tension band wiring is the classic osteosynthesis technique for transverse patellar fractures. In selected cases of comminuted fractures, they can be helpful, as they do not require great technical skill and require implants available in almost every center.[18,26–28] The disadvantage of this technique is that not all comminuted fractures are candidates for osteosynthesis with this technique, since multidirectional fracture lines can shear with the application of tension to the band wiring. This is why a cerclage can be added to contain the non-synthesizable fragments with the tension band wiring and thus increase the stability of the construct. Another disadvantage is the high rate of removal, which, depending on the series, can reach up to 60%.[1]

Synthesis with independent screws is useful to solidify medium-sized fragments and thus reduce the complexity of the fracture. It serves as a complement to other techniques such as the use of tension band wiring or plates.[29]

Finally, there is the use of plates, which vary from minifragment plates to anatomical or mesh plates. Minifragment plates have been studied by many authors,[5,25,30] and they have different possible configurations, but are limited regarding the positioning of the screws for each fragment. In order to solve this problem, anatomical patella plates were designed that are more versatile when it comes to

Fig. 6 (**A**,**B**) Coronal and sagittal CT scans of the knee showing adequate joint reduction and signs of advanced consolidation.

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synthesizing each fragment with a screw.[22–24,31–33] Mesh plates enable multiple possible configurations for the screws, with a true adaptation to the anatomy in an individualized way.[23,34–38] These plates are implants commonly used in maxillofacial surgery, spine surgery, and neurosurgery; however, since 2015, their use has been expanded for the fixation of patellar fractures, with reports of good results.[35,36,38,39] They have characteristics that make them an osteosynthesis method with some advantages over traditional fixation methods. Among these characteristics are its multiple holes designed for the placement of variable-angle locked screws, its easily contourable and at the same time resistant structure, which enables its adaptation to the patient's anatomy[35] and, lastly, its low profile, which facilitates the subcutaneous placement.[28–33]

Biomechanical studies[30,34,40–42] have evaluated the use of these plates for the treatment of patellar fractures, showing comparable and even superior results in terms of force required for failure compared to the standard treatment with screws and wires.

Comminuted patellar fractures are candidates for management with mesh plates, since these can facilitate the manipulation, reduction, and fixation of multiple fragments. Preliminary results have shown favorable outcomes and a low complication rate.[28] Lorich et al.[39] presented the use of these plates for the treatment of 9 patients with complex patellar fractures (2 with type-34-C1 and 7 with type-34-C3 patellar fractures on the AO/OTA classification). The authors[39] used a mesh plate that encompassed half of the circumference of the lateral half of the patella, providing multiplanar, bicortical fixation from distal to proximal and from lateral to medial; while the fixation from anterior to posterior was unicortical, without compromising the articular surface. The plate is fixed to the patella using a combination of 2.4-mm and 2.7-mm compressive screws, seeking to provide compression and absolute stability of the main fracture fragments. Direct observation and palpation through a lateral parapatellar arthrotomy enable the verification of the reduction and that the articular surface has been spared. Alternatively, patellar eversion in comminuted fractures also plays a role in the evaluation of fragment reduction, and it has been described in some studies.[32,41–43] In their series, Lorich et al.[39] reported consolidation in all of the 9 cases in 23 weeks on average. All cases achieved complete ROM and only one of the patients required removal of the osteosynthesis.

Singer et al.[36] reported good results with the use of these plates in a series of 9 patients with closed comminuted patellar fractures. The average consolidation time was of 10 weeks. Only one patient did not recover full ROM, reaching a ROM of 10° to 90°. The functional scores (on the Lysholm scale, and the average postoperative score on the Böstman scale) showed good and excellent results in 4 and 5 patients respectively. None of the patients required reintervention or removal of the osteosynthesis.

Siljander et al.[38] described a retrospective series of 16 patients with patellar fractures (75% of them comminuted) fixed with mesh plates, without loss of reduction or osteosynthesis failure despite an unrestricted rehabilitation protocol. All fractures presented union at 3 months of follow-up and the ROM ranged from 0° of extension to a mean flexion of 138° (range: 115° to 151°), with a mean difference of 4.8° compared to the contralateral ROM.

The use of these low-profile plates significantly reduces one of the most frequent complications of patellar fractures: symptomatic osteosynthesis, reducing the need for reintervention.[38] A reintervention rate of 37% has been reported for symptomatic osteosynthesis using Kirschner wires[44] and tension band;[45] on the other hand, studies[28,36,38] in which mesh plates are used have not reported this type of complications or the need for a new procedure. Possible explanations for this include the low profile of the plate, its easy malleability, and its grid design, which enables the soft tissue to herniate through its spaces, preventing its prominence.[38] On the other hand, Volgas and Dreger,[35] in their series of 16 patients treated with mesh plates, presented 5 cases of removal of the osteosynthesis due to pain. Despite this, their results in terms of consolidation and ROM were satisfactory, so the authors[35] concluded that these plates are an alternative to consider when facing a comminuted patellar fracture or a case of non-union of a patellar fracture.

In a recent study, Vajapey et al.[28] reported the use of very low-profile mesh plates with a thickness of 0.4 mm (MatrixNEURO, DePuy Synthes) for the management of complex patellar fractures. These plates, which are commonly used in craniofacial surgery, were the fixation method chosen to treat four cases of severely comminuted patellar fractures. The authors[28] reported promising results with the use of this implant, since three out of four patients began mobility exercises early, and there were no postoperative complications; no patient required removal of the osteosynthesis.

Among the limitations of the present study is the small number of cases included, which is why comparative studies with a larger sample are suggested to establish results about conventional mesh plates versus very low-profile mesh plates.

Conclusion

We presented a case of comminuted patella fracture managed with the use of a mesh plate and an associated cannulated screw, thus avoiding partial patellectomy and its possible complications. The patient evolved satisfactorily, achieving the expected consolidation and early rehabilitation. The management of comminuted patellar fractures continues to be a challenge, which is why various options have been proposed for the treatment. An attractive alternative for the management of these injuries is the use of mesh plates, which show favorable results and a low rate of complications in the reviewed literature. However, studies with larger samples are required to draw conclusions about the use of this implant; for now, it seems to be a promising choice to solve complex cases.

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