



PATELLA FRACTURES, EPIDEMIOLOGY, ANATOMY, FUNCTION, MECHANISMS OF ACTION, CLASSIFICATION, CLINICAL PRESENTATION, IMAGING PRESENTATION, TREATMENT AND COMPLICATIONS

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SUMMARY

Introduction: The patella has a great importance in the extension and flexion activities of the knee, being paramount in the patient's quality of life. Nowadays the surgical options that stand out the most are open reduction plus internal fixation and resection of the patella. The patella increases the leverage of the quadriceps. Management following patella injury has been based on preservation of bone and vascular supply, in addition to joint restoration and extensor function. In patella fractures, it is essential to reflect on the biomechanics of the bone and the fixation technique to be used.

Objective: to detail the current information related to patella fractures, epidemiology, anatomy, function, mechanisms of action, classification, clinical presentation, imaging presentation, treatment and complications.

Methodology: a total of 32 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 24 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: patella, patellar fractures, knee trauma.

Results: Patellar fractures comprise 1% of all fractures in humans, with a 2:1 male to female ratio. They occur more frequently in individuals between 20 and 50 years of age. The frequencies of pseudarthrosis and infection are relatively lower after the surgical procedure. Approximately 2 to 7% of patellar fractures are open fractures. Their classification is descriptive.



Conclusions: The patella is the largest sesamoid bone in the human body with several important functions. Frequently, patellar fractures appear after falls on the knee, blows and unexpected and energetic muscular pulls. The diagnosis is made by means of clinical history, physical examination and complementary radiography. Anteroposterior and lateral projections of the knee should be performed. For conservative treatment it is essential that the knee extensor mechanism is intact. There are several methods of surgical treatment, in general the open reduction and internal fixation present good results. Complications include post-traumatic osteoarthritis, alteration or loss of mobility of the knee, refracture, fixation failure, osteonecrosis, intolerance to osteosynthesis material, loss of strength of the extensor mechanism, loss of extension, instability of the patella and pseudoarthrosis.

KEY WORDS: patella, knee, fracture, treatment, osteosynthesis.

INTRODUCTION

The patella has a great importance in the extension and flexion activities of the knee, being primordial in the quality of life of the patient. Nowadays the surgical options that stand out the most are open reduction plus internal fixation and resection of the patella. Internal fixation techniques include ring-joint patella fixation, tension band wiring and enhanced technology, screw fixation, steel plate fixation, tension band wiring combined with other methods, and patellar fixation with patellar fixator. Each of these treatments has distinct advantages, disadvantages and indications(1).

The patella increases quadriceps leverage. Management following patella injury has been based on preservation of bone and vascular supply, in addition to restoration of joint and extensor function. Surgical indications for patellar fractures include exposed fractures, fractures involving extensor apparatus function, those with a joint gap greater than 5 mm and/or joint incongruity greater than 3 mm. Anatomic reduction and stabilization with a modified tension band is the most common treatment. Some biomechanical trials show that tension band stabilization replacing Kirchner wires with cannulated screws shows good endurance to fracture displacement, providing greater stability. In patella fractures, it is essential to consider the biomechanics of the bone and the fixation technique to be used. The treatment through eversion of the patella allows a direct view of the articular surface, in addition to monitoring and correcting possible unevenness of it, leaving unnecessary the use of fluoroscopy in surgery; the management without patellar eversion and use of fluoroscopy, is less interventional, so theoretically presents a lower potential intraoperative risk(2).

METHODOLOGY

A total of 32 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 24 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: patella, patellar fractures, knee trauma.

The choice of bibliography exposes elements related to patella fractures, epidemiology, anatomy, function, mechanisms of action, classification, clinical presentation, imaging presentation, treatment and complications.

DEVELOPMENT

Epidemiology

Kneecap fractures comprise 1% of all fractures in humans, presenting a 2:1 ratio between men and women, frequently occur unilaterally and happen more frequently in individuals between 20 and 50 years of age; however, there are some studies that show other characteristics. In the elderly, especially in women, fractures may be caused by a low-impact mechanism, such as falls from a height of one foot or less, and are considered fragility fractures. Approximately 2 to 7% of patellar fractures are open fractures(3-5).

Anatomy and Function

The patella is the largest sesamoid bone in the human body, in other words, it is a bone embedded within a tendon; specifically, the patellar tendon. The patella has different functions of utmost importance such as:

- Exercises as a protector of the knee joint.
- Protect the femoral condyles from direct trauma.
- Increases the mechanical strength and leverage of the quadriceps tendon.
- Supports nutrition of the articular surface of the femur.
- Presents cosmetic function.

The appearance of certain fractures in this anatomical area can lead to alteration of the previously mentioned functions. The patella has a rounded triangular structure and has 7 articular facets; the lateral facet is the largest, representing almost 50% of the articular surface. The articular cartilage is usually up to 1 cm thick. The tendon of the quadriceps is inserted in the superior part of the patella and the patellar ligament in the inferior part. The extensor retinaculum, medial and lateral, support the longitudinal extensions of the quadriceps. If they are not affected by a patellar fracture, the individual can perform knee extension. Vascularization comes from the genicular arteries, which form a circumferential anastomotic network around the patella(3,4,6).

Mechanism of Injury

Frequently, patellar fractures appear after falls on the knee, blows and unexpected and energetic muscular pulls. The mechanisms of action are usually direct, indirect and mixed impact. Some authors refer to fractures related to patellar luxation as a different mechanism of action.



Direct Impact: a direct traumatism on the patella generates some forms of fracture such as incomplete, simple, stellate or comminuted. Usually, the displacement is almost null since the medial and lateral expansions are maintained. They commonly present with abrasions and wounds in the region. In this type of impingement, active knee extension may remain preserved.

Indirect Impact: this is the most common mechanism, generally following a forced eccentric contraction of the quadriceps while the knee is in semi-flexion. The traction of the ligamentous and musculotendinous parts exceeds the patella's own resistance. The most common pattern is transverse fracture, with mutable comminution of the lower pole. The level of fragment displacement has a direct impact on the level of extensor retinaculum injury. In this type of impingement, active knee extension is usually not preserved, with the patient being unable to extend the knee.

Combined Mechanism: the individual presents direct and indirect trauma to the knee, such as a fall from a height(3,4,6).

Clinical Assessment

In most cases the diagnosis of patella fracture is made by clinical history, physical examination and a complementary radiography; generally affected individuals are unable to walk or show an alteration with limitation to walk accompanied by pain and swelling in the affected knee, sometimes on palpation can feel an alteration in the patella. When an open fracture is evidenced, it should be treated as a surgical emergency. Sometimes at the time of the evaluation it is possible to choose to inject more than 100 ml of physiological saline solution in the knee to check for the existence of communication with the overlying lacerations. In

addition, the active extension of the knee must be evaluated to know if the retinacular expansions are altered, sometimes it is necessary to decompress the hemarthrosis or to place lidocaine inside the joint. In a strong impact trauma, it is necessary to evaluate the ipsilateral hip, femur, tibia and ankle, in addition to an evaluation with complementary examinations such as X-rays if necessary(3,4).

Imaging Assessment

Anteroposterior and lateral projections of the knee should be performed. Usually it is not necessary to request CT or MRI, however preoperative CT has presented a fundamental role in the diagnosis of patella fractures by accurately assessing the structure of the fracture and improving decision making for planning and treatment.

Anteroposterior Projection: allows the identification of patellar fractures, it should be taken into account the existence of a bipartite patella that is usually located in the superolateral portion, it is usually confused with a fracture, however the bipartite patella has smooth edges and is bilateral in 50% of those affected.

Lateral Projection: usually allows to see the displacement of the fractures.

Axial Projection: also called rising sun projection allows the identification of osteochondral fractures or vertical marginal fractures. However, in acute trauma, due to pain and other factors, it is not usually relevant and it is difficult to perform, so it is preferable to use CT to better visualize the fracture pattern, marginal fractures or free osteochondral fragments(3,4,7).

Figure 1. Radiographs in AP and lateral projections, showing fracture of the patella treated by the use of a tension band with a wire loop by means of cannulated screws.



Source: Carredano G X, Valderrama R J, Valderrama S I, Hube L M, Bernal B N, Mellado M C, et al.(2).

Classification

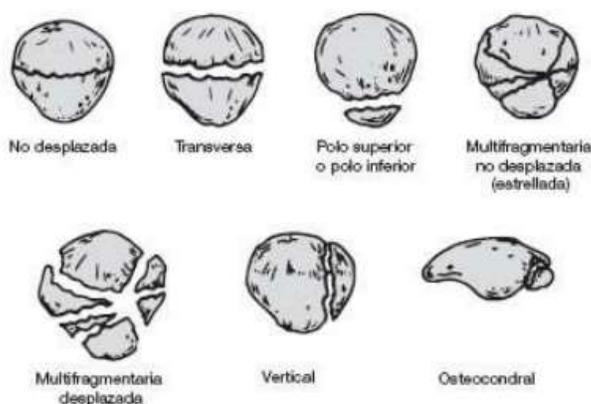
The classification can be made according to different descriptive parameters such as:

- Open versus closed.
- Not displaced versus displaced.

- By pattern: comminuted, transverse, vertical, stellate, polar, osteochondral.

Management preferences differ according to the displacement of the fracture, the classification and the factors specific to the affected individual(4,8).

Figure 2. Classification of patella fractures.



Source: Bucholz RW, Heckman JD, Rockwood CA, Green DP. Rockwood & Green's *fracturas en el adulto*(6).

Treatment

Conservative Treatment

For this type of management it is essential that the knee extensor mechanism is intact, if so, it is indicated in non-displaced or minimally displaced fractures of 2 mm to 3 mm with slight joint involvement of 1 mm to 2 mm. An inguino-malleolar cast or an extension-locked knee brace may be used for approximately 4 to 6 weeks. Early partial bracing with the knee in extension is also indicated, continuing with full bracing with English canes as the affected individual tolerates. Elevation exercises with the leg straight can be started quickly, and strengthening of the quadriceps femoris by isometric exercises can be performed in the following days. After evidence of bone consolidation through a complementary examination, it is recommended the progressive inclusion of active exercises that help to improve and strengthen flexion and extension, however, the articulated orthosis should remain locked in extension while walking.

Surgical Treatment

Within the management in the operating room, open reduction and internal fixation, most of the times show good results. The indications for surgery are:

- Open fracture.
- Joint incongruence > 2 mm.
- Fragment displacement > 3 mm.
- Loss of active extension.
- Lack of full extension.

There are multiple surgical fixation options to name a few:

- The oblique or tension band where K-wires or parallel longitudinal cannulated longitudinal screws can be used.
- Circumferential cerclage with wire.

It is advisable to fix the retinaculum breakage. In comminuted fractures, many small fragment screws, mini-fragments or K-wires may be needed. After the surgical procedure, the joint should be immobilized with a splint for about 3 to 6 days, and then begin early mobilization, after which the affected individual will have to do active range-of-motion assisted exercises, increasing the load progressively. Severe comminuted fractures or with marginal repair, mostly in elderly people, require immobilization for about 3 to 6 weeks, leaving the load free with the knee in extension according to tolerance. The orthosis can be removed when performing a range of motion movements.

Partial patellectomy may be performed when there is a large salvageable fragment along with several small comminuted polar fragments that are thought to make it difficult to repair the articular surface or allow stable fixation. Removal of the distal fragments may result in a low patella. The patellar ligament can be reintegrated by non-absorbable sutures.

Total patellectomy is used in fractures with significant comminution. The maximum strength of the quadriceps muscle is decreased by half. After partial or total patellectomy, the knee should be immobilized with an inguinopedic or inguinomalleolar cast with 10° of flexion for about 3 to 6 weeks(4,6,9).

The options for surgical management of comminuted patellar fractures include:

- Open reduction and internal fixation: the first-line treatment in comminution.
- Cable-pin system.
- Titanium cerclage with cable.
- Nickel-titanium patella concentrator.



- Plate and screw fixation: used in patella fracture, for the treatment of transverse patella fracture or inferior patella fracture.
- Modified tension band fixation: has a good effect in simple transverse patellar fracture.
- Partial or total patellectomy: causes alteration of the extensor mechanism and the normal contact surface of the patellofemoral joint, impairing the function of the knee joint.
- Circumferential cerclage wire fixation: widely used in the treatment of comminuted patellar fracture. With worse results in terms of stability compared to tension band and modified tension band.
- Modified cerclage wire: effective for treatment of comminuted patellar fracture, showing strong and stable fixation, in addition to early functional exercise(4-18).

Figure 3. Postoperative Patella Fracture.



Source: The Authors.

Complications

Post-Traumatic Osteoarthritis: usually present in approximately 50% of patients, when patellofemoral pain is intractable it may be necessary to perform an advancement osteotomy of Maquet's tibial tubercle.

Impairment Or Loss of Knee Mobility: following long-term immobilization or due to post-surgical fibrosis. Stiffness and contracture compromise long-term recovery of joint function.

Post-Surgical Infection: infrequent, interrelated with open fractures and recurrent debridement. If the infection is very complicated, removal of non-viable fragments and restoration of the extensor mechanism may be necessary.

Refracture: following the reduction of the fracture site's own resistance, it usually occurs in 1% to 5%.

Failure of Fixation: occurs more frequently in individuals with osteoporosis, it occurs when the fracture site is not properly compressed.

Osteonecrosis: interrelated with fractures with more initial displacement. The proximal fragment is the most affected. Management is usually periodic observation, usually revascularize spontaneously in about 2 years.

Intolerance to Osteosynthesis Material: sometimes it may be necessary to remove the material.

Loss of Strength of the Extensor Mechanism and loss of extension: in about 5 degrees, generally without relevance.



Instability of the Patella.

Pseudarthrosis: with an incidence of approximately 2 percent, most affected individuals maintain good function, however, when the pseudarthrosis generates great pain, partial patellectomy may be chosen. In young, active individuals, revision osteosynthesis can be performed, however, in most cases of patellar pseudarthrosis, management is challenging. Some studies indicate that the non-metallic fixation technique supported by sutures related to platelet-rich plasma and mesenchymal stem cells may be an option to be used in pseudoarthrosis following patellar fractures and also in primary patellar fractures(4,6,24). In a meta-analysis of reintervention, pseudoarthrosis and infection after open reduction and internal fixation of patellar fractures, the frequencies of pseudoarthrosis and infection are relatively lower after the surgical procedure; the frequency of reintervention was 33.6%, that of infection 3.2% and that of pseudoarthrosis 1.3%(5).

CONCLUSIONS

The patella is the largest sesamoid bone in the human body with several important functions. Frequently, patellar fractures appear after falls on the knee, blows and unexpected and energetic muscular pulls. The diagnosis is made by means of clinical history, physical examination and complementary radiography. Anteroposterior and lateral projections of the knee should be performed. For conservative treatment it is essential that the knee extensor mechanism is intact. There are several methods of surgical treatment, in general the open reduction and internal fixation present good results. Among its complications we find post-traumatic osteoarthritis, alteration or loss of mobility of the knee, refracture, fixation failure, osteonecrosis, intolerance to osteosynthesis material, loss of strength of the extensor mechanism, loss of extension, instability of the patella and pseudoarthrosis.

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