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"Floating Knees": Epidemiological, Clinical, Therapeutic and Prognostic Study of 67 Cases

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Abstract

The floating knee is a simultaneous homolateral fracture of the femur and tibia separating the knee joint from the rest of the lower limb. Our work aims to study the epidemiological, clinical, therapeutic and prognostic aspects of patients with floating knee surgery in the Clinic of Traumatology and Orthopedics of Hôpital Principal Dakar (HPD), a reference trauma center from January 2008 to December 2021. We conducted a retrospective, discontinuous study that included all patients who were operated on and followed up at DMH with 67 patients with complete records. The data was entered on Epi info 7 via a computerized observation sheet and the analysis was carried out by Epi info and Excel 365. The average age of our patients was 36.58 years old with a sex ratio of 5.27. Road traffic accidents were causes of 92.53% of cases. Floating knees were open in 65.7% of cases. Floating knees were classified according to Fraser: 49.3% type I, 17.9% type IIa, 8.9% type IIb and 6% type IIc with 13 unclassifiable lesions. The floating knee was part of a polytrauma in 44.8% of cases with an average clinical severity score of 18.1. The most commonly used treatment methods were centromedullary clamping for the femur (38.8%) and external fixation for the tibia 41.8%. The functional outcomes assessed by the Karlstrom score were excellent in 16.67% of cases, good in 30% of cases, average in 30% of cases and 23.33% of poor results.

Keywords

Floating Knees, Road Traffic Accident, Polytraumatized

1. Introduction

A floating knee is the combination of a tibia fracture and a femur fracture in the

same limb. This concept was described by McBryde in 1975 [1]. It is referred to as a "floating knee" or "flail knee" by Anglo-Saxons. The term means that the knee is free between the two discontinuities. These lesions were isolated because of their severity, their difficult treatment and often their poor results. Floating knees often occur during high-energy trauma and in the context of polytrauma. Many authors have emphasized the frequency of associated lesions (polytrauma, skin openings, damage initial control necessary) as a consequence of high-energy trauma, and the high risk of complications and serious functional after-effects. The circumstances of occurrence are dominated by road traffic accidents (RTAs), primarily involving two-wheeled vehicles and pedestrians [2]-[6]. In order to improve the results, the 1980s saw the widespread use of systematic surgical management of these lesions. Treatment is essentially surgical with intramedullary nailing and sometimes with the temporary placement of an external fixator given the severity of the associated lesions occurring in the context of polytrauma (25% of cases) [5]. Open floating knees and Fraser type II are associated with the worst results [2] [5]. In Africa, the majority of studies found concern the Maghreb countries. The literature on this condition is sparse in West Africa. Studies on floating knees in Senegal are few.

The goal of this work is to study floating knee from its epidemiological, clinical, therapeutic and prognostic aspects in order to improve management.

2. Methods

This was a single-center, retrospective, discontinuous study. It took place within the Clinic of Traumatology and Orthopedics of Hôpital Principal Dakar (HPD). Our study took 11 years: from January 2008 to December 2015 and from January 2019 to December 2021. We included any patient with a floating knee, treated at the DMH during the study period and with usable medical records: medical record with all required data (civil status, clinical and therapeutic data) or reachable patient in case of missing data. Any patient under 16 years of age and any patient who didn't come to the follow-up after surgery were not included. Seventy-nine records were collected, of which 12 were unusable or untraceable. Sixty-seven records were retained for data collection.

The variables studied included:

- Epidemiological data: frequency, gender, age (according to WHO), and circumstances of onset

- Clinical and radiological data: affected side, the existence of associated injuries and their classification (Injury Severity Score: ISS [7]), fracture site, and floating knee classification (Fraser [8], Blake and McBryde [1]). An ISS of 18 is considered polytrauma.

- Treatment modalities (expectant treatment; tactics, chronology, and operative methods)

- Progression modalities: consolidation, complications, and functional assessment using the Karlstrom score [9].

Data were collected using staff and operating room registers plus a data collection sheet. Data entry and processing were performed using Epi info 7 statistical software. Data were analyzed using Epi info 7, Word, and Excel 365; we primarily performed descriptive and univariate analyses.

3. Results

We found an average of 7 cases per year. Floating knees affected at least 1.2% of traumatic injuries treated in 2020 and 2021. The average age was 36.58 years. The extremes were 16 and 77 years. Young and middle adults represented 95.52% (64 patients) of the population (Figure 1). Men accounted for 84.06% of the series, with a male/female sex ratio of 5.27. The circumstances of occurrence were road traffic accidents (RTAs), workplace accidents (WA), falls, and aggressions. Sixty-two floating knees were related to road traffic accidents, representing 92.53% of cases (Figure 2). Twenty-six RTAs (41.9%) involved passengers or drivers of 2-wheeled vehicles and pedestrians were involved in 22 patients (35.5%). Pedestrians were struck by 2-wheeled vehicles in 68.18% of cases (15 patients). Left-sided injury was found in 52.24% of cases (35 patients). One patient had bilateral floating knee. Forty-four patients had skin openings, or 65.7%. The 72.7% of skin openings were located only on the tibia and 11.4% on both the femur and the tibia. Six femoral skin openings were Cauchoix and Duparc type I (50%). Twenty (54%) skin openings on the tibia were type II (Table 1). Twenty-one patients (31.3%) had locoregional lesions associated with floating knee. Among these patients, we found: 4 nerve injuries (6%), 5 vascular injuries (7.5%) and 5 ligament injuries (7.5%). Seven patients (10.5%) had an ipsilateral patella fracture associated with a floating knee. Forty-three patients (64.2%) had associated remote injuries, including 13 with multiple fractures (19.4%) and 30 with multiple trauma (44.8%).

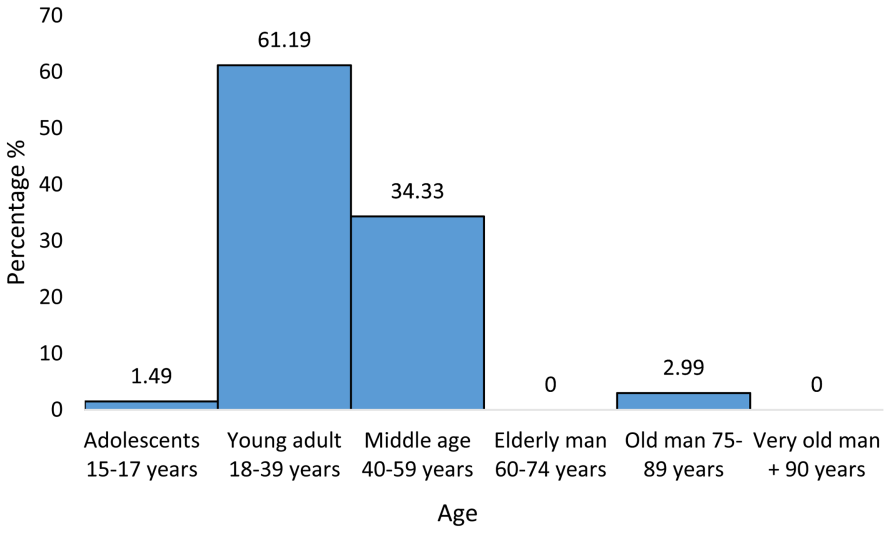

Figure 1. Distribution by age according to WHO N = 67.

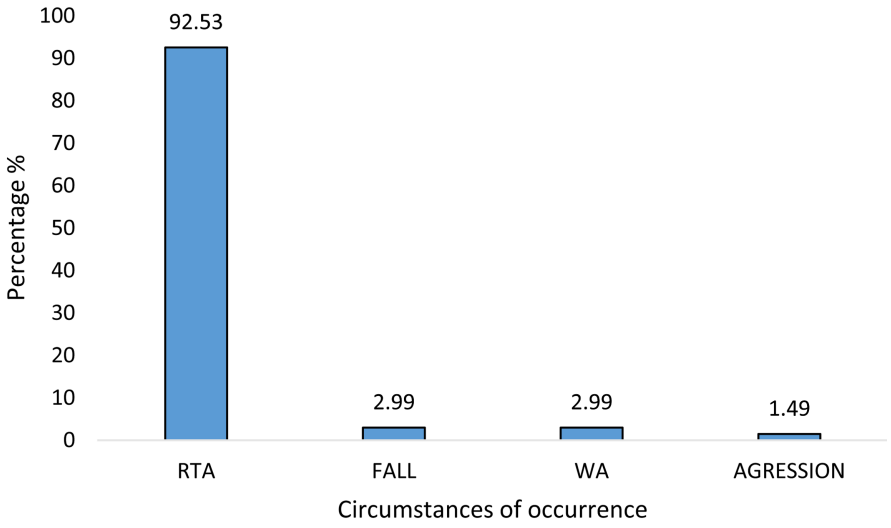

Figure 2. Distribution by circumstances of occurrence N = 67.

Table 1. Distribution of open fractures according to Cauchoix and Duparc classification (including the 5 open floating knees at the femur and tibia) n = 49.

Location	Number	Classification of Cauchoix and Duparc (%)					
		Type I		Type II		Type III	
		n	%	n	%	n	%
Femur	12	6	50.0	4	33.3	2	16.7
Tibia	37	10	27.0	20	54.0	7	19.0

The associated remote injuries were located in the soft tissues in 77.6% of cases, and in the limbs and girdles in 55.2%. The average injury severity score was 18.1 with extremes ranging from 8 to 36. The condition of 15 patients (22.4%) among the trauma patients required a stay in intensive care. The fractures were diaphyseal at the level of the femur and tibia in 79.1% (53 patients) and 67.2% (45 patients) respectively. Fraser type I was diagnosed in 43.3% (29 patients). Thirteen floating knees involved the hip or ankle joint (Table 2). The 12 floating knees not classifiable according to Fraser could be classified according to Blake and McBryde. There was one floating knee associating a multifocal fracture (diaphyseal and epiphyseal) to the femur (Table 3). The waiting treatment was bone traction in 28.4% of cases (19 patients), temporary bone exofixation using Damage Control in 5 patients (7.5%). Fifty patients (74.63%) were treated for the femur and tibia in one operation and 17 cases (25.4%) in 2 operations. The average operating time was 5.9 days with extremes ranging from 0 to 27 days. In the 17 patients, the average time between the 2 operations was 10.2 days with extremes ranging from 1 to 47 days. The femur was treated in the first stage in 33 patients (49.3%) (Figure 3). Intramedullary nailing (IMN) of the femur was performed in 38.8% of floating knees (26 patients) and external fixation (EF) in 25.3% of cases (17 patients). The

tibia was treated by external fixation in 28 patients (41.8%) and by IMN in 21 patients (31.4%). Forty-four patients had followed a functional rehabilitation program (65.67%). The average hospital stay in our study was 35.38 days with extremes of 6 and 90 days. The floating knee consolidation was noted in 59 patients (88.1%). The time to consolidation was achieved in 42 patients with an average of 10.1 months and extremes ranging from 7 to 21 months.

Table 2. Distribution of floating knees according to the Fraser classification N = 67.

Type (Fraser)	Numbers	Percentages (%)
Type I	29	43.3
Type IIA	12	17.9
Type IIB	8	11.9
Type IIC	5	7.5
Not classable	13	19.4
Total	67	100

Table 3. Distribution of floating knees according to Blake and McBryde classification N = 67.

Type (Blake and McBryde)	Numbers	Percentages (%)
Type I	29	43.3
Type IIA	25	37.3
Type IIB	12	17.9
Not classable	1	1.5
Total	67	100

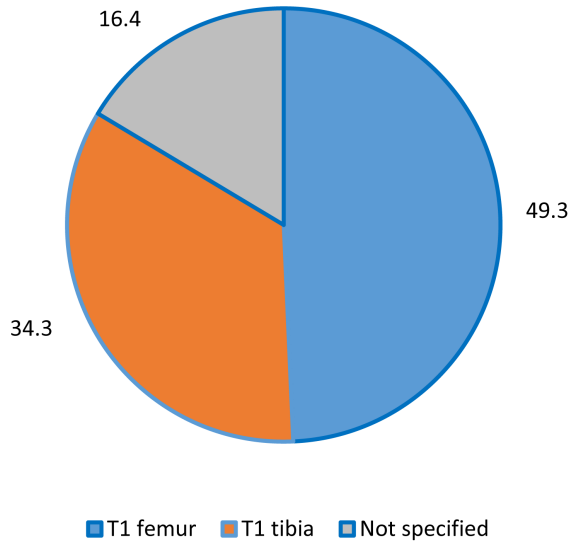

Figure 3. Distribution of floating knees according to operative chronology N = 67.

Three immediate complications were noted, including one death (1.5%) and two fat embolisms (3%). Secondary complications were found in 17 patients, or 25.4%. They were located at the tibia in 13 patients. The complications found were infections (11.9%), including 2 superficial and 6 deep, skin necrosis (10.4%), bone exposure (10.4%), including 5 at the tibia. Late complications were found in 38 patients, or 56.72%. Twenty-four cases of knee joint stiffness were observed (35.8%), 10 cases of non-union (14.9%), including 6 septic cases and 7 located in the tibia, 6 cases of malunion (8.96%), including 4 at the tibial level, 7 cases of osteitis (10.4%), including 4 located in the tibia, one case of algoneurodystrophic syndrome (1.5%), and 5 cases of lower limb length inequalities (7.5%). The average decline was 40.1 months with extremes of 16.5 and 93 months. Functional assessment according to the Karsltrom score was carried out in 30 patients (reachable and having agreed to do the test) (44.8%). It was excellent and good in 46.67% of cases (14 patients) (Figure 4). Functional assessment according to the Fraser classification in 29 patients (classifiable according to Fraser) showed that patients with a type I floating knee had 71.5% excellent and good results (10 patients), patients with a type IIb floating knee had 50% poor results (2 patients) and patients with a type IIc floating knee had 100% average and poor results (5 patients) (Table 4).

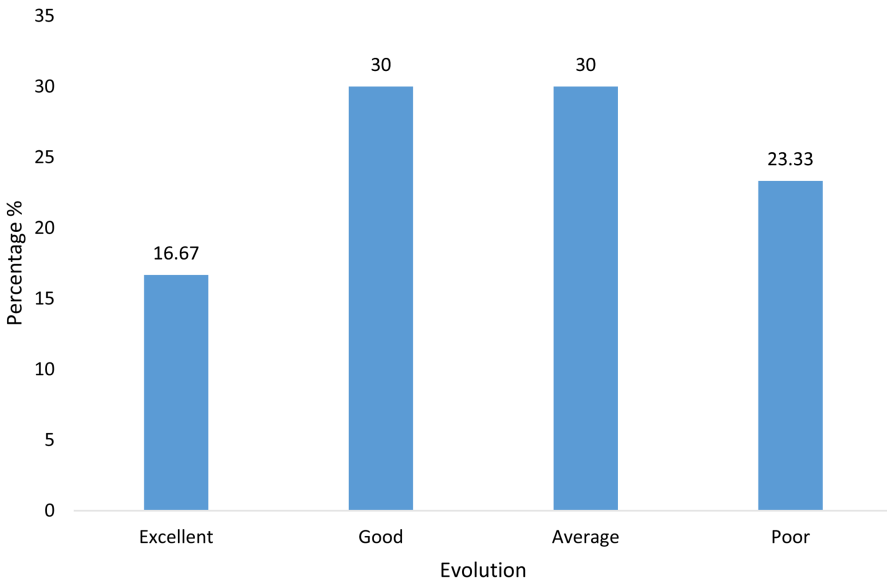

Figure 4. Distribution of patients according to outcome assessed by the Karlstrom score n = 30.

Table 4. Bivariate analysis of the relationship between the Fraser classification and functional outcome of floating knees (n = 29).

Type of Fraser	Functional Outcomes							
	Excellent		Good		Average		Poor	
	Cases Number	%	Cases Number	%	Cases Number	%	Cases Number	%
Type I (n = 14)	4	28.6	6	42.9	3	21.4	1	7.1

Continued

Type IIa (n = 7)	1	14.3	2	28.6	3	42.8	1	14.3
Type IIb (n = 4)	0	0	1	25.0	1	25.0	2	50.0
Type IIc (n = 5)	0	0	0	0	1	20.0	4	80.0

4. Discussion

The annual incidence of floating knees in our structure is clearly increasing, also found in the Oudrhiri series [5]. This evolution is probably linked to the high incidence of RTAs in Senegal, which increased from 17,213 in 2019 to nearly 27,000 in 2021, according to the WHO [10] [11]. RTAs represent the main etiology of floating knees (92.53%) with a predominance of accidents involving two-wheeled vehicles (41.9%) [12]-[14]. All age groups are affected with a predominance of young subjects [6]-[8] [14]-[16] and male genders [2] [8] [13] [14] [17]. The involvement of both sides varies according to the authors [5] [8] [14] and bilateral involvement was reported by Oudrhiri and Loubignac [5] [18] as in our series. Two-thirds of our floating knees (65.7%) and those of other studies [5] [14] are open. The skin opening is preferentially located at the level of the tibia (55.2% of cases) [5] [8] [14] and is type II of Cauchoix and Duparc (54%) in line with the results of Veith RG [19]. These results are probably linked to the anatomical vulnerability of the tibia which is subcutaneous over its entire anteromedial face unlike the femur which is surrounded by thick muscle masses. On the other hand, some authors have noted a predominance of type I [5] [19]. At the femoral level, a high frequency of type I of Cauchoix and Duparc (50%) was noted in line with other results [5] [15] [19]. Associated locoregional lesions were noted (vascular-nervous, ligamentous, patella fracture) in 31.3% of cases as in some patients [2] [8] [14] [20]. Floating knees were frequently associated with other distant lesions in 64.2% of cases including 44.8% (30 patients) with polytrauma [5] [19] with a mean ISS score above 18 in almost all series [5] [14] [20]. Fraser type I was the most frequent (43.3%), followed by types IIa and IIb as in the majority of series [2] [8] [19]. We found 13 floating knees not classifiable according to Fraser of which 12 are classifiable according to Blake. A reflection should be made on this classification to consider fractures involving the hip or ankle, bifocal fractures and even open fractures. These parameters may influence the functional results [2] [14]. Osteosynthesis of the femur was performed first in 49.3% of cases as in Pietu [14] and unlike Oudrhiri [5] where the tibia was synthesized first in 75% of cases. Primary femoral fixation is the recommended approach. However, primary tibial fixation is preferred in cases of significant deterioration or ischemia of the leg as well as in certain metaphyseal-epiphyseal fractures requiring external fixation. Primary fixation of the tibia can also facilitate the reduction of a complex fracture of the distal femur [14]. IMN of the femur is the most used method in the literature [2] [5] and also at the level of the tibia [2]. There are discrepancies between patients with a predominance of the screwed plate in some patients [15] [19]. In

our series, tibial exofixation (41.8%) was the most performed. These results are probably related to the frequency of skin openings at the level of the tibia and the time to treatment which is generally greater than 6 hours in our countries. The most reported complications are infection (11.9%) associated with skin necrosis and bone exposure [8] [9], malunion (8.96%) [5] [8] [19], joint stiffness in 35.8% higher than the literature data [5] [19], non-union 14.93% [8] and osteitis (10.4%) [5] [8]. These complications can be explained by the delay in taking care of young subjects who are victims of road traffic accidents and who often present economic difficulties for follow-up. Our functional results are excellent and good in 71.5% of cases in Fraser type I floating knees, generally average and poor in type IIb and especially type IIc floating knees. These data are comparable to those in the literature [2] and show that the evolution of floating knees could be influenced by their type according to Fraser and that joint involvement would have a poor prognosis. However, the small size of the patients evaluated may constitute a bias.

5. Conclusions

Floating knees are rare but have been on the rise in recent years with the advent of two-wheeled vehicles. It is a serious pathology because it often occurs in the context of polytrauma or multiple fractures, with a skin opening present in more than half of cases. Management sometimes involves intensive care, making resuscitation a sequential process involving several interventions, including Damage Control Orthopaedic. A reflection should be given to a classification that allows the factors of bad prognosis to be considered, and the need for a study with a larger sample.

Current State of Knowledge on the Subject

• Several literature series on floating knees have shown that it is a pathology affecting young male genders who are victims of road traffic accidents, particularly drivers of two-wheeled vehicles;

• It is a pathology occurring in the context of polytrauma, often requiring intensive care, and management is sequential, including Damage Control.

Contribution of Our Study to Knowledge

• We reported 67 cases of floating knees recorded over a period of 11 years with an average annual incidence of 7 cases/year linked to the advent of two-wheeled vehicles, and that two-thirds of pedestrians are struck by them;

• We demonstrated that some floating knees are not covered by the Fraser and Blake and McBryde classifications.

Author Contributions

Abdoulaye Lindor Diop (main author), Dior Sy: Study planning, data analysis, results analysis, and manuscript writing. René André Macodou Ndiaye, Papa Amadou Ba, Cheikh Coundoul, Madior Diouf, Assane Diatta, and Coumba Diouf Niang: Critical review of the work and final approval.

Conflicts of Interest

The authors declare no conflicts of interest.

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