

Fractures of Patella: Prospective Analysis of a Series of 51 Cases

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Abstract

Introduction: The patella is a key component of the knee's extensor system. Fractures of the patella can be treated using a variety of methods. The objective of this study was to describe the epidemiological, anatomical-clinical, therapeutic and evolutionary aspects. **Methods:** This was a prospective, observational, analytic study conducted from January 2018 to December 2021. It concerned all patients over 15 years of age treated surgically for a patella fracture. The variables to be studied were epidemiological, anatomo-clinical, therapeutic and evolutionary. Statistical analysis was performed using the Chi-square test and Fisher's exact test. **Results:** It concerned 51 cases. There were 39 men and 12 women. The average age was 35.13 years. The fracture was caused in 78.5% of cases by a road traffic accident. The main fracture was transverse (49.1%). Tension band technique predominated (92.1%). Complications included superficial suppuration (n = 7) and irritation of the material (n = 7). Mean time to consolidation was 66.39 days. Bösman scores were Excellent (n = 23; 45.10%). Some patients presented osteoarthritic knee symptoms (n = 14; 27.45%), and no pseudarthrosis. **Conclusion:** Patella fractures are rare. Surgical treatment gives good results, and the choice of method depends essentially on the anatomo-clinical characteristics of the fracture. Kinesitherapy is an essential and important weapon in functional recovery.

Keywords

Patella, Fracture, Haubanage, Patellectomy, Kinesitherapy

1. Introduction

Patella is the largest sesamoid bone. It is subcutaneous and located on the anterior face of the knee [1] [2]. As a key component of the knee's extensor mechanism,

its fractures were treated with cast immobilization until the end of the 19th century. Failures due to this type of treatment had given them the title of severe fractures [2]. Their treatment became surgical with specific factors, the most important was a rupture of the extensor mechanism. Several surgical techniques (bracing, screwing, bolting, etc.) have been used in the search for an osteosynthesis with sufficiently strong fixation [1] [3]-[9]. The implementation of the figure-of-eight fixation technique (haubanage) has overcome many of these limitations and has enabled early mobilisation [3] [4] [6] [7]. In the case of comminuted fractures, where conservative treatment was not possible, partial or total patellectomy was performed [3].

All these therapeutic developments reflect the functional importance of the patella. Despite this considerable impact on the function of the knee extensor mechanism, there seems to be little literature on patella fractures [10]-[12]. While new techniques are gradually being developed, haubanage, described as the technique of choice, is still taught and practised in Ivory Coast [3] [8]-[10] [12]. Also, haubanage appears to be described only for transverse fractures [3] [7] [8]. No local therapeutic algorithm has been described in previous studies [12]. There was a need for a study of patella fractures requiring surgical treatment. The objective was to describe their epidemiological, anatomical-clinical, therapeutic and evolutionary aspects.

2. Methods

This was a prospective, observational and analytical study conducted over 4 years, from January 2018 to December 2021. It included all patients over 15 years of age admitted for a patella fracture that was treated surgically. Criteria for surgical treatment were cutaneous opening, diastasis ≥ 3 mm, incongruity of the articulation ≥ 2 mm and/or interruption of the knee extensor mechanism [7] [13]. There were not included patients who refused surgical treatment ($n = 22$) and cases treated orthopedically ($n = 03$), including one patient aged 71 and two patients aged 15 and 17.

Bone lesions were documented by Neyret's morphological classification [14]. Cutaneous lesions were documented using Tscherne [15] and Cauchoix—Duparc [16].

The surgical treatment objective was to obtain stable fixation for early mobilization and to avoid secondary displacement [10]. Several techniques were used to restore continuity of the knee extensor mechanism [3]. These included the tension band in figure of eight technique (haubanage), the cerclage wiring, partial patellectomy and trans-osseous sutures [1] [4]-[6] [17]-[19].

In simple fractures, haubannage with two wires and a steel wire were sufficient for reduction. In multifragmentary cases, additional wires were used and remained until the material was removed [9] [19]. In cases of loss of bone substance or necrosis of fracture fragments, partial patellectomy was indicated [2] [9]. Treatment of open patella fractures followed the same algorithm as for open long bone

fractures [16].

The osteosynthesis was combined with a fenestrated plaster knee cast on the anterior side of the knee to allow for wound dressing. The knee cast was removed at D30, unless consolidation was evident on radiographic images. As from removal, passive and active reeducation exercises were conducted by a physiotherapist [20].

All patients were followed up at regular intervals of thirty days, by clinical examination and standard knee X-rays. The results were evaluated 12 months after surgery. Functional results were evaluated using the Bösman score [21]. Anatomical results, based on restoration of articular congruence and patella level, were assessed by the Caton-Deschamps index [22].

The variables studied were collected in a Microsoft Access database. Statistical analysis was performed using Epi Info 7, with Chi-square and Fisher's exact tests. Statistically significant relationships with functional outcome were researched.

3. Results

There were 76 cases of patella fractures out of 1759 cases of trauma fractures, corresponding to a frequency of 0.05%. In accordance with our inclusion criteria, 51 cases were selected.

There were 39 men and 12 women. The mean age was 35.13 ± 11.92 years (19 - 65).

The fracture was caused in 78.5% (n = 40) by a road traffic accident. The injuries circumstances are listed in **Table 1**.

Table 1. Patient distribution according to injuries circumstances.

INJURIES CIRCUMSTANCES		VALUES
Road traffic accidents	Motorbike-Motorbike	16; 31.4%
	Motorbike-Car	9; 17.8%
	Motorbike-Pedestrian	5; 9.8%
	Car-Pedestrian	2; 3.9%
	Motorbike fall	4; 7.8%
	Dashboard accident	4; 7.8%
Workplace accidents		5; 9.8%
Falling from height		3; 5.9%
Aggressions	White weapon	2; 3.9%
	Firearm	1; 1.9%
TOTAL		51; 100%

The professions of the patients are listed in **Table 2**.

Table 2. Distribution of patients by profession.

PROFESSIONS	VALUES
University students	8; 16.2%
Artisans (coal. metal. brick. mechanical)	7; 13.9%
Businessmen	7; 13.9%
Motorbike drivers	6; 12.1%
Agricultural workers	6; 12.1%
Housewives	5; 9.9%
Military corps (soldiers. gendarmes)	3; 6.1%
Administration official	3; 6.1%
Teachers	2; 3.9%
Animal farmers	2; 3.9%
Students	1; 1.9%
TOTAL	51; 100%

According to the post-traumatic cutaneous aspect, the fractures were represented in **Table 3**.

Table 3. Distribution of patients according to the cutaneous aspect of the knee.

CUTANEOUS ASPECT OF THE KNEE		VALUES
Closed fractures	Tscherne 0	8; 15.8%
	Tscherne 1	7; 13.8%
	Tscherne 2	4; 7.8%
Opened fractures	Cauchoix – Duparc 1	14; 27.4%
	Cauchoix – Duparc 2	14; 27.4%
	Cauchoix – Duparc 3	4; 7.8%
TOTAL		51; 100%

In open fractures, there was bone substance loss (n = 5). The fractures were closed and opened (**Figure 1**).

By Neyret's morphological classification, the fracture was transverse (n = 25; 49.1%), comminuted (n = 20; 39.2%) (**Figure 2**), vertical (n = 3; 5.9%), marginal (n = 1; 1.9%), osteochondral (n = 1; 1.9%) and at the tip of the patella (n = 1; 1.9%).

Associated fractures concerned the tibial plates (n = 4) and the distal femur (n = 6). There was a floating knee (n = 2). The femoral (n = 1) and tibial (n = 1) diaphyses were fractured. Intraoperative damage to the lateral meniscus (n = 7) and both menisci simultaneously (n = 5) was noted.

Some patients had a healthy knee before the trauma (n = 36). The other cases were characterized by gonarthrosis (n = 12), old trauma to the knee without fractures (n = 2) and treated and healed osteoarthritis of the knee (n = 1).

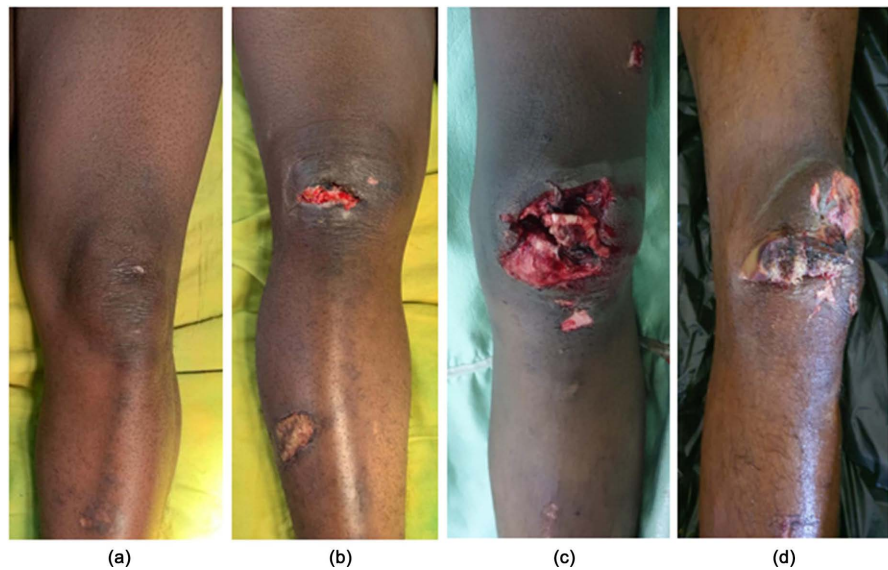


Figure 1. Closed and opened fractures of patella: (a) Tscherne 0 (dashboard accident); (b) Cauchoix—Duparc Type 1 without bone substance loss (fall in height); (c) Cauchoix—Duparc Type 2 without bone substance loss ((traffic road accident); (d) Cauchoix—Duparc Type 2 with bone substance and cutaneous loss (traffic road accident).



Figure 2. Standard knee X-rays: comminuted fracture (ballistic origin) with bone substance loss.

The mean time to treatment was 23.70 ± 15.32 hours (4; 79).

Surgical methods included simple haubanage ($n = 33$; 64.7%) (**Figure 3(a)**), haubanage with additional Kirschner wire ($n = 9$; 17.6%), and haubanage with cerclage wiring ($n = 5$; 9.8%). There were cases of partial patellectomy ($n = 2$; 3.9%) (**Figure 3(b)**). Some cases required transosseous suture with absorbable suture ($n = 2$; 3.9%).

The mean hospitalisation time was 4.45 ± 1.5 days (3 - 8). Radiographic signs favourable to the beginning of bone callus, with the appearance of a bony cloud, were visible at D30 post-op in all patients. Passive and active knee rehabilitation exercises were started as soon as the knee cast was removed on D30 post-op. The

complications observed were superficial suppuration (n = 7), all due to staphylococcus aureus, and irritation of the fixation materials (n = 7).



Figure 3. Post-operative knee X-ray. (a) Haubanage of vertical line fracture of patella; (b) haubanage-cerclage wiring and partial patellectomy of a comminuted fracture with bone substance loss.

The mean time to consolidation was 66.39 ± 15.25 days (45 - 96).

The osteosynthesis material was removed in all patients from the 6th month post-op. There were no cases of fistulas or suppuration of the fixation materials.

At 12 months post-op, the Caton-Deschamps index of patella height was comparatively normal (n = 46; 90.2%), low (n = 2; 3.92%) and high (n = 3; 5.88%). High and low patella were observed in patients with bone loss. The mean Bösman score was 26.04 ± 3.87 [16] [23]. Anatomical and functional results according to Bösman were Excellent (n = 23; 45.10%), Good (n = 26; 50.98%) and Unsatisfactory (n = 2; 3.92%). The Bösman score according to knee history, osteoarticular lesions and meniscus injuries was listed in **Table 4**.

Table 4. Distribution of Bösman Score according to the anterior condition of the knee, the osteoarticular and meniscal lesions of the trauma.

		BOSMAN SCORE			VALUES
		Excellent	Good	Unsatisfactory	
PREVIOUS KNEE INJURIES	Healthy knee	23	11	2	36
	Gonarthrosis	0	12	0	12
	Osteoarthritis of the knee	0	1	0	1
	Old knee trauma	0	2	0	2

Continued

	None	22	15	0	37	
ASSOCIATED OSTEO-ARTICULAR INJURIES	Diaphyseal femur fractures	1	3	0	4	51
	Distal femur fractures	0	3	0	3	
	Tibial plate fractures	0	3	1	4	
	Diaphyseal tibial fractures	0	1	0	1	
	Floating knee	0	1	1	2	
	None	23	16	0	39	
MENISCUS INJURIES	External meniscus	0	7	0	5	51
	Internal and external menisci	0	3	2	4	

Knee amplitudes were between 90° - 120° (n = 25; 49%) and greater than 120° (n = 26; 51%). Some patients presented with symptoms of arthrosis of the knee (n = 14; 27.45%) and there was no pseudarthrosis. In **Table 5**, significant statistical links were found between functional knee results and previous knee injuries, associated osteoarticular injuries, meniscus injuries and patella height.

Table 5. Statistical analysis for significant links to functional knee results.

		Excellent (Bösman score: Excellent)	Acceptable (Bösman score: Good, Unsatisfactory)	Statistical tests (n = 51; α = 5%; ddl = 1)
PREVIOUS KNEE INJURIES	Healthy knee	23	13	$p = 0$
	Gonarthrosis	0	12	$p = 0.0002$
	Osteoarthritis of the knee	0	1	$p = 1$
	Old knee trauma	0	2	$p = 0.4949$
ASSOCIATED OSTEO-ARTICULAR INJURIES	No osteoarticular injuries	22	1	$\chi^2 = 11.28$
	Osteoarticular injuries	15	13	$p < 0.001$
MENISCUS INJURIES	No meniscus injuries	22	17	$\chi^2 = 8.567$
	Meniscus injuries	1	11	$p < 0.01$
HEIGHT OF PATELLA	Standard	23	23	$p = 0.0562$
	Unusual (high, low)	0	5	

There was a statistically significant link between functional knee outcome and pre-fracture gonarthrosis, associated osteoarticular injuries and meniscus injuries. There was no significant link between functional knee outcome and patella height.

4. Discussion

Patella fractures were rare, representing 1% of all skeletal injuries [13] [24]. The literature on clinical, radiological and functional results is not very rich [25].

They generally resulted from direct impact and, as in most studies, were caused by traffic accidents involving motorbikes [12] [24]. All professions were affected, with a male predominance and an average age of 38 years [12]. These results were justified by the high incidence of motorbike transport, which is popular with this young population, who are the most active. These epidemiological results were in agreement with several authors [26]-[28]. The transverse line remained the most frequent [12] [24] [25] [29].

The functional results of the knee were similar to other authors, and there was no pseudarthrosis or dismantling of material [10] [12] [13] [25] [29] [30]. Osteoarthritis symptomatology at 27% was similar to Gwinner's in Berlin, which ranged from 15% to 30%; and lower than Lazaro's in New York at 80% [25].

Low complications are generally due to good therapeutic indications. Although there is no consensus about the ideal technique of fixation, the indication was based on the type of fracture [4]-[6] [8]-[11] [19]-[25] [31] [32]. The most commonly used technique was haubanage, this technique was best satisfied the treatment objectives. The stainless steel wire provides strong compression of the fracture site, making it possible to start early re-education without risk of dismantling as of D30 [7] [33].

Prolonged immobilisation is one of the causes of reduced amplitude of movement in the knee. Haubanage allows traction forces to be transformed into compression forces, which prevents secondary diastasis [11]. Other studies have waited up to 6 weeks [8]. Rehabilitation started as early as the 4th week had given good and excellent functional results. This biodynamics of haubanage also facilitated the absence of secondary displacement, as evidenced by the fact that no pseudarthrosis was observed [9] [25]. The reduction in muscular strength was negligible, probably due to the kinesitherapy and early removal of the implants [9] [25]. Loss of knee movement was more related to associated lesions [20]. Nikiforidis stated that locoregional traumatic injuries can lead to subcutaneous and intra-articular adhesions resulting in limited amplitudes of the knee [34].

In the same ways as associated osteoarticular fractures have been identified as factors with an unsatisfactory functional outcome [25], meniscal lesions could be at the root of osteoarthritic symptoms, especially if there is normal alignment of the patella [20] [32]. Cases of gonarthrosis were found in patients with a history of osteoarthritic symptoms and/or an associated fracture of the femoral condyles. Similar to Yercan, the lateral side was the most affected, and the causes of the pain were still unclear [32]. Intraoperative lesion assessments also showed preferential involvement of the lateral meniscus.

Patellectomy should remain the exception, as it gives poor functional results for the knee [7] [19]. It leads to a reduction in the isokinetic strength of the knee's extensor mechanism, with resection which reduces the extensor mechanisms [8] [18]. Patellectomy was performed in cases of comminuted open fractures with bone fragments of uncertain quality. The high velocity of trauma leading to comminuted fractures also damaged soft tissue. The blood supply to the bone fragments

was cut off, and the fracture fragments were more likely to become necrotic or sequestered. This was not a preferred choice, especially as these were cases of open fractures, preventing conservative treatment as in the case of closed fractures [9] [11]. The clinical case reported by Zhang could be applied in a future study. Its 3-stage management should be explored further in order to limit the need for patellectomy [35].

In cases of transosseous sutures, the quality of braided wire fixation had been shown to be similar to that of steel [7] [13]. Their indications remained limited to small fragment and non-articular fractures (osteochondral and tip). The advantage of non-metallic implants was that no removal was necessary without causing functional complications [24] [25].

Metal implants can rupture and protrude over time, causing pain and skin irritation [1] [30]. These are precursors of fistulas [9] [13] [30] [31]. It was important to bend the ends of the wires posteriorly at distal level, since this reduces irritation and migration [6] [31]. In almost all patients, implant-related pain was negligible [9]. Wire irritation at 10% was close to that of Heusinkweld [30].

The mean time to consolidation and the functional results of the knee were similar to other studies [11] [12] [19] [29] [30].

For patella height, comparative images were used to minimise bias due to the variable shape and initial position of the patella. The heights did not vary after osteosynthesis [29]. The differences in these criteria were significant in cases of partial patellectomy [20]. Also, the height of the patella had no impact on the functional outcome of the knee [29]. This result is probably justified by the fact that all patients received regular and early kinesitherapy [9] [19].

Patella fractures did not require long post-operative hospitalisation [3] [12] [29]. These fractures had a low rate of infection [25] [30]. Patella fractures were characterised by almost zero lethality. Patients were released on the third day after the first wound dressing.

This study had limitations. It was monocentric and its population was small. The population was limited to cases of patella fractures requiring surgery, unlike other studies in the literature which explored all types of fracture. A single model for collecting data was used to minimise any possible bias.

5. Conclusions

Patella fractures are rare. Road traffic accidents are the main cause. Transverse fractures are the most common.

The choice of technique depends essentially on the anatomical and clinical features of the fracture. While the current trend is towards minimally invasive approaches and resorbable implants rather than conventional methods, the cable-stay technique is still the most widely used and gives good results. Conservative treatment remains the ideal option. Partial patellectomy appears to be the only solution when it is used. Its poor functional results should lead to a search for a palliative solution. The functional outcome of the knee is not only linked to the

surgical technique. It also depends on the anterior arthrosis knee status, associated osteoarticular and meniscal lesions. Kinesitherapy is an essential and important implement in functional recovery.

Authors' Contributions

OCHOU JR Pierre Germain: data collection, data analysis, writing the manuscript.

KOUASSI Adélaïde Aya Natacha: data analysis, writing the manuscript.

AKOBE Achie Jean Régis: data analysis, writing the manuscript.

SORO Colleague Marcel: data collection, reading and correction of the manuscript.

SOUMAHORO Ibrahim: data collection, reading and correction of the manuscript.

KODO Michel: reading and correction of the manuscript.

Conflicts of Interest

All the authors declare no conflict of interest in the process of researching and writing the article.

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