Trends in Le Fort Fractures at a South American Trauma Care Center: Characteristics and Management

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Abstract

Purpose To assess the trends in Le Fort (maxillary) fractures in patients seen at a South American trauma care center based on the characteristics and management of these.

Materials and Methods Of all patients with facial fractures seen at a trauma hospital during a six-year period, 50 (6.6 %) presented with Le Fort fractures. Medical charts were reviewed for characteristics presented and management performed. To improve the analyses, computed tomography and intraoperative findings were used. Statistical analyses involved descriptive statistics and the likelihood ratio test.

Results The fractures were Le Fort II (52 %), Le Fort I (22 %), Le Fort type-associated (20 %) and Le Fort III (6 %). Male patients (90 %) in their third decade of life (38 %) were more frequent ($p = 0.022$). Traffic accidents (56 %) were the major etiologic factor ($p = 0.048$). There were 1.4 additional facial fractures per patient, with predominance of zygoma fractures (36.5 %). Most of the cases were managed by open reduction (60 %) ($p = 0.015$) with the subciliary approach (42.7 %) ($p = 0.001$). The 1.5-mm system was the most used fixation and the zygomatico-maxillary suture the most frequent location ($p = 0.001$).

Conclusion the most common patient with a Le Fort fracture is an adult male, with a Le Fort II fracture due to a

traffic accident requiring surgical fixation on zygomatico-maxillary suture.

Keywords Maxillary fractures · Maxillofacial injuries · Fracture fixation · Epidemiologic studies

Introduction

Fractures of the middle third of the face are frequent and are potentially disfiguring and even lethal injuries that require careful examination and expectant management skills [1, 2]. The midface is the central focus of our gaze. Developmental or acquired aberrations of this region are likely to be more obvious than lower face abnormalities and, consequently, are perceived as more disfiguring [3]. The Le Fort classification is commonly used in describing such fractures [4–6].

The management of maxillary fractures begins with the establishment of an accurate diagnosis, which has been dramatically improved by the routine use of computerized tomography. In particular, it is possible that fractures come through more than one Le Fort level on the same side. Other mid-facial fractures frequently occur in association with Le Fort fractures, including fractures of the hard palate and mandible that affect occlusion and consequently the repair of Le Fort fractures [6]. Treatment of these complex injuries should follow guidelines such as early definitive treatment, wide exposure of fracture segments and anatomic repositioning with stable fixation of fracture segments in all planes [7].

Epidemiological studies are essential to assess detailed data analyses of these types of injuries. Understanding the causes, severity and clinical manifestations of maxillofacial trauma can aid in establishing effective treatment and

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recommending preventive measures that could decrease their incidence [8–10]. Le Fort fractures present with special features with which the professionals involved in their treatment should be familiar. Each level has its own characteristics relative to diagnosis and, particularly, management [5]. However, few studies have evaluated current aspects of their clinical features and treatment.

The purpose of this study was to assess the current aspects of the characteristics and management of patients presenting with Le Fort fractures.

Materials and Methods

A retrospective study was conducted with information from the medical charts of patients treated at the Oral and Maxillofacial Surgery Clinic of the Hospital M. Dr. Arthur R. de Saboya, which is a trauma hospital that provides coverage for the southern area of Sao Paulo, Brazil. Charts from 2006 to 2012 were reviewed for the characteristics and medical management of patients presenting with Le Fort (maxillary) fractures. This study received approval from the local human research ethics committee.

All charts were reviewed, and the age, gender, etiology and associated facial fractures were recorded. The fractures were classified based on the Le Fort classification system: Le Fort I or horizontal; Le Fort II or pyramidal; and Le Fort III or craniofacial disjunction [6, 11]. In addition, a Le Fort type-associated designation was used when there were coexisting Le Fort type fractures. Also called compound fractures, these fractures include cases with Le Fort I + II fracture, Le Fort II + III fracture and Le Fort I + II + III fracture [12]. The Le Fort IV fracture category—Le Fort II or III fracture and cranial base fracture [3], was not included in this study. To improve the classification of fractures, computed tomography features and intraoperative findings were used. The presence of bilateral pterygoid fractures to the following levels assisted in the classification: lateral piriform aperture—Le Fort I; inferior orbital rim—Le Fort II; and zygomatic arch—Le Fort III [11].

The treatment was divided into the following groups: conservative—favorable fractures without occlusal alterations or compromised function; open reduction—fracture reduction and internal fixation under general anesthesia; and no treatment—when a systemic condition, in particular polytrauma, prevented treatment or the patient was transferred. Access for surgical reduction, the fixation system used and their location were recorded.

The data were tabulated, and statistical analyses were performed. They involved descriptive statistics and the likelihood ratio test to determine the differences between each variable. The level of significance was set at 5 %

($p < 0.050$) in all statistical analyses. The Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Software Group, Chicago, USA) was used to conduct the analyses.

Results

Among the 754 patients with facial fractures, 50 (6.6 %) presented with Le Fort type fractures. The fractures were diagnosed as Le Fort II (52 % of cases), Le Fort I (22 %), Le Fort type-associated (20 %) and Le Fort III (6 %). The Le Fort type-associated fractures were Le Fort I + Le Fort II (6 %) and Le Fort II + Le Fort III (14 %), and there were no cases of an association of Le Fort I + Le Fort II + Le Fort III. Midline split of the palate was observed in 4 (8 %) cases and was associated with Le Fort I (2 cases) or Le Fort II (2 cases).

The distribution of patients into age groups by gender is shown in Fig. 1. The predominant age group was 21- to 30-year-olds, with 38 % of cases, followed by 31- to 40-year-olds, with 26 % of cases. There was a predominance of males, comprising 90 % of cases, with a ratio of males to females of 9:1. There was a significant difference in the proportion of each gender among the different age intervals ($p = 0.022$).

The distribution of patients by etiology and fracture classification is shown in Fig. 2. The predominant etiology was motorcycle accidents (32 %), followed by physical aggressions (26 %), automobile accidents (12 %), vehicle–pedestrian collisions (12 %) and falls (10 %). There was a significant difference in the proportion of each fracture level among the kinds of etiologies ($p = 0.048$). Half of the cases due to motorcycle accidents were Le Fort II fractures.

The distribution of associated facial fractures by fracture classification is shown in Fig. 3. There were 1.4 associated fractures per patient. The most common associated fracture was of the zygoma (36.5 %), followed by the nasal bone

Fig. 1 Patient distribution by gender and age group (years; $n = 50$)

Fig. 2 Patient distribution by etiology and fracture classification (n = 50)

(29.5 %), mandible (19.6 %), orbit (5.6 %), frontal bone (4.2 %; which would represent Le Fort IV fractures), naso-orbito-ethmoidal complex (2.8 %) and dentoalveolar (1.4 %). There was no significant difference in the proportion of each fracture level among the kinds of associated facial fractures ($p = 0.055$).

The distribution of patients by treatment performed and fracture classification is shown in Table 1. The predominant treatment was open reduction (60 %), followed

by conservative treatment (30 %) and no treatment (10 %). There was a significant difference in the proportion of each fracture level among the kinds of treatment ($p = 0.015$).

The distribution of surgical approaches by fracture classification is shown in Table 2. In general, Le Fort I cases underwent intraoral access, Le Fort II cases and Le Fort type-associated cases underwent subciliary access, and Le Fort III cases underwent lateral eyebrow access or upper lid blepharoplasty incisions, while unilateral access was used mainly in associated zygomatic fractures. When the access was bilateral, there was a predominance of the subciliary approach (36.7 %), followed by the intraoral (16.2 %) and lateral eyebrow (14.2 %). When the access was unilateral, there was a predominance of the lateral eyebrow approach (20.3 %), followed by the subciliary approach (6 %) and intraoral approach (2 %). There was a significant difference in the proportion of each fracture level among the surgical approaches ($p = 0.001$).

The distribution of fixation systems used by fracture classification is shown in Table 3. The titanium 1.5-mm system was the most used fixation (73.3 % of total), which predominated in Le Fort I (50 % of cases), Le Fort II (70.5 %), Le Fort III (100 %) and Le Fort type-associated (87.5 %) fractures. A combination of 1.5-mm and 2.0-mm systems was used in 20 % of cases and the 2.0-mm system in 6.6 %. There was no significant difference in the

Fig. 3 Distribution of associated facial fractures by fracture classification (n = 71). NOE = naso-orbito-ethmoidal complex. The total number of cases surpasses the number of patients, as many presented with more than one associated facial fracture

Table 1 Distribution of patients by treatment performed and fracture classification (n = 50)

Classification	Open reduction n (%)	Treatment Conservative n (%)	Performed No treatment n (%)	Total n (%)
Le Fort I	4 (8)	6 (12)	1 (2)	11 (22)
Le Fort II	17 (34)	8 (16)	1 (2)	26 (52)
Le Fort III	1 (2)	0	2 (4)	3 (6)
Associated	8 (16)	1 (2)	1 (2)	10 (20)
Total	30 (60)	15 (30)	5 (10)	50 (100)

Table 2 Distribution of surgical approach used by fracture classification (n = 49)

Classification	Intraoral bilateral n (%)	Intraoral unilateral n (%)	Surgical Lateral eyebrow bilateral n (%)	Accesses Lateral eyebrow unilateral n (%)	Subciliary bilateral n (%)	Subciliary unilateral n (%)	Midline nasal vertical n (%)	Total n (%)
Le Fort I	3 (6.1)	1 (2)	0	0	0	0	0	4 (8.1)
Le Fort II	3 (6.1)	0	0	8 (16.3)	10 (20.4)	2 (4)	2 (4)	25 (51)
Le Fort III	0	0	1 (2)	0	0	1 (2)	0	2 (4)
Associated	2 (4)	0	6 (12.2)	2 (4)	8 (16.3)	0	0	18 (36.7)
Total	8 (16.2)	1 (2)	7 (14.2)	10 (20.3)	18 (36.7)	3 (6)	2 (4)	49 (100)

The total of approaches surpasses the number of patients surgically treated, as many presented with associated facial fractures

Table 3 Distribution of fixation systems used by fracture classification (n = 30)

Classification	Fixation		System	
	1.5-mm n (%)	2.0-mm n (%)	1.5 & 2.0-mm n (%)	Total n (%)
Le Fort I	2 (6.6)	1 (3.3)	1 (3.3)	4 (13.3)
Le Fort II	12 (40)	1 (3.3)	4 (13.3)	17 (56.6)
Le Fort III	1 (3.3)	0	0	1 (3.3)
Associated	7 (23.3)	0	1 (3.3)	8 (26.6)
Total	22 (73.3)	2 (6.6)	6 (20)	30 (100)

proportion of each fracture level among the fixation systems used ($p = 0.135$).

The distribution of the fixation location by fracture classification is shown in Table 4. Fixations were predominantly bilateral and on the zygomaticomaxillary suture region (41 %). Unilateral fixations were frequently on the zygomatic buttress (16.1 %) and frontozygomatic suture (16.1 %). Le Fort I cases were predominantly on the zygomatic buttress (50 %), and Le Fort II were predominantly on the zygomaticomaxillary suture (44.8 %). Le Fort type-associated fractures were predominantly on the zygomaticomaxillary suture (30 %) and frontozygomatic suture (30 %). There was a significant difference in

the proportion of each fracture level among the fixation location ($p = 0.001$).

Discussion

The present study assessed the trends in Le Fort (maxillary) fractures in patients seen at a trauma care center based on the characteristics and management of these. Such cases represented 6.6 % of all facial fractures. Other studies have shown a higher frequency of these fractures in maxillofacial trauma, ranging from 10 to 18.2 % [9, 13–15]. However, these figures include maxillary dentoalveolar trauma,

Table 4 Distribution of the fixation location by fracture classification (n = 56)

Classification	Location of fixations									Total n (%)
	Zigomático buttress bilateral n (%)	Zigomático buttress unilateral n (%)	Canine buttress bilateral n (%)	Canine buttress unilateral n (%)	Zigomático maxillary bilateral n (%)	Zigomático maxillary unilateral n (%)	Fronto zigomático bilateral n (%)	Fronto zigomático unilateral n (%)	Fronto nasal n (%)	
Le Fort I	3 (5.3)	0	1 (1.7)	2 (3.6)	0	0	0	0	0	6 (10.7)
Le Fort II	3 (5.3)	2 (3.6)	0	0	13 (23.2)	2 (3.6)	0	7 (12.5)	2 (3.6)	29 (51.8)
Le Fort III	0	0	0	0	0	1 (1.7)	1 (1.7)	0	0	2 (3.6)
Associated	3 (5.3)	0	0	1 (1.7)	6 (10.7)	2 (3.6)	6 (10.7)	2 (3.6)	0	20 (35.7)
Total	9 (16)	2 (3.6)	1 (1.7)	3 (5.3)	18 (32.1)	5 (8.9)	7 (12.5)	9 (16.1)	2 (3.6)	56 (100)

which represents a significant proportion of cases [9, 16]. The level of fractures, with Le Fort II comprising half of the cases, followed by Le Fort I, Le Fort type-associated and Le Fort III, is characteristic of maxillary fractures [9, 10, 14, 17]. A study demonstrated a statistically significant difference in the injury severity score (ISS) between patients with Le Fort I versus those with Le Fort II or III fractures, and these patients had a higher probability of intensive care unit admission or immediate operative intervention. However, no significant differences in age, gender and number of associated injuries were observed among the three levels [5]. It was decided not to include the category of Le Fort IV fractures [3]. Most of the midface fractures studies use the classic study by Le Fort [5, 12, 17]. However it is important to recognize the complexity of the cases of Le Fort IV fracture, as they involve a cranial base fracture and the treatment may need an intervention by the neurosurgical team.

The predominance of males and those in their third decade of life is consistent with previous studies [9, 14, 18]. This predominance probably results from a higher level of physical activity and a higher frequency of involvement in traffic accidents and fights by young men [16]. Motorcycle accidents were the major etiologic factor, followed by physical aggressions, automobile accidents, vehicle–pedestrian collisions and falls. In this study, motor vehicle accidents were the most common cause of Le Fort fractures, comprising 56 % of the cases, which is similar to some studies on maxillofacial fractures [10, 14, 19]. On the other hand, traffic accidents have been associated with more severe injuries than other causes [9], as was the case in this Le Fort fractures series.

There were 1.4 associated facial fractures per patient, with a predominance of zygoma fractures, followed by nasal bone and mandible fractures. Other facial fractures are frequently associated with Le Fort fractures, which complicates the diagnosis and increases the complexity of fracture repair [6]. If we consider the associated frontal bone fractures, we would have 4.2 % of the Le Fort IV fractures in this series. The predominant treatment in this series was open reduction, followed by conservative treatment and no treatment. This finding is similar to those of many studies on maxillofacial fractures [1, 13, 14, 20]. Conservative treatment is reserved for cases without occlusal changes or other functional problems. In the cases without mobility, observation and traction elastics may be useful [21]. Open reduction allows anatomic repositioning and stable fixation of fracture segments in all planes [7]. Increasing the expertise of surgeons and establishing a better infrastructure worldwide have led to an increased number of patients undergoing open reduction and fixation

[10, 16, 18]. During open reduction, reestablishing the occlusion is essential [9]. Even in edentulous patients, establishing the maxillary-mandibular relationships is important in the treatment of Le Fort fractures [22].

The surgical approaches were performed according to the level of fractures and were intraoral in Le Fort I cases, subciliary in Le Fort II and Le Fort type-associated cases and lateral eyebrow or upper lid blepharoplasty in Le Fort III cases. Thus, because of the frequency of Le Fort fracture types, the approaches were bilateral, with a predominance of the subciliary approach, followed by the intraoral and lateral eyebrow approaches. These results are in agreement with prior studies [1, 23]. The 1.5-mm system was the most used fixation at all Le Fort levels. In general, the use of this system is effective to treat these fractures. However, some surgeons use only the 1.5-mm in Le Fort I cases, because of the fewer structural forces at Le Fort II and III levels, and recommend smaller plates such as 1.0- or 1.3-mm in these cases [23].

The location of fixations was related to the fracture type and was performed on zygomatic buttresses in Le Fort I cases, zygomaticomaxillary sutures in Le Fort II cases and zygomaticomaxillary sutures and frontozygomatic sutures in Le Fort type-associated cases. Thus, because of the frequency of Le Fort fracture types, the fixations were predominantly bilateral on zygomaticomaxillary suture, followed by zygomatic buttresses and frontozygomatic sutures. This finding is similar to those of some studies on maxillofacial fractures [1, 23]. The location of the fixations is in accordance with the principles for treating these fractures [7]. Biomechanical evaluation of Le Fort I fracture plating techniques has demonstrated that the fixation of two miniplates on each side restores 90 % of the bite force [24].

Conclusion

This study assessed the trends in Le Fort (maxillary) fractures in patients seen at a trauma care center based on the characteristics and management of these. Patients with Le Fort fractures were most often males in their third decade of life with a Le Fort II fracture due to a traffic accident who required open reduction with a subciliary approach and bilateral 1.5-mm system fixation on the zygomaticomaxillary suture region.

Conflicts of interest None

Ethical standard Approved by the local human research ethics committee.

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