EPIDEMIOLOGICAL STUDY ON TIBIAL PLATEAU FRACTURES AT A LEVEL I TRAUMA CENTER

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ABSTRACT

Objectives: To review the epidemiological aspects of fractures of the tibial plateau in a level one hospital. Methods: We retrospectively analyzed 239 tibial plateau fractures treated surgically. We took into account age, gender, trauma mechanism, classification of the injuries, associated injuries and affected side. Results: 168 were male, the fifth decade has been the most affected, the mechanism of trauma, car accident was the main causal fator, 128 cases were on the left side and 22,6% had associated injuries. Conclusions: Most patients were male, in the fifth decade of life, and victim of traffic accidents, and the depression and shear fractures of the tibial plateau are the most frequent. Associated lesions were infrequent in our study. ***Level of Evidence II, Prognostic Studies. Investigating the Effect of a Patient Characteristic on the Outcome of Disease.***

Keywords: Tibial Fractures/epidemiology. Knee joint. Knee injuries.

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INTRODUCTION

The tibial plateau fractures represent 1-2% of all fractures and approximately 8% of the fractures in elderly.[1]

Epidemiological studies are essential tools for understanding the occurrence of the injury. In this study, we observed age, side, gender, mechanism of injury, most frequently type of injury and injuries associated with tibial plateau fractures.

The objective of this research was to provide a retrospective epidemiological study of tibial plateau fractures in a level I trauma hospital.

METHODS

Two hundred and thirty nine tibial plateau fractures treated surgically in a trauma hospital level I, between January 2006 and January 2011, were analyzed retrospectively. The survey was conducted through an active search in Hospital Municipal Miguel Couto (HMMC) database using the International Classification of Diseases (ICD) S82-1, which corresponds to fractures of the proximal tibia. We then performed, from the record number of the patient in HMMC, consulting of the records and archives of images of the same patients. Inclusion criteria were patients of both sexes and all ages, who underwent surgical treatment of tibial plateau fractures, regardless of having or not related injuries, as well as comorbidities. Patients treated by non-surgical method and those whose records and/or imaging were insufficient were excluded from the study. Age, gender, side of the lesion, injury mechanism and classification of lesions were taken into consideration. All charts and radiographs in antero-posterior and lateral knee were evaluated by a physician with a PhD degree member of Sociedade Brasileira de Cirurgia do Joelho (Brazilian Society of Knee Surgery).

Of the 244 patients analyzed, five were excluded from the analysis, two due to non-surgical treatment, three for presenting records and/or imaging with incomplete information regarding the questions considered in this study. Such exclusion was due to failure in obtaining information regarding the trauma mechanism of injury. Were effectively included 239 patients in our analysis. This research is in accordance with the Declaration of Helsinki of the World Medical Association. The descriptive analysis presented in tables the observed data, expressed as mean ± standard deviation (SD) for numeric data, and frequency (n) and percentage (%) for categorical data. Graphs were plotted to illustrate the relative distribution of severity scales. Statistical analysis was conducted using the statistical software SAS® System version 6.11 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Table 1 provides the frequency (n) and percentage (%) of the characteristics of the 239 patients in study.

Figure 1 illustrates the relative distribution in descending order of the mechanisms of injury to the sample.

All the authors declare that there is no potential conflict of interest referring to this article.

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Figure 2 shows the frequency distribution by age of patients with tibial plateau fractures. It was observed that 71% of injuries occurred in those aged 30-60 years.
Table 2 provides the frequency (n) and percentage (%) of classifications of tibial plateau by Hohl, Schatzker and AO.
It can be observed in Table 2 that 52% of the lesions were of low energy (level ≤ 3) according to Schatzker and Hohl scales, approximately 36% of the lesions were in the high energy in the scales of Hohl (level 5), Schatzker (levels 5 and 6) and AO (levels C1, C2 and C3). (Table 2) The Chart 1 shows the overall sample of injuries.

Table 1. Sample Characteristics.

Variable	Category	n	%
Age (years)*	44,5±14,4	(15 - 92)	
Sex	male	168	70,3
	female	71	29,7
Side of the lesion	right	111	46,4
	left	128	53,6
Mechanism of the lesion	fall from height	96	40,2
	motorcycle crash	54	22,6
	run over	45	18,8
	car crash	26	10,9
	beach injury	10	4,2
	football	7	2,9
	fight	1	0,4
Associated lesions	present	54	22,6
	absent	185	77,4

(*) Age is expressed by mean ± St. deviation (minimum - maximum).
Source: SOT-HMMC, 2011.

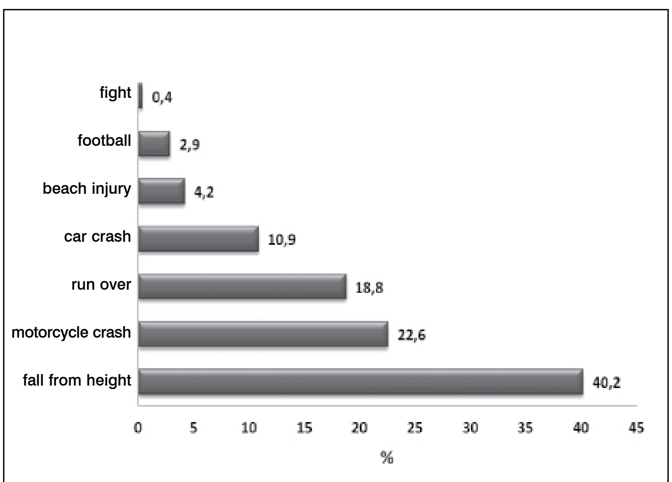

Figure 1. Relative distribution in ascending order of lesion mechanisms in the whole sample.

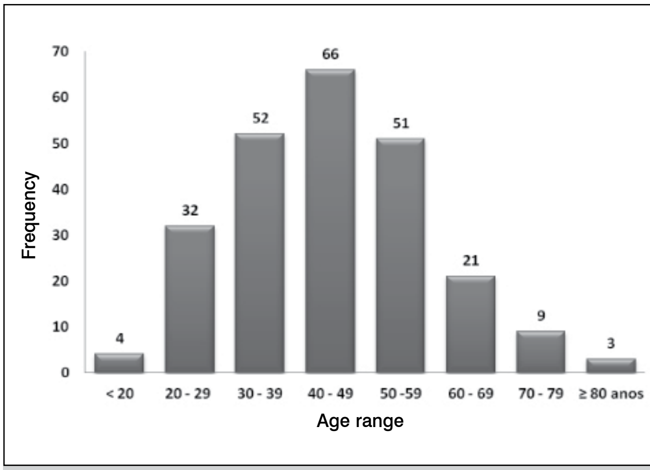

Figure 2. Frequency distribution by age range.

Table 2. Classification of the tibial plateau to the 239 lesions.

Scale	Level	n	%
Hohl	1	20	8,4
	2	20	8,4
	3	86	36
	4	28	11,6
	5	85	35,6
Schatzker	1	20	8,4
	2	84	35,1
	3	21	8,8
	4	28	11,7
	5	38	15,9
	6	48	20,1
AO	B1	44	18,4
	B2	23	9,6
	B3	88	36,9
	C1	13	5,4
	C2	20	8,4
	C3	51	21,3

Source: SOT-HMMC, 2011.

DISCUSSION

There is, to date, no research on epidemiological study of tibial plateau fractures in the national literature. For this reason, our study is important and relevant, especially if we take into consideration the huge socioeconomic impact involved in the genesis of this and many other traumatic injuries produced mostly by traffic violence. At the beginning of the last decade, between 20 and 50 million people around the world were fully or partially disabled due to injuries caused by traffic accidents and about 10% occupied hospital beds during this period.[2]
Although there are no consistent data from the Ministry of Health specifically on the tibial plateau fractures, but taking it as a marker of musculoskeletal trauma, and considering that 52.3% of patients in our sample were victims of traffic trauma and 22.6% had associated injuries, it becomes evident the need of adopting a series of proactive actions to reduce accidents on public roads. Recent government campaigns such as the "Alcohol Prohibition Law", in which the risks of alcohol intake

Chart 1. Lesion general samples.

Patient	Age	Side of lesion	Gender	Hohl	Schatzker	AO	Associated lesions	Lesion Mechanism
1	28	L	M	3	2	B3		run over
2	21	R	M	1	1	B1	Exposed 1/3 distal femur L	fall from height
3	40	R	M	3	2	B3		fall from height
4	52	R	M	4	4	B3		fall from height
5	20	L	M	3	2	B3		fall from height
6	48	L	M	4	4	B1		fall from height
7	30	R	M	4	4	B1		run over
8	44	L	M	3	2	B3		fall from height
9	47	R	M	5	5	C3		fall from height
10	36	L	M	3	2	B3	Exposed tibia L	car crash
11	41	L	F	5	5	C2		car crash
12	41	L	F	1	1	B1	Femoral shaft fractures L	run over
13	24	R	M	4	4	B3	Femoral shaft fractures R	motorcycle crash
14	52	R	M	3	2	B3		run over
15	48	L	M	1	1	B1	Fibular fracture R and dislocation of the knee R	run over
16	17	L	F	2	3	B2		motorcycle crash
17	39	R	F	5	5	C3		car crash
18	66	L	M	3	2	B3		motorcycle crash
19	47	R	M	3	2	B3		motorcycle crash
20	19	R	M	3	2	B3		motorcycle crash
21	56	L	M	5	5	C1		fall from height
22	47	L	M	4	4	B3		football
23	15	L	M	5	6	C3		motorcycle crash
24	41	L	F	3	2	B3		run over
25	36	L	M	2	3	B2		motorcycle crash
26	23	L	M	5	5	C3	Humeral shaft fracture L	car crash
27	58	R	M	2	3	B2		run over
28	52	R	M	5	5	C1		run over
29	20	R	M	5	5	C1		run over
30	46	R	M	4	4	B3		fall from height
31	54	R	M	5	5	C3		beach injury
32	45	R	M	3	2	B3		motorcycle crash
33	51	R	F	4	4	B1		fall from height
34	56	L	M	3	2	B3		run over
35	31	R	M	3	2	B3		motorcycle crash
36	59	R	M	3	2	B3	Fracture of the calcaneous L	beach injury
37	38	L	F	4	4	B1		fall from height
38	34	L	M	3	2	B3	Fibula fracture L+ acetabulum L	motorcycle crash
39	42	L	M	5	6	C1		motorcycle crash
40	73	R	M	3	2	B3		fall from height
41	32	R	M	3	2	B3		motorcycle crash
42	54	R	F	5	5	C3		run over
43	73	R	F	5	6	C3	Terrible Triad R	run over
44	38	L	M	1	1	B1	Proximal humerus fracture L + Supracondylar femur L + Diaphyseal femur fracture L + Diaphyseal femur fracture R + Femur neck fracture R	fall from height
45	74	L	M	3	2	B3		run over
46	49	L	M	5	6	C3		motorcycle crash
47	46	L	M	1	1	B1		run over
48	45	L	F	3	2	B3		fall from height
49	30	R	F	5	6	C3	Base 5 mtt fracture R	fall from height
50	49	L	M	5	6	C3	Patella fracture L	car crash
51	41	L	M	5	6	C3		motorcycle crash
52	69	R	F	2	3	B2		fall from height
53	48	R	M	5	5	C1		run over
54	26	L	F	5	5	C3		fall from height
55	50	R	F	5	5	C2		fall from height
56	59	R	F	3	2	B3		beach injury
57	51	L	M	5	6	C3	Distal fibula L	fall from height
58	28	R	M	5	6	C3		motorcycle crash
59	33	R	M	4	4	B1	Radio head diaphysis R + fibula head R	car crash
60	32	R	M	3	3	B2		car crash
61	44	L	M	5	6	C2	Exposed tibia diaphysis L	car crash
62	69	L	F	3	2	B3	1/3 distal radio L	run over
63	77	L	F	3	2	B3		fall from height
64	47	R	F	3	2	B3		beach injury
65	39	L	M	3	2	B3		motorcycle crash
66	36	L	M	1	1	B1		football
67	33	L	M	5	6	C2		run over
68	30	R	F	5	6	C3	Exposed supracondylar femur R + Ischiopubic branch R + radius and ulna L + wrist R + fibula R + clavicle R	run over
69	65	R	M	5	6	C3		run over

Chart 1. Lesion general samples.

Patient	Age	Side of lesion	Gender	Hohl	Schatzker	AO	Associated lesions	Lesion Mechanism
70	52	L	M	3	2	B3		fall from height
71	41	R	M	5	6	C1		run over
72	41	L	M	3	2	B3		run over
73	50	R	M	3	2	B3		fall from height
74	31	L	M	3	2	B3		beach injury
75	39	L	M	3	2	B3		car crash
76	66	L	M	5	6	C3		fall from height
77	24	L	F	2	3	B2		beach injury
78	50	L	M	3	2	B3		car crash
79	40	R	M	5	6	C2		motorcycle crash
80	34	R	F	5	6	C3		fall from height
81	37	R	M	5	6	C3	Acetabulus R and ankle L	motorcycle crash
82	?	L	M	1	1	B1		motorcycle crash
83	36	R	M	5	5	C3		motorcycle crash
84	51	L	F	5	5	C3		fall from height
85	65	L	M	3	2	B3		run over
86	61	L	F	3	2	B3		fall from height
87	53	L	F	3	2	B3		fall from height
88	62	L	F	3	2	B3		beach injury
89	62	L	F	3	2	B3		fall from height
90	48	L	F	3	2	B3		fall from height
91	28	R	M	4	4	B1		fall from height
92	42	L	F	5	6	C3		fall from height
93	85	R	F	2	3	B2		run over
94	43	L	M	3	2	B3		fall from height
95	39	L	M	2	3	B2		fall from height
96	54	R	M	3	2	B3		fall from height
97	53	R	M	5	6	C3		car crash
98	67	R	M	3	2	B3		fall from height
99	32	L	F	4	4	B3		fall from height
100	53	L	F	4	4	B3		fall from height
101	40	L	M	5	6	C3		fall from height
102	36	R	M	3	2	B3		football
103	55	R	F	5	5	C3		beach injury
104	44	R	F	3	2	B3		run over
105	35	L	F	4	4	B1		fall from height
106	41	R	M	3	2	B3		football
107	22	R	M	5	6	C3		fall from height
108	31	L	M	5	6	C3		motorcycle crash
109	55	R	M	5	6	C3		fall from height
110	38	R	M	5	5	C2	Compartmental syndrome R	fall from height
111	43	R	M	3	2	B3	Big tuberosity humerus L	fall from height
112	36	L	M	3	2	B3	Fracture of the fibula head L	fall from height
113	45	R	F	5	5	C3		run over
114	45	L	M	4	4	B1	Exposed tibia R	fall from height
115	30	R	M	3	2	B3	Fracture of the proximal phalange 5 qdd R	fall from height
116	24	R	M	5	6	C1	Exposed tibia and fibula R	car crash
117	35	L	M	1	1	B1		car crash
118	59	L	M	3	2	B3	Ankle fracture R	fall from height
119	54	L	F	3	2	B3	Fracture of the fibula head L	run over
120	43	R	M	3	2	B3		run over
121	65	R	F	2	3	B2		run over
122	21	L	M	5	5	C2	Exposed tibia fracture L	motorcycle crash
123	20	R	M	3	2	B3		fall from height
124	57	R	F	3	2	B3		fall from height
125	49	L	M	3	2	B3		run over
126	40	R	M	2	3	B2		motorcycle crash
127	46	L	M	2	3	B2		car crash
128	42	R	M	1	1	B1		fall from height
129	57	R	M	4	4	B1		run over
130	57	L	M	4	4	B1		run over
131	59	L	M	4	4	B1	Exposed ankle fracture R	car crash
132	38	L	F	3	2	B3		beach injury
133	44	L	M	2	3	B2		fall from height
134	59	L	F	3	2	B3		fall from height
135	45	L	M	5	6	C3		football
136	31	R	M	2	3	B2		fall from height
137	24	L	M	4	4	B1		car crash
138	22	R	M	3	2	B3		car crash
139	48	L	M	3	2	B3		car crash
140	29	R	M	4	4	B1		motorcycle crash
141	31	L	F	5	6	C3		motorcycle crash

Chart 1. Lesion general samples.

Patient	Age	Side of lesion	Gender	Hohl	Schatzker	AO	Associated lesions	Lesion Mechanism
142	45	L	M	1	1	B1		motorcycle crash
143	52	R	M	3	2	B3		fall from height
144	28	R	M	3	2	B3		motorcycle crash
145	49	R	F	2	3	B2		run over
146	35	L	M	3	2	B3		motorcycle crash
147	72	L	F	2	3	B2		fall from height
148	17	L	M	5	6	C3		motorcycle crash
149	39	L	M	3	2	B3		car crash
150	68	R	F	3	2	B3		fall from height
151	30	R	M	5	5	C3		motorcycle crash
152	63	R	M	5	6	C2		car crash
153	61	L	M	5	5	C3		fall from height
154	37	L	F	1	1	B1		fall from height
155	40	R	F	1	1	B1		car crash
156	43	L	F	3	6	B3		run over
157	27	R	M	3	2	B3		motorcycle crash
158	43	R	M	5	5	C3	1/3 distal clavicle R	car crash
159	28	L	M	3	2	B3	2 and 3 mtt R	motorcycle crash
160	42	L	M	4	4	B3		fall from height
161	51	R	F	5	5	C3		run over
162	30	L	M	3	2	B3		Luta
163	60	R	M	3	2	B3	Calcaneous R + medial malleolus R + 1/3 distal radius R + 5 mtc L	fall from height
164	56	R	M	2	3	B2		beach injury
165	27	L	M	5	5	C3		motorcycle crash
166	56	L	M	1	1	B1		motorcycle crash
167	32	R	F	5	6	C3		motorcycle crash (exposed)
168	25	L	M	5	6	C2	Femur Diaphysis L+1/3 distal clavicle L+ scapula L	motorcycle crash (exposed)
169	37	L	M	5	5	C1		motorcycle crash
170	55	R	F	2	3	B2		fall from height
171	47	R	F	3	2	B3	Lateral malleolus R	fall from height
172	45	R	M	3	2	B3		fall from height
173	60	R	M	5	6	C2	4 and 5 metatarsus R + supracondylar femur L + patella L + Lisfranc joint injury L	fall from height
174	59	L	F	5	5	C3		fall from height
175	46	R	M	3	2	B3		fall from height
176	43	L	M	5	5	C1		car crash
177	64	L	F	3	2	B3		fall from height
178	43	L	M	5	6	C2		motorcycle crash
179	50	R	M	5	6	C3		motorcycle crash
180	69	R	M	2	3	B2		fall from height
181	55	L	F	5	5	C2		fall from height
182	36	R	M	5	6	C3		motorcycle crash
183	25	L	M	5	6	C2		motorcycle crash
184	52	L	M	3	2	B3		fall from height
185	45	L	M	5	6	C2	Exposed 1/3 proximal ulna L	fall from height
186	48	R	F	5	6	C1		run over
187	48	L	F	3	2	B3		run over
188	73	L	M	5	5	C1		run over
189	53	L	F	1	1	B1		fall from height
190	42	L	F	2	3	B2		fall from height
191	35	R	M	3	2	B3		motorcycle crash
192	81	L	F	4	4	B2		fall from height
193	41	L	M	5	6	C2		motorcycle crash
194	71	L	F	5	5	C3		car crash
195	34	L	M	5	6	C2	Bimalleolar L + popliteal artery L	motorcycle crash
196	48	L	M	1	1	B1		motorcycle crash
197	22	R	F	3	2	B3		fall from height
198	46	R	M	5	5	C3	Diaphyseal tibia L	motorcycle crash
199	54	L	M	3	2	B3	L1 fracture	fall from height
200	38	R	F	5	5	C3		run over
201	48	L	M	3	2	B3	Diaphyseal femur L	car crash
202	54	R	M	1	1	B1	Scapula R	fall from height
203	51	L	M	5	5	C1		fall from height
204	33	L	M	4	4	B1		fall from height
205	36	R	M	1	1	B1	1/3 distal radio L + base of the thumb R + popliteal artery R	motorcycle crash
206	21	L	M	3	2	B3	Exposed femur diaphysis R + patella R + 2 and 3 mtt L	motorcycle crash
207	92	R	F	1	1	B1		fall from height
208	63	R	M	5	6	C2		fall from height
209	41	L	F	1	1	B1		fall from height

Chart 1. Lesion general samples.

Patient	Age	Side of lesion	Gender	Hohl	Schatzker	AO	Associated lesions	Lesion Mechanism
210	20	R	F	3	2	B3		motorcycle crash
211	43	R	M	3	2	B3		football
212	57	R	M	2	3	B2		fall from height
213	26	R	M	3	2	B3		fall from height
214	21	L	F	3	2	B3		fall from height
215	47	L	M	5	6	C3		motorcycle crash
216	29	R	M	3	2	B3	Exposed 1/3 proximal radio L	fall from height
217	55	L	M	2	3	B2	Exposed tibial pilon L	fall from height
218	35	L	M	5	5	C3	Popliteal Artery L	motorcycle crash
219	27	L	M	1	1	B1		football
220	51	L	M	4	4	B1	Calcaneous L	fall from height
221	38	L	M	5	6	C2	Great tuberosity of the humerus R	motorcycle crash
222	36	L	M	4	4	B1		run over
223	77	L	F	5	5	C2	Diaphysis fibula L	fall from height
224	30	L	M	4	4	B1	Supracondylar femur R	run over
225	61	L	M	5	5	C2		fall from height
226	27	R	M	4	4	B1		motorcycle crash
227	54	L	M	5	6	C3	Exposed supracondylar humerus fracture L + lateral malleolus L + supracondylar femur + navicular fracture R + maissoneuve R + proximal phalange 3,4 and 5 L	fall from height
228	56	R	M	3	2	B1	Tibial Pilon L	run over
229	75	L	F	3	2	B1		fall from height
230	58	R	M	4	4	B1	Radio distal L	fall from height
231	41	L	M	3	2	B1	Ankle L	fall from height
232	47	R	M	5	5	C3		fall from height
233	35	R	F	4	4	B1		run over
234	57	R	F	5	6	B2		car crash
235	39	L	M	5	5	C1		motorcycle crash
236	63	R	M	5	6	C3		run over
237	29	R	F	5	5	C3		run over
238	59	R	M	3	2	B1		run over
239	46	R	M	5	6	C3	Acetabulus L	fall from height

M: male; F: female; L: Left; R: right; Sd: syndrome; fract: fracture.
Source: SOT-HMMC, 2011.

and disrespect traffic rules are strongly cautioned and offenders punished, as well as the "Projeto Vida no Transito" (Project "Life in Traffic", or National Pact for Accident Reduction), signed in September 2012 by the Minister of Health, aim to reduce the number of accidents and deaths on Brazilian roads and streets.[3] Moreover, mostly from medium to long term, we believe that standardization of control and education measures can change the existing epidemiological paradigm in our country.
Besides traffic accidents, 7.5% of our patients underwent tibial plateau fractures through sports trauma. Characteristically, we believe that the reason is due to the physical location of our hospital, situated in the coastal region of the city, a place that encourages sports activities. Quite punctual and curious, we observed that some injuries due to injury at sea (in the beach) occurred in older populations, probably due to a lower bone quality.
In our study, the most affected gender was the male sex, which was not seen in the study of Schulak Gunn[4], who found no difference between genders. In our opinion, the predominance of males in the population due to their greatest vulnerability and exposure to risk situations, such as the use of physical strength during most physical activities and physical labor or dangerous high speed driving and disregard to traffic laws.[5]
Another important observation of the current study was that most fractures occurred in individuals in the fifth decade of life, usually associated with traffic injuries and falls from height. Schatzker *et al*.[6], in his classic 1979 study, reported the sixth and seventh decades of life as the most frequent ages of tibial plateau injuries. Again, we believe that the increased traffic trauma greatly influenced the decrease in most frequent age of injuries observed by Schatzker *et al.*[6] Due to this fact, the fracture patterns most frequently observed in our study were moderate and high energy, namely, the bicondylar injuries and the combination of shear and depression of the lateral tibial plateau, respectively seen in 36% and 35.1% of the patients.
We classified the fractures according to three distinct systems which are usually used in the literature, Hohl's, Schatzker's *et al.*[6] and the AO Group's.[7-9] It is known that there is no consensus on which classification should be adopted in tibial plateau fractures, although the two most used are Schatzker's *et al*.[6] and the AO Group's.[7-9] In a national survey, Albuquerque *et al*.[10] included Hohl's classification to the previous two, noting that the later present greater interobserver accordance. More recently, Luo *et al.*[11] proposed the use of the "three collumn" concept in the classification of tibial plateau fractures, giving a new perspective on a subject still undefined in the literature.
Finally, regarding to imaging tests, we routinely used radiographs in anteroposterior and lateral knee. We know that ideally a series of knee trauma was to be performed , in which the oblique radiographs at 45° are included, and not rarely, computed tomography (CT), which we began to use on a regular basis from 2009.[12] Because this retrospective study started in 2006, our sample included some patients who did not undergo the oblique views or CT of the knee. For this reason, we adopted as standard only knee anteroposterior and lateral radiographic incidences, which is corroborated by the study of Dirschl and Dawson.[13]
One of the weaknesses of our study was the inability to search the associated intra-articular lesions of the knee. We know that the lateral tibial plateau fractures are associated with significant risk of meniscal and capsuloligamentous injuries. In these patients, when the joint depression is greater than 6mm and the extension of the plateau greater than 5mm, the lesion of the lateral meniscus may be present in 83% of fractures, compared

with 50% in fractures with less deviation. The medial meniscus injury happens more often when depression and enlargement overcome 8mm.[8] Magnetic ressonance imaging (MRI), in our view, should be sought in all patients with tibial plateau fractures, a procedure corroborated by several authors, although its high cost, and not being available in many public Brazilian hospitals.[8,14-17]. One of the authors' suggestions, based on this last observation is that the MRI might soon become popular in hospitals of the Unified Health System (SUS), considering that a great number of patients shall benefit, either for intra-articular lesions analysis of the knee in tibial plateau fractures as well as in many other traumatic and non-traumatic musculoskeletal system diseases, such as spinal cord injuries and herniated discs, respectively.

CONCLUSION

In the population studied, the authors noted that most patients who suffer complete tibial plateau are male, around the fifth decade of life, mostly victims of traffic accidents with depression type bicondylar fractures or shear joint. Perhaps due to the lack of MRI images, associated injuries were uncommon in our study.

The adoption of preventive measures such as educational campaigns, surveillance and traffic education, and the inclusion of sensitive imaging methods in major trauma centers in our country, such as CT and MRI, can respectively reduce the number of injuries and improve victim patient care of tibial plateau fractures.

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