KNEE JOINT STABILITY IN A "FLOATING KNEE" CONDITION

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SUMMARY

The "floating knee" condition is a significant therapeutic challenge to the entire medical team responsible for multiple-trauma patients. It is a severe injury produced by high-energy trauma and usually associated with other lesions. In this study, 22 patients who had undergone surgical treatment for ipsilateral fractures of the femur and tibia were called for reassessment. Seventeen patients were reassessed after a follow-up period of four months by applying physical and X-ray tests, the Lysholm's knee scale and the Karlstron score. Fractures were classified according to degree of exposure (Gustillo & Andersen), comminution (AO) and "floating knee" condition (Fraser). Twelve patients (70.6%) presented with definite alterations during the physical examination of the knee. The most common alteration was joint instability, which was present in eight cases (47%), followed by motion restraint in seven patients (41.2%). Anterior instability was diagnosed in five cases (29.4%), three of them associated with varus instability. Posterior instability was observed in two patients (11.8%) and in both cases it was associated with varus instability. One patient presented with peripheral varus-valgus instability and an important knee motion restraint. Intra-joint and open femoral and tibial fractures present a higher incidence of restrained range of motion. The results found in this study reinforce the need for a systemic assessment of knee joint stability in view of the fact that the "floating knee" condition is often associated with lesions of the knee joint capsule and ligament.

Keywords: *Traumatology; Knee/ Injury; Knee joint; Joint instability.*

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INTRODUCTION

In literature, the phrase "Floating Knee" was first used by Blake and Mcbryde, in 1975, to define simultaneous fractures of femoral and tibial shafts occurred on a same limb[1]. Subsequently, intra-joint fractures of the knee have been included in this definition.

The incidence of such injuries has increased over the last few years. This is a serious injury, caused by high-energy trauma, such as motorcycle and car accidents, producing life-threatening musculoskeletal and visceral injuries[2-4].

In the 1960's and 1970's, treatment constituted of a conservative approach, provided by means of skeletal traction and plastered apparatus. Comminutive fractures involving joints became a real therapeutic challenge and, invariably, evolved to pain, stiffness and significant joint function loss. The challenge to keep fractures aligned and the complications inherent from the long periods of bed rest required contributed to provide really catastrophic clinical outcomes[1,5].

In the last fifteen years, an increased knowledge of the clinical evolution of fractures and their complications, advanced stabilization and permanent fixation techniques combined with less traumatic approaches produced significantly superior results comparing to conservative treatments[6,7]. Thus, a better quality pre-hospital healthcare and the standardization of assessment of multiple-trauma patients have contributed to the survival of patients presenting with increasingly severe injuries, thus establishing a new therapeutic challenge: the functional recovery of the involved limb.

However, the lack of a systematic assessment of joints surrounding fractures has been claimed as one of the causes of poor late outcomes. In this context, knee joint deserver stronger attention, because a potion of the trauma energy is absorbed by the capsulo-ligamentar complex of the knee[8]. At baseline evaluation, the identification of clinical signs such as presence of hemarthrosis, scratches, ecchymosis, joint snaps, may suggest potential mechanisms of capsulo-ligamentar injury. Therefore, an early diagnosis is crucial, because it allows for a more suitable therapeutic approach, avoiding injury to become chronic and the emergence of complications secondary to joint instability[9,10].

In this study, the presence and frequency of knee joint instability in a "floating knee" picture was assessed, as well as the identification, in the various fracture patterns presented on this case series, of its potential contribution to joint motion.

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MATERIALS AND METHODS

Between 1999 and 2004, 22 patients with simultaneous ipsilateral femoral and tibial fractures were examined and surgically treated. After being called for, seventeen patients came to review. Knee joint stability was assessed by physical examination, which was constituted of anterior and posterior stability tests, valgus and varus, as well as knee range of motion tests.

In parallel, X-ray images of fracture sites and of knee joint at anteroposterior and lateral planes, taken at the moment the patient was admitted in the emergency room, were assessed. This X-ray study was complemented by the following planes: anteroposterior, lateral and comparative anterior and posterior stress. Fractures were classified by taking the X-ray images obtained at the time of accident. It is important to outline that, in this case series, no patient had previous history of knee injuries or symptoms.

The postoperative clinical outcome was classified according to the criteria described by Karlström and Olerud[11] (Chart 1). In this study, any outcomes rated as excellent or good were regarded as satisfactory.

From medical files, the following general demographic data were recorded: age, gender, involved side, presence of associated visceral injuries and other fractures, time of hospitalization and postoperative follow-up, time elapsed between temporary and definitive fixation, as well as the time elapsed until referral to knee surgery group for assessment (Charts 3 , 4 and 5).

Fourteen patients were males (82.3%) while three were females (17.7%), with a mean age of 31.2 years (ranging from 15 to 55 years old). They had suffered accidents on the streets (falls from motorcycles, trampling, crashes). In three cases (17.6%) associated visceral injuries were diagnosed, and in ten cases (58.8%) fractures on bones other than knee and tibia were seen. In fifteen patients (88.2%) the left side was involved, with the right side being involved in only two cases (11.8%). The postoperative follow-up time ranged from 4 to 61 months (mean: 21.8 months).

The location of femoral and tibial fracture traces (shaft or intra-joint) was described according to the classification by Fraser[12] (Chart 2). The exposure degree of fractures was classified according to the method by Gustillo and Anderson[13], for each individual bone. The degree of comminution of fractures was classified by the AO method[7].

Chart 3 – Data describing age, gender, involved side, presence of visceral injuries and fractures on bones other than femur and tibia.

Chart 4 describes how patients were managed at the emergency room, the kind of osteosynthesis employed as permanent treatment, and the postoperative follow-up time. Figure 1-A illustrates case nr. 2, in which the early stabilization of fractures was provided by a tubular external fixator (transarticular assembly) and minimal osteosynthesis with 2 spongy screws with washers for reducing femoral and tibial joint surfaces. Figures 1-B and 1-C show X-ray imaging monitoring of permanent osteosynthesis of fractures, at frontal and lateral planes, respectively.

The patients were divided into two groups: one group initially treated with temporary fracture fixation and the other group receiving permanent synthesis at the emergency room.

In the subjective assessment of the knee, the range of motion as measured with the aid of a goniometer, joint stability according to Lachman's tests, anterior and posterior drawer, stress in varus and valgus (at zero and thirty degrees of flexion) have been taken into account associated to comparative X-ray images taken with and without ligament stress. Figure 2-A and B illustrates the anterior drawer test and the X-ray control of the clinical maneuver at lateral plane, respectively.

Patients' subjective interpretation of the knee-related symptoms was scored according to the Lysholm scale[14], with scores ranging from zero to one hundred. In this case series, results scoring > 85 were regarded as satisfactory. The statistical analysis compared data addressing knee motion restraint, joint instability and the various fracture patterns according to the classification by Gustillo and Andersen, Fraser, AO and to the kind of fixation determined at the emergency room. In this study, we used as statistical methods the Mann-Whitney's non-parametric test and the Fisher's exact test.

RESULTS AND DISCUSSION

The classification of the several fracture patterns was based on the criteria described by Gustillo and Andersen (degree of exposure), Fraser ("floating knee") and A.O. (comminution), as presented on Chart 5. In two cases (nr. 14 and 15), we could not classify the fractures due to the lack of baseline X-ray images.

criterion (symptoms)		excellent	good	acceptable	poor
subjective	thigh and leg	0	mild, intermittent	severe, restrains function	pain at rest
	knee and ankle	0	idem	Idem	idem
Gait		normal	idem	limited distance	use of supports
work and sports		pre-injury level	normal work sport restraint	changed work	permanent disability
angular and rotational displacement		0	< 10°	10 - 20°	> 20°
Shortening		0	< 1cm	1 - 3cm	> 3cm
ROM restraint	ankle	0	< 10°	10° - 20°	> 20°
	hip and knee	0	< 20°	20° - 40°	> 40°

Chart 1 *– Criteria for assessing end results according to Karlström and Olerud.*

Type I		Femoral shaft and tibial shaft
Type II	A	femoral shaft and tibial intra-joint
	B	femoral intra-joint and tibial shaft
	C	femoral and tibial intra-joint

***Chart 2** – Classification of the Floating Knee according to Fraser.*

Case	Age (years)	gender	side	Visceral injuries	Other fractures
1	40	M	L	-	-
2	28	F	L	-	+
3	15	F	R	-	-
4	25	M	L	-	-
5	55	M	L	-	+
6	23	M	R	-	+
7	16	M	L	-	+
8	17	M	L	-	-
9	37	F	L	+	+
10	17	M	L	-	-
11	47	M	L	-	+
12	45	M	L	+	+
13	36	M	L	-	+
14	31	M	L	+	+
15	28	M	L	-	-
16	35	M	L	-	+
17	35	M	L	-	+

***Chart 3** – Data describing age, gender, involved side, presence of visceral injuries and fractures on bones other than femur and tibia.*

Cases	Stabilization of Fractures		Time interval until permanent synthesis (months)	postop follow-up (months)
	Initial	Permanent		
	Femur /Tíbia	Femur /Tíbia		
1	TAEF	Plate/ plate	2	4
2	TAEF	Plate/ plate	21	4
3	Plate/ fixator	Plate/ fixator	-	6
4	Traction	Plate/ plate	4	9
5	TAEF	Plate/ plate	21	9
6	TAEF	Plate/ fixator	45	10
7	Plate/ plate	Plate/ plate	-	11
8	TAEF	Plate/ plate	10	12
9	Plate/ plate	Plate/ plate	-	13
10	TAEF	Plate/ plate	71	15
11	Nail/fixator	Nail/ Fixator	-	17
12	TAEF	Plate/ fixator	11	20
13	TAEF	Plate/ plate	120	26
14	Plate/ plate	Plate/ plate	-	35
15	TAEF	Plate/ fixator	81	58
16	TAEF	Plate/ plate	7	60
17	TAEF	Plate/ plate	13	61

TAEF = transarticular external fixator

***Chart 4** – Initial treatment of fractures, permanent treatment, time interval until permanent treatment (days), and follow-up time in months.*

cases (number)	Gustilo & Andersen (exposure)		AO (comminution)		Fraser (location)
	femur	tibia	femur	tibia	
1	3B	3B	A	B	1
2	2	3B	A	C	1
3	2	3A	B	A	1
4	1	1	C	A	1
5	F	3B	B	B	1
6	F	2	A	B	1
7	F	2	A	A	1
8	F	F	A	A	1
9	F	1	C	C	1
10	3A	F	A	B	2B
11	F	F	A	C	1
12	3A	F	C	C	2B
13	3A	3B	A	C	2C
14	3A	F	--------	--------	2A
15	F	3A	C	B	2C
16	3A	3A	--------	--------	2C
17	2	2	B	B	2A

***Chart 5** – Data describing the classification of fractures according to Gustilo and Andersen, A.O., and Fraser.*

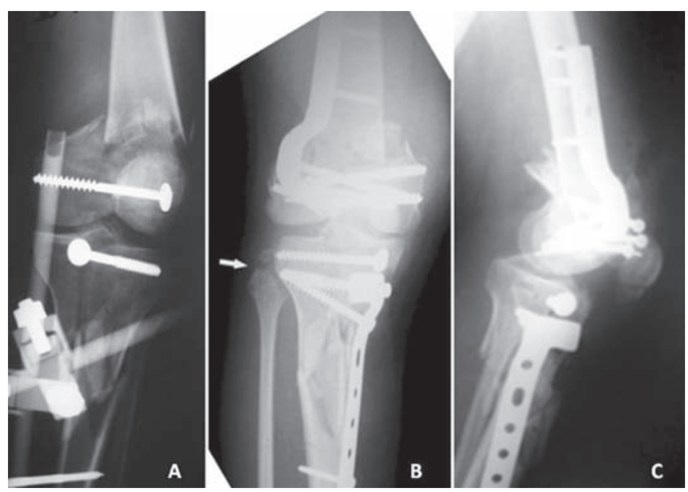

***Figure 1 –** X-ray controls for clinical case nr. 2: (1-A) X-ray image at AP plane: temporary early stabilization with tubular external fixator and minimal osteosynthesis with spongy screws and washers for reducing femoral and tibial joint surfaces. (1-B) X-ray image at AP plane: permanent synthesis and detail of the fibular head bone avulsion (arrow) and (1-C) X-ray image at lateral plane: permanent synthesis.*

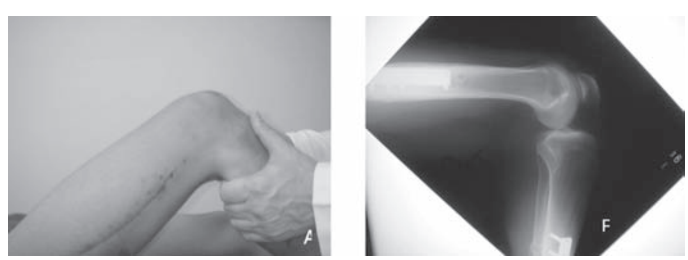

***Figure 2 –** Detail of the clinical maneuver of the anterior drawer test (A) and X-ray evaluation of the maneuver on the knee at lateral plane (B).*

Chart 6 shows the results achieved from physical examination assessments, Lysholm's scale, Kärsltron's scoring at the postoperative follow-up of the 17 patients.

DISCUSSION

The "floating knee" condition is a significant therapeutic challenge for the whole medical staff involved in multiple-trauma patients' care. It is a serious injury, produced by high-energy trauma and usually associated to other injuries. In this series, 64.71% of the cases showed concomitant injuries.

Karlström[11] presents a case series involving 32 "floating knee" subjects followed up at his service over the last fifteen years. The author emphasizes that about 18 cases (56.25%) occurred in the last five years, thus reflecting a significantly increased incidence of this kind of injury. According to Hee[15], the most affected population is constituted of young male adults, victims of traffic accidents as a consequence of high-energy trauma. Due to the magnitude of the trauma, fractures can present variable patterns, with several configurations, fragments comminution, and association with important soft parts injuries. Yokoyama[8], assessing 66 cases, reported the incidence of 29% of femoral open fractures, and 65.2% of tibial open fractures.

Our case series is consistent to the findings reported by Hee[15], showing a prevalence of 82.35% of male patients with a mean age of 31.18 years. The incidence of femoral and tibial open fractures was, respectively, 58.82% and 70.59%, while intra-joint fractures were present in 41.2% of the cases, 76.5% being classified for exposure according to the criteria by Gustillo & Andersen with a score higher or equal to two.

In the presence of extensive soft parts injuries, with large tissue degradation, the use of external transarticular fixators helps on addressing soft tissues injuries, while the temporary stabilization of fractures is done with joint blocking. In this series, the transarticular external fixator was employed in 64.71% of the cases.

When assessing the prognostic end result of the treatment to this kind of injury, Hee[15] concluded that comminutive fractures, intra0joint fractures, and extensive soft parts injuries are contributing factors to joint restraint in postoperative clinical evolution. According to Karlström, a joint function restraint of at least 20° or less than normal is enough to provide a fair result.

Similarly, cases with poor evolution, coursed with joint motion restraint. Such restraint was directly related to the presence of intra-joint fractures (Fraser 2), femoral open fracture and tibial open fracture, which occurred, respectively, in 20%, 71.4% and 66.7% of the cases.

In providing care to a multiple-trauma patient with a "floating knee" condition, medical staff's attention is always towards handling life-threatening conditions, stabilizing fractures, and managing soft parts injuries, all of these are contributing factors to the lack of knee joint stability assessment. Undiagnosed ligament injuries is a situation reported on literature. Fraser[12] reports that only 8% of the patients were discharged from hospital with a diagnosis of instability, but, when reassessed, this number was as high as 39%. Walling[10], emphasizes the need of probing the presence of ligament injuries in patients with femoral fractures associated to high-energy trauma, or with localized signs of swelling or scratches on the knee.

Walker[6] found 33% of knee instability in patients with "floating knee". When studying the incidence of ligament injuries in "floating knee" condition and in isolated femoral fractures, Szalay[16] found rates of 53% and 31%, respectively. Yue[17] dem-

case	ROM	Anterior instability	posterior instability	stress		Lysholm	Kärlstrom
				Varus	Valgus		
1	0° - 40°	---	---	---	---	44	Poor
2	0° - 130°	positive	---	Positive	---	72	Fair
3	0° - 120°	---	---	---	---	99	Poor
4	0° - 20°	---	---	---	---	55	Poor
5	0° - 130°	---	---	---	---	56	Fair
6	0° - 130°	---	Positive	positive	---	100	Poor
7	0° - 130°	---	---	---	---	90	Good
8	0° - 130°	positive	---	positive	---	95	Poor
9	0° - 100°	positive	---	---	---	81	Poor
10	0 – 130°	---	---	---	---	92	Poor
11	0 – 130°	---	---	---	---	95	Good
12	0°	---	---	---	---	60	Poor
13	0° - 30°	---	---	positive	positive	62	Poor
14	0° - 30°	---	---	---	---	64	Poor
15	0° - 90°	positive	---	---	---	62	Poor
16	10° - 40°	---	Positive	positive	---	77	Poor
17	0° - 30°	positive	---	positive	---	72	Poor

*** ROM**= *range of motion; positive = presence of ligament injury*

***Chart 6 –** Data describing knee range of motion, tests to assess the presence of anterior and posterior instability and stress in varus and valgus, evaluation by Lysholm and Karsltron scores for the 17 patients included in the study.*

onstrated that, in children, this pattern is also found, although on a smaller scale. When assessing the knees of patients with extra-joint fractures, Walker[9] identified 50% of anterior instability, 31% medial, 13% posterolateral, and 6% posterior. Similarly, Szalay[16] found, in 54.2% of the cases, anterior instability of the knee, posterolateral in 29.2%, and posterior in 29,2%.

Twelve patients (70.59%) presented with some objective change at the physical examination of the knee. An important restraint was seen for range of motion, defined as flexion below 40°, in seven patients (41.18%). Knee joint instability was diagnosed in eight patients, accounting for 47.06% of the cases, with the following distribution: five cases of anterior cruciate ligament injury, three of them associated to posterolateral edge injury. In one patient, we could not appropriately assess anterior and posterior knee stability, because, despite showing associated varus and valgus instability, no more than 30º of knee flexion could be achieved. It is worthy to highlight that, in this case series, 88.2% of the patients (15), for various reasons, did not return to their professional activities. Despite of the high incidence of instability at physical examination, few patients complained about missteps, as described by Fraser[12].and Szalay[16].

Literature evidences that the clinical results achieved with the treatment of "floating knee" condition vary considerably. Whereas Anastopoulos[18] and Hee[15] present, respectively, 81% and 68.6% of satisfactory results, Fraser[12], regards as satisfactory only 30% of the results in operated patients, reporting even that the treatment of "floating knee" provides discouraging results.

In this study, the subjective evaluation of the knee, as measured by the Lysholm's scale, was shown to be unsatisfactory in 64.7% of the cases, while in 35.3% of the reassessed patients, the outcomes were regarded as satisfactory. However, in an analysis using the Karlström's scale, 88.2% of the cases were regarded as unsatisfactory. Only in 11.8% (2) of the cases, the outcomes were rated as satisfactory by both evaluation methods, and 64.71% (eleven) cases were regarded as presenting unsatisfactory results according to both scores. The following were regarded as the major causes of the poor results: the inability to return to professional activities, in 88.2% of the cases; the reduced knee range of motion, in 46.7% of the cases, and; misstep complaints, in 5.9%.

The results in this case series reinforce the need of including a careful inspection of the affected limb, during the early evaluation of patients with "floating knee" condition, for detecting clinical signs such as scratches, ecchymosis, and wounds that could help us to identify potential mechanisms of ligament injury, as well as to probe radiological signs suggesting ligament injuries, such as the presence of bone avulsion (Segond fracture, case nr. 17). In parallel, after fracture reduction and fixation, knee joint stability must be reassessed.

Standardizing and systematizing healthcare is crucial for these injuries to be diagnosed as quickly as possible, allowing for a more suitable approach, establishing the best surgical strategy for each case, such as access ports and the use of implants that will not compromise future ligament reconstructions.

CONCLUSIONS

A better pre-hospital healthcare and the standardization of care in multiple-trauma patients have contributed to the survival of patients with increasingly severe injuries, thus establishing a new therapeutic challenge: the functional recovery of the involved limb. In this context, the results achieved in this study reinforce the need of a systematic assessment of knee joint stability, since the "floating knee" condition is frequently associated to capsulo-ligamentar injuries on this joint.

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