PATELLAR FRACTURES: A DECADE OF TREATMENT AT IOT-HC-FMUSP – PART I: FUNCTIONAL ANALYSIS

ALEXANDRE FELICIO PAILO[1], EDUARDO ANGELI MALAVOLTA[1], ALEXANDRE LEME GODOY DOS SANTOS[1], MATEUS TIAGO RONCHI MENDES[1], MÁRCIA UCHOA DE REZENDE[2] , ARNALDO JOSÉ HERNANDEZ[3], GILBERTO LUIS CAMANHO[4]

SUMMARY

Patellar fractures are prevalent within the age group of 20 – 50 years old and account for 1% of total fractures. They are classified according to 2 major aspects: fracture trace characteristic and bone exposure presence, which drives treatment selection towards the various proposed techniques. This study aimed to investigate the incidence of patellar fractures patterns and to analyze the functional outcomes found with the different treatment modalities at the IOT-HC-FMUSP. One hundred and three files of patellar fracture patients treated at IOT during the period of 1988 – 1999 with a minimum follow-up time of 5 years were gathered. Mean age was 39.4 years old, being 68% males, 51.5% with right side affected, and 2.9% bilateral. Transverse fractures were prevalent (36%); 30% with bone exposure; the most used techniques were: partial patellectomy (46.6%), tension band (20.4%), plastered immobilization (17.5%), cerclage (4.8%), and total patellectomy (2.9%). Outcomes were considered as excellent or good in 57.1% for tension band AO, and in 44.4% for partial patellectomies. It was concluded that the end functional outcome in the patellar fracture treatment is multifactorial; the kind of fracture, the treatment approach (conservative or surgical), age, and the mechanism of trauma, alone, do not influence therapy success.

Keywords: *Fractures; Patella; Motion; Pain*

INTRODUCTION

Patellar fractures account for approximately 1% of all fractures[1], present a higher prevalence within the age group of 20 to 50 years old[1,2] and males are twice more affected than females[2]. The injury mechanism may be either direct - the most common - or indirect[2].

Patellar fractures are classified regarding trace as: transversal, apex, basis, comminuted, vertical and osteochondral, and regarding deviation degree as: deviated and non-deviated, according to the illustrations on Figure 1. Transversal fractures are the most common ones, accounting for 50 - 80% of the patellar fractures[1,2]; comminuted fractures account for 30 - 35%, and the vertical ones for 12 - 17%[1].

Torchia and Lewallen[3] found an open-fractures rate of 7% among patellar fractures, with 14.5% being type-I open fractures, 76.4% type II, 1.8% type IIIA, and 7.3% type IIIB, as per Gustillo and Anderson's classification.

Catalano et al.[4] studied 79 patients with patellar open fractures in a total of 226 patients (34%); 15 of them were type-I open fractures, 53% type II, and 32% type III[4]. Related injuries were present in 79% of the cases, being 44% at the ipsilateral lower limb.

As therapy options we can mention: conservative treatment with joint immobilization, tension band or screw fixation, cerclage, and partial and total patellectomy[5,6]. Historically, patella preservation, whenever possible, is seen as a preferable approach compared to other patellar resection techniques, since a significant loss of the extensor mechanism occurs when the patella is partially or totally excised[7,8].

Marya et al.[9] studied the outcomes of patellar fractures submitted to osteosynthesis and patellectomy, and found 80% of excellent outcomes in the first group and 50% in the second.

Surgical outcomes range from excellent (in 70% or 80%) to fair and bad (in 20% to 30%)[10,11,12]. Nummi, in a long-term follow-up of patients submitted to partial patellectomy, found good to excellent outcomes in 62%, fair in 29% and bad in 9%[2]. Surgical outcomes in a long-term follow-up after total patellectomy are good to excellent in 22 to 85% of the cases and fair or bad in 14 to 64%[1,2].

Torchia and Lewallen[3] noticed that open fractures present a worse prognosis than closed fractures.

Non-union rates for patellar fractures range from 1% to 7%[3,4,13]. Infection rates range from 0% to 5%[3,13,14,15].

Knowing patterns and characteristics of a given kind of fracture in a medical school and highly complex specialized-treatment institution, such as the IOT-HCFMUSP, is important for improving care, for driving future guidelines, and for assessing the kind of service provided. The retrospective study of patellar fractures helps to achieve this.

The objective of the study is to assess the incidence of patellar fractures patterns and to analyze functional outcomes achieved with different treatment modalities at IOT-HC-FMUSP.

CASE SERIES AND METHODS

One hundred and three medical files were obtained from patients with patellar fracture who received healthcare at IOT-HC-FMUSP

Study conducted by the Institute of Orthopaedics and Traumatology, Hospital das Clínicas, Medical College, University of São Paulo (IOT-HC-FMUSP), São Paulo-SP - Brazil.

Correspondences to: Rua José Maria Lisboa, 356, apto 82 – Jardim Paulista – 01423-000 - São Paulo/SP – e-mail:alexandrelemegodoy@gmail.com

1. *Resident Doctor, Department of Orthopaedics and Traumatology*
2. *PhD Doctor, Assistant to Knee Group*
3. *Full Professor and Head of the Knee Group*
4. *Full Professor and Head of Specialties Group*

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within the period of 1988 to 1999 and with a minimum follow-up time of 5 years. It is believed that the number of healthcare provided on this pathology at the ER-IOT in the same period is higher, however, one must consider that the referral of patients with less complex fractures to secondary services of the public hospitals network is very common in this quaternary institution.
The analysis of medical files was performed according to the following protocol.

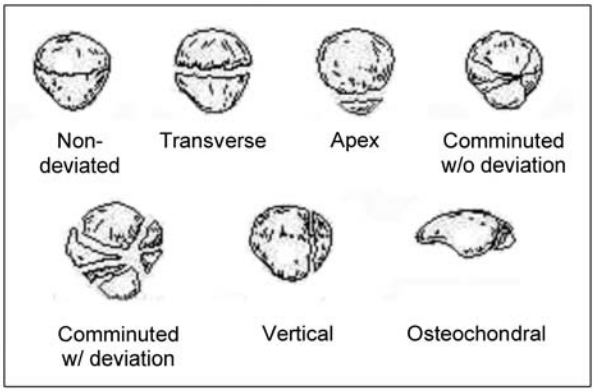

Figure 1 - *Classification of patellar fractures*

techniques.
Those cases treated and followed up at IOT were analyzed regarding the presence of pain and range of motion, considering a non-restricted range of motion when this was higher or equal to 135°, somehow restricted range of motion when this was higher or equal to 90° but lower than 135°, and a restricted range of motion when this was lower than 90°.
Treatment final outcomes were subdivided into 4 groups:

- ID
- Gender
- Age
- Affected side
- Trauma mechanisms
- Types of Fractures – x-ray classification
- Open/ closed fracture
- Infection
- Related injuries
- Types of treatment
- Time elapsed until knee mobilization
- Union rate
- Treatment outcomes: presence or absence of pain
- Treatment outcomes: range of motion (ROM)

Open fractures were subdivided into type I, II, IIIA, IIIB, and IIIC, according to Gustillo and Anderson classification.
Trauma mechanism was categorized as: direct falls (simple falls) - DF -, high falls - HF -, car accidents - including motorcycle, car, and trampling - gun shots - GS - and indirect trauma (forced flexion) - IT.
Fractures were classified regarding type as: transverse, apex, basis, vertical, non-deviated comminuted, deviated comminuted and related.
The presence of related injuries was assessed, including any other kind of fracture or traumatic injury occurred as a result of the accident, which were divided into three groups:
1. without related injuries affecting lower limbs (in this group, the cases without related injuries or those with related injuries affecting only upper limbs, trunk or skull are included);
2. related injuries affecting the lower limb at an ipsilateral plane to patellar fracture;
3. related injuries affecting the lower limb at a contralateral plane to patellar fracture.
The kinds of treatment for patellar fractures were divided into: plastered immobilization, partial patellectomy, total patellectomy, tension band fixation, screw fixation, cerclage, and combined

A. no pain and with a ROM >= 135° - excellent
B. no pain and with a ROM >= 90° and < 135° - good
C. no pain and with a ROM < 90°, with pain and ROM >= 90° - fair
D. with pain and ROM < 90° - bad

P values were analyzed by using the "chi-square" test and the Fisher's test at a significance level of <0.05.

RESULTS

The analysis of gathered data revealed that the average age in cases of patellar fractures was 39.4 years old, ranging from 13 to 87 years old; 32% of the cases (33/103) were females and 68% (70/103) were males. The right side was the most affected one, in 51.5% (53/103) of the cases; the left side was affected in 45.6% (47/103), and bilaterally in 2.9% (3/103).
Direct falls accounted for 43.7% (45/103) of the cases, followed by car accidents 33% (34/103), high falls 10.7% (11/103), trampling 6.8% (7/103), GS 3.9% (4/103) and forced flexion 1.9% (2/103).
According to the x-ray classification, we found 37 (36%) transverse fractures, 24 (23.3%) deviated comminuted fractures, 20 (19.4%) apex fractures, 9 (8.7%) non-deviated comminuted fractures, 6 (5.8%) vertical fractures, 3 (2.9%) basis fractures and 4 (3.9%) related fractures.
Bone exposure was present in 30% of the cases (31/103). From these, five patients (16.1%) presented with type I open fractures, 16 (51.6%) type II, 5 (16.1%) type IIIA, 1 (3.2%) type IIIB case and 4 (13%) cases with non-specified open fracture. No IIIC-type fracture was found. Postoperative infection occurred in 6.8% (7/103) of the cases.
Related fractures were present in 36% (37/103) of the cases. According to the proposed division, 73.8% (76/103) of the cases belonged to group I, 15,.5% (16/103) to group II, and 10.7% (11/103) to group III.
Treatment performed was partial patellectomy in 46.6% (48/103) of the cases, tension band fixation AO in 20.4% (21/103), plastered immobilization in 17.5% (18/103), cerclage in 4.8% (5/103), total patellectomy in 2.9% (3/103), screw fixation in 1% (1/103) and combined methods in 6.8% (7/103).
Early mobilization (less than 2 weeks of immobilization) was performed in 17.5% (18/103) of the cases. Late mobilization (3 or more weeks of immobilization) was present in 60.2% (62/103) of cases. In 22.3% (23/103) of the cases, the evaluation was not possible. There was no union failure in the 103 cases studied.

After a minimum follow-up time of 5 years, 38 patients (36.9%) presented some degree of pain and 60 cases (58.3%) did not complain about pain in the knee. In five time points (4.8%) evaluation was not possible.

Range of motion was higher or equal to 135° in 12 cases (11.7%), higher or equal to 90° and lower than 135° in 57 (55.3%), and lower than 90° in 25 patients (24.3%); for 9 medical files (8.7%) evaluation was not possible. Thus, according to the functional final outcome, we found: 11 in group A (10.7%), 36 in group B (34.9%), 32 in group C (31.1%) and 15 in group D (14.6 %). In 9 patients (8.7%) data were not enough for classification.

For statistical analysis, fractures were initially classified into 2 groups, according to the degree of trauma energy: low energy (caused by direct fall - simple falls) and indirect trauma (forced flexion); and high energy, caused by high falls, car accident and GS. These groups were correlated to the kind of fracture - comminuted, transverse, and apex by the highest level of incidence - and patients' ages. Results are shown on Tables 1 and 2.

The same kinds of fractures mentioned above were compared to age and exposure presence and represented on Tables 3 and 4.

Transverse and comminuted fractures were further compared to related injuries (Table 5), with groups 2 and 3 of related injuries being combined (no statistical difference was found between group 2 and 3 when separately compared) and to types of treatment - partial patellectomy and tension band AO (Table 6).

The degree of ROM was correlated to the time elapsed until the beginning of knee mobilization (Table 7), this being divided into early (up to 2 weeks) and late (more than 2 weeks).

Finally, the time for mobilization was compared to related injuries and the final outcome was compared to related injuries, exposure presence, trauma mechanisms, types of fractures, age, and types of treatment. In all analyses no statistically significant values were evidenced when separately compared ($p >$ 0,05). Values were not changed when pain and ROM were withdrawn from final outcome data and separately correlated (except for ROM and time for mobilization, according to above mentioned).

	Comminuted	Transverse	Apex
LOW ENERGY	9	22	10
HIGH ENERGY	24	15	10

$x^2 = 7.491$ GL = 2 $p = 0.024$

DF: direct fall; HF: high fall; GS: gun shot
LOW ENERGY: DF and INDIRECT (forced flexion)
HIGH ENERGY: HF, CAR ACCIDENT (car, motorcycle, and trampling), and GS

Table 1 - *Distribution of types of fractures by trauma mechanism*

	LOW ENERGY	HIGH ENERGY
13 to 30	6	33
31 to 50	21	17
51 to 87	19	7

$x^2 = 23.748$ GL = 2 $p < 0.001$

Table 2 - *Distribution of age by trauma mechanism*

	Comminuted	Transverse	Apex
13 to 30	17	11	2
31 to 50	11	13	12
51 to 87	5	13	6

$x^2 = 11.988$ GL = 4 $p = 0.017$

Table 3 - *Distribution of age by types of fractures*

	Comminuted	Transverse	Apex
Open	15	4	5
Closed	18	33	15

$x^2 = 10.742$ GL = 2 $p = 0.005$

Table 4 - *Distribution of exposure by types of fractures*

	Transverse	Comminuted
1	30	19
2 + 3	7	14

$x^2 = 3.538$ GL = 1 $p < 0.060$

Table 5 - *Distribution of related injuries by types of fractures*

	Partial Patellectomy	Tension Band AO
Transverse	10	16
Comminuted	14	5

$x^2 = 4.148$ GL = 1 $p < 0.042$

Table 6 - *Distribution of types of fractures by treatment*

DISCUSSION

The mean age in those mentioned cases and the higher incidence in male patients reinforce literature data, also agreeing with the absence of a prevalent affected side and a low incidence of bilateral fractures (2.9%)[1,2].

Gathered data reveal similar incidence rates for transverse and comminuted fractures: 36% and 32%, respectively, which slightly differ from mentioned data[1,2]. The lower incidence rate of transverse fractures - low energy - in the studied population may denote the profile of patients receiving healthcare at IOT-HC-FMUSP, victims of high-energy trauma with highly complex related injuries.

The rate of open fractures - 30% - found is similar to that of Catalano et al.[4], as well as its distribution by types according to Gustillo and Anderson's classification. From these 37 cases of open fractures, 16.1% were type I - Catalano et al. =15% ; 51.6% type II - Catalano = 53%; and 32% type III - Catalano = 32%.

	I (< 90º)	II (90 - 135º)	III (> 135º)
Early	4	10	6
Late	18	38	5

$\chi 2 = 6.158$ GL = 2 $p = 0.046$

Table 7 - *Distribution of time for mobilization by final ROM*

The number of postoperative infection cases (6.8%) was higher than that described in literature (0 to 5%)[3,10]. Pseudoarthrosis rate was lower: we had no case of non-union among the 103 cases studied, while in literature, a pseudoarthrosis rate of 1 to 7% is reported[3,4,13].

In literature, the presence of related injuries may reach 74% when only patellar open fractures are considered[3]. In this study, we found 58.1%. When considering the total number of patellar fractures, related injuries were present in 36%. No data was found in literature regarding related injuries versus total number of patellar fractures.

According to function and pain evaluation after treatment, good to excellent outcomes were found in 50% of the cases, and the other 50% were considered as fair or bad. Those values contrast with the data found in literature, of 70 to 80% good-to-excellent outcomes against 20 to 30% of fair-to-bad outcomes[2]. A result that, again, could be justified by the trauma mechanism pattern, typical of patients receiving healthcare at IOT-HC-FMUSP.

By analyzing gathered data, we saw an association between:

1) trauma mechanism and kind of fracture, being low-energy fractures associated to transverse, high-energy fractures with comminuted ($p = 0.024$);

2) age and trauma mechanism, being low-energy trauma associated to an age higher or equal to 51 years old and high-energy trauma being associated to young individuals up to 30 years old ($p < 0.001$);

3) age and kind of fracture, being transverse fractures associated to an age higher or equal to 51 years old and comminuted fractures associated to young individuals up to 30 years old ($p = 0.017$);

4) exposure and kind of fracture, being comminuted fracture mostly correlated to open fractures and transverse fractures correlated to closed fractures ($p = 0.005$);

5) time for mobilization and ROM, with early mobilization cases presenting better ROM degrees, and late mobilization presenting poorer degrees ($p = 0.046$); that is, the early mobilization determined better degrees of range of motion, and not necessarily absence of pain and the best outcomes.

On the other hand, treatment final functional outcome cannot be separately determined by trauma mechanisms ($p = 0.703$), by types of fractures ($p = 0.558$), by related injuries ($p = 0.237$), by age ($p = 0.678$ and p = 0.139), by patellar open fracture ($p = 1.0$) or by the kind of treatment ($p = 0.486$).

The presence of related injuries did not influence the time for knee mobilization ($p = 0.331$). We would like to highlight that individuals with patellar fractures and related fractures are as twice as likely to achieve poor outcomes against good outcomes; while isolated injury cases have a higher number of good outcomes, despite of not being statistically significant.

It is expected that, in a quaternary and educational institution – with highly complex cases - such as the IOT-HC-FMUSP, final functional outcomes are worse than those described in literature.

The final functional outcome seems to be determined by multiple variables acting in conjunction and thus justifying the absence of a statistically positive correlation when separately assessed.

CONCLUSION

It is not possible to identify an isolated factor determining the final functional outcome in patellar fractures treatment.

Transverse fractures occur in older individuals through a low-energy mechanism, are closed and treated with tension band AO; however, they do not necessarily present the best outcomes.

Comminuted fractures are often caused by high-energy trauma, in young individuals, being preferably treated with partial patellectomy and not necessarily present bad outcomes.

Early mobilization provided good outcomes, because it allows for a wider ROM. Nevertheless, this did not prevent from pain.

Late mobilization undoubtedly determined a stronger joint stiffness.

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