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Clinical and radiographic evaluation of surgical treatment of zygomatic fractures using 1.5 mm miniplates system

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ABSTRACT

Fractures of the zygomaticomaxillary complex are among the most common face traumas. Based upon the complexity and great variety of reported diagnoses and treatments, the proposal of this study was to evaluate, clinically and radiographically, unilateral zygomatic fractures treated through internal rigid fixation with miniplates and screws of 1.5 mm. Material and Method: 15 patients with unilateral fractures of the zygomaticomaxillary complex were analyzed, and compared with 15 patients without fractures so that a comparative analysis of the area and the perimeter of the orbital cavities could be made, as well as the distance from the nasal point to the zygomatic prominence between both groups. Results: In the radiographic analysis, the both groups presented similarity in the perimeter and in the area of the orbital cavities. Concerning the distance from the nasal point to the zygomatic prominence, only the operated group showed a significant difference between the sides, even though clinically the observation of the asymmetry had been absent or discreet. Conclusions: The treatment of unilateral fractures of the zygomaticomaxillary complex with the use of plates and screws of the 1.5 mm system proved to be effective, showing good esthetic results and low complication rates.

Keywords: Zygomatic Fractures; Internal Fracture Fixation; Facial Injuries

1. INTRODUCTION

The treatment of the fractures of the zygomaticomaxillary complex (ZMC) is amply discussed in the literature, being that three great conflicts still persist in relation to the applied therapy [1]. The first concerns the best way for surgical reduction of the fractures. The second is related to the necessity to fix them or not after the reduction, and the third concerns the number of fixation points necessary so that the fractures of the ZMC are stabilized [2].

Treating with miniplates and screws provided facility of use, good stability, bio-compatibility, as well as the possibility of being used in areas where the bone is not so thick, with little soft tissue overlap, minimizing the symptoms of local esthetic discomfort [3].

Technological development together with surgical necessity stimulated the development of extremely delicate systems of plates and screws with guarantees of promoting adequate resistance to bending and three-dimensional mechanical stability assuring predictability in the treatment of facial fractures [4-6].

Considering the high rate of fractures in the ZMC and the disagreements about treatment we proposed to carry out the present study to evaluating the zygomatic fractures treated with a 1.5 mm fixation system.

2. MATERIAL AND METHODS

Thirty patients were analyzed clinically and radiographically. Fifteen had been submitted to surgical treatment of a non-comminuted unilateral fracture of the zygomaticomaxillary complex, and made up the Treated Group (TG) and fifteen peoples without fractures of the ZMC were called the Control Group (CG).

On the fifteen patients of the TG access to the frontozygomatic region was carried out through a supraciliary incision. The second region to be accessed varied according to the case, using the infra-orbital region and/or zygomaticomaxillary pillar. The surgical reduction was carried out through the use of the Caroll-Girard screw and the internal fixation was done in all the patients with titanium miniplates and screws of the system of 1.5 mm.

Posteroanterior X-rays for the cheeks of the face (Water's X-ray) were carried out in the thirty patients, fifteen in the TG and fifteen in the CG. After obtaining all radiographs, fifteen being from the operated patients and fifteen from the salutary patients without fractures, the scanning of the same were done on a "ScanJet 4c/T" scanner

(Hewlett-Packard). For all of the radiographs a size of standard image was established, so that there would not be differences among them. After obtaining the images, the analysis was carried out by way of the program ImageLab 2000/2.4—a program of analysis and digital processing/computerized image (**Figure 1**).

Two radiographic points were established in order to evaluate the symmetry of the zygomatic bone from both sides. The first point was defined by the intersection of the nose bones (nasal pyramid) and the nasal septum, being called the nasal point (NP). The second point, called the zygomatic point (ZP), was established from the most sideward point and outside the zygomatic arch.

In this way, the operated side (OpS) was compared to the opposite side (OS) in the Treated Group, and in the Control Group, the right side (RS) and the left side (LS) was compared, in order to obtain fundamental values for the statistical study.

The clinical evaluation of the TG was carried out with the intention of determining clinically the possible consequences resulting from the surgical procedures, as well as the persistent symptomatology originating from the trauma. Pointing out that in order to do so, only one observer was used, and he considered the following parameters for evaluation: ocular movement, dystopia, diplopia, paresthesia, limitation of mouth opening, malocclusion, discomfort, ectropion, entropion, apparent sclera, enophthalmos, exophthalmos, facial symmetry and the presence of post operative infection. The fifteen patients from the TG were observed in frontal norm, mento-occipital, profile, and supero-inferior.

The data obtained was submitted to the test of variance for analysis of normality by the Kolmogorov-Smirnov test and presented normal distribution, which allowed for the carrying out of the parametric t-student test for matched data ($p < 0.05$).

3. RESULTS

In the analysis of the Treated Group (TG), the patients' ages varied from 21 to 64 years (mean = 33 years). Of these, 87% were men and 13% were women.

In relation to the side of the face that had a higher incidence of fractures of the zygomatic bone, 67% were on the left side and 33% on the right side. The postoperative

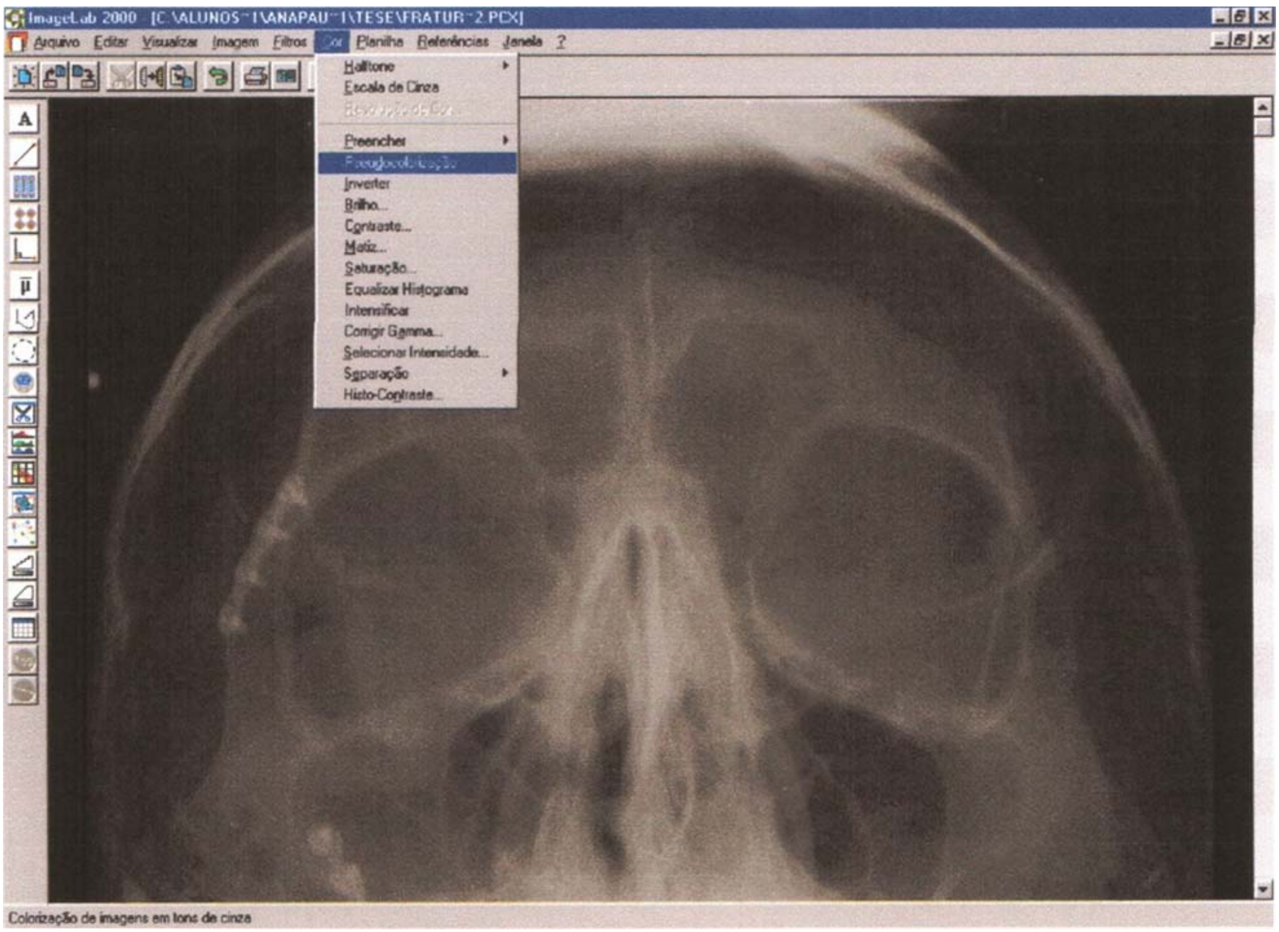

Figure 1. Standard scanning posteroanterior X-rays on the program ImageLab 2000 / 2.4.

periods were 6 months at the minimum and 16 months at the maximum. Among the etiological factors, automobile accidents prevailed (33%), followed by motorcycle accidents (26.6%) and physical aggression (20%). Automobile accidents with pedestrians, falls and work accidents were responsible for one of each being responsible for 6.6% in each group.

In order to analyze and compare the Treated Group with the Control Group we selected individuals of the same sex and age as the patients with the ZMC fracture. In the analysis of the Control Group the ages varied from 16 to 62 (mean = 37.3 years), also with 80% of the patients in this group being men and the women being only 20%.

The surgical procedures of fixation with mini-plates and screws of 1.5 mm system in the patients that made up the Treated Group included different pillars of support. The zygomaticomaxillary pillar was the main choice, used in 14 patients (93.3%), followed by the frontal-zygomatic region in 13 patients (86.6%) and the infra-orbital border involved in 5 (33.3%) operated patients. The internal fixations, depending on the sustaining pillars, presented combinations among themselves. The total of 11 patients (73.3%) received fixation in two osseous pillars, 3 patients (20%) in three pillars and only 1 patient (6.6%) in one sustaining pillar.

The numbers obtained from the perimeter, area and distance from the NP to the ZP in the Treated Group and Control Group are contained in **Table 1**.

Through the Image lab 2000 Program, it was possible to enhance the osseous outlines in order to facilitate the demarcations of the NP and the ZP (**Figures 2** and **3**).

4. STATISTICAL ANALYSIS

4.1. Control Group

The analysis of the matched data of the perimeter between the right side and the left side did not present any significant difference ($p = 0.782$), with measurements of 62.32 mm for the right side and 62.43 mm for the left side.

For the area, the average of the right side was 263.32 mm and 264.38 for the left side, there not being any significant statistical difference ($p = 0.378$).

In measuring the distance from the NP to the ZP, the average values 42.45 mm for the right side and 42.57 mm for the left side, were also not statistically signifycant ($p > 0.243$).

4.2. Treated Group

The analysis of the matched data of the perimeter between the operated side and the opposite side did not present any significant difference ($p = 0.249$), with values of 62.90 mm for the operated side and 62.15 mm for the opposite side.

For the area, the average of the operated side was 263.86 mm and 269.19 mm for the opposite side, not having any statistical difference between them.

From the measuring of the distance from the NP to the ZP, the average values of 44.50 mm for the right side and 45.16 mm for the left side presented a statistically significant difference ($p = 0.003$).

4.3. Treated Group × the Control Group

Mean and standard deviation from the perimeter, area and distance from the NP to the ZP between the Control Group and Treated Group is on **Table 2**.

Table 1. Perimeter, area and distance from the nasal point (NP) to the zygomatic point (ZP) from the orbital cavities on the operated side (OpS) and the opposite side (OS) in the Treated Group (TG) and Control Group (CG).

Patient	Perimeter OpS (mm) TG/CG	Area OpS (mm) TG/CG	Distance OpS (mm) TG/CG	Perimeter OS (mm) TG/CG	Area OS (mm) TG/CG	Distance OS (mm) TG/CG
1	63.9/56.3	279.0/219.5	40.26/39.66	61.8/60.6	275.2/217.4	39.64/40.05
2	62.4/63.8	267.0/263.4	43.95/40.84	58.2/62.5	269.2/261.1	43.58/40.74
3	66.4/64.2	304.3/287.5	47.18/42.53	65.0/65.3	301.2/285.4	48.88/42.85
4	73.4/62.3	325.2/267.5	47.98/41.21	70.8/62.4	322.9/266.4	48.15/41.52
5	62.2/59.7	295.0/221.9	44.28/46.44	62.3/59.1	290.6/220.9	46.13/46.97
6	58.6/55.8	230.4/227.0	45.46/40.82	60.3/54.5	234.9/224.2	46.12/40.00
7	63.7/66.5	275.6/297.7	41.35/46.15	63.4/66.8	274.5/304.4	42.49/46.27
8	58.3/64.2	221.3/280.4	43.11/41.79	58.9/65.9	228.9/281.3	44.48/41.89
9	61.5/61.7	235.7/252.2	44.03/42.30	62.1/61.5	246.1/251.7	44.86/42.03
10	73.8/69.8	317.2/321.5	46.17/41.57	72.4/68.5	310.5/322.5	46.82/42.07
11	62.3/61.6	254.6/258.1	45.19/38.82	58.1/60.9	250.2/258.7	45.79/38.91
12	56.0/64.8	205.9/288.0	45.58/41.33	61.2/64.5	210.8/288.4	46.66/41.94
13	62.3/58.5	269.7/237.5	44.84/45.49	61.9/57.6	359.9/252.5	44.97/45.08
14	59.8/61.7	244.4/256.5	42.89/43.05	59.8/62.5	239.0/257.9	43.29/43.12
15	58.9/63.9	232.6/271.1	45.20/44.71	56.1/63.8	224.0/272.9	45.51/45.12
Mean TG/CG	62.4/61.7	263.4/262.9	44.07/41.93	61.7/62.0	268.7/263.8	44.60/42.13

Table 2. Mean and standard deviation from the perimeter, area and distance from the nasal point (NP) to the zygomatic point (ZP) between the Control Group and Treated Group (significant difference for $p < 0.05$).

Variable	Mean	standard deviation	t	p
Perimeter				
Control Group	62.37	3.62	0.142	0.888
Treated Group	62.53	4.71		
Area				
Control Group	263.85	29.02	0.305	0.762
Treated Group	266.53	38.41		
Distance NP to ZP				
Control Group	42.51	2.30	4.024	<0.001
Treated Group	44.83	2.16		

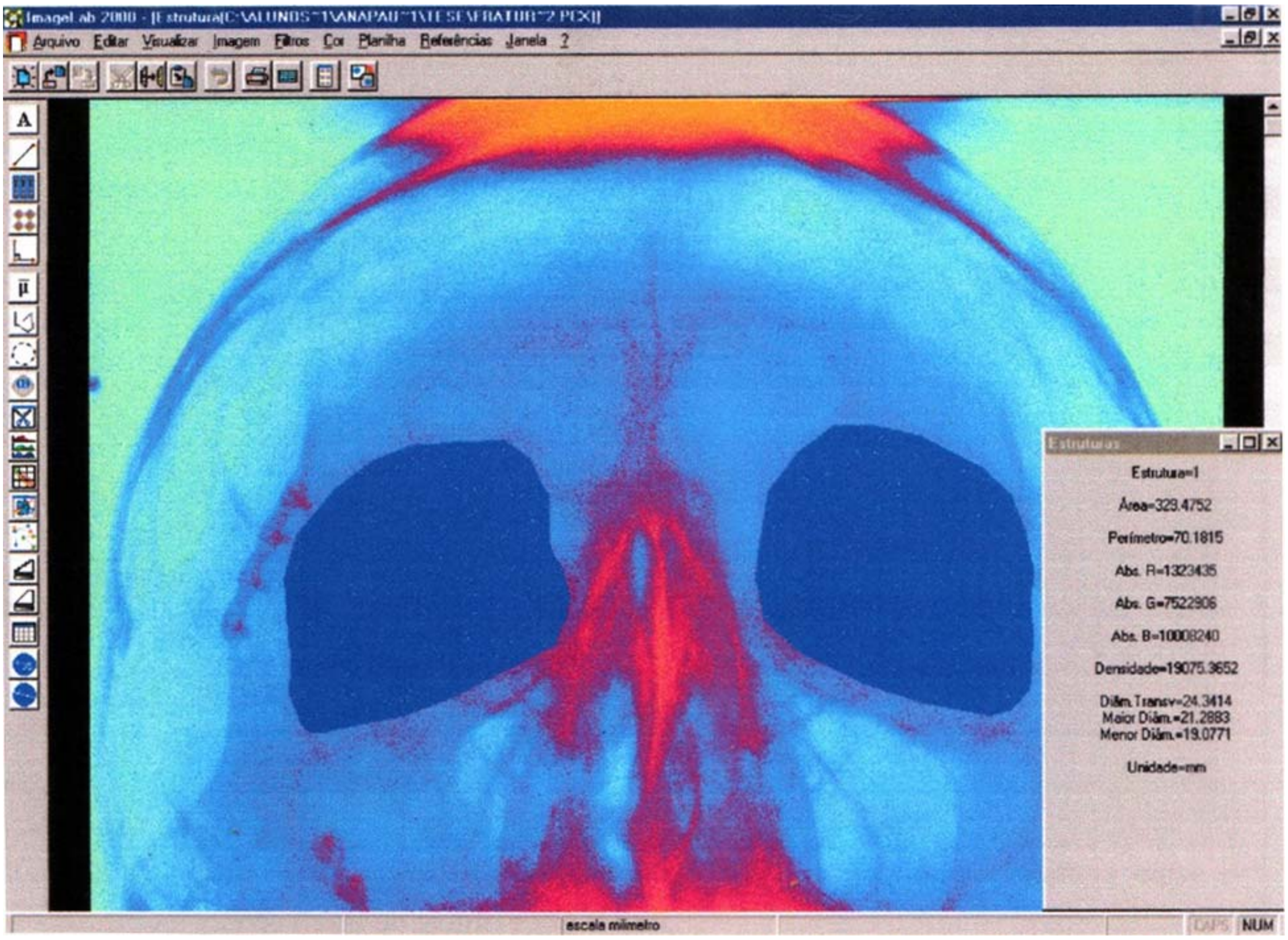

Figure 2. Enhancing the osseous outlines in order to facilitate the demarcations of the NP, ZP and to calculate the perimeter and area of the orbitas.

present any significant difference (p = 0.888), with values of 62.37 mm for the control group and 62.53 for the treated group. The analysis of the matched data for the area between the control group and the treated group did not present any significant difference (p = 0.762), with values of 263.85 for the control group and 266.53 for the treated group.

In measuring the distance from the NP to the ZP the mean values of 42.51 mm for the control group and 44.83 mm for the treated group presented a significant statistical difference ($p < 0.001$).

In the clinical analysis among the patients of the Treated Group no cases of ectropion, entropion, enophthalmos, exophthalmos, diplopia, sclera apparent, malocclusion or

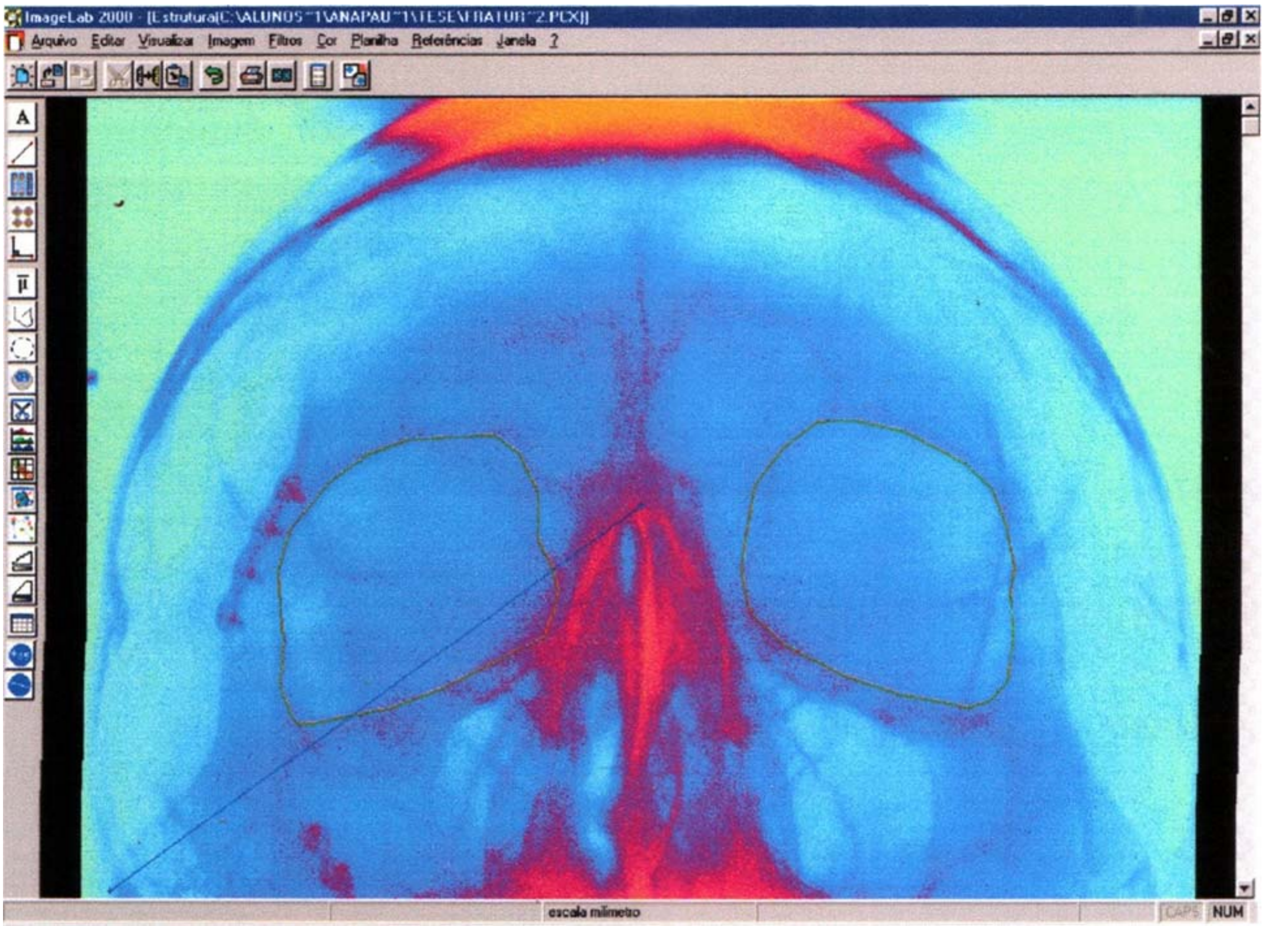

Figure 3. Line of the distance from the NP to the ZP.

mouth opening limitation were found. There was only one case of asymmetry that was classified as "discreet", with an appearance of distopia, but without any complaints by the patient. Only one patient reported a discreet paresthesia in the region of the alveolar mucosa innerved by the superior anterior alveolar nerve associated with a slight discomfort after nine postoperative months.

5. DISCUSSION

From the analysis of the collected data, we observed that traffic accidents (with automobiles and motorcycles) were responsible for 59.9% of the fractures, and in second place, patients who were victims of physical aggression made up 20% of the cases. This corroborated the rates from Covington *et al.* [7], who pointed out as main etiological factors, accidents caused by motor vehicles, with 78.6% of the cases, being 68.8% automobiles and 9.8%, motorcycles.

One of the most controversial topics in the literature is about the number of fixation points that are necessary to avoid the post-surgical dislocation of the fractured zygomatic maxillary complex [8-10]. The great majority of the authors are divided about the need for two or three places, with a variation of the complexity of the trauma and the degree of dislocation of the fractured segment [7, 11].

Whenever the primary stabilization of the ZMC fracture was necessary fixation in the region of the zygomatic maxillary pillar (ZM) was chosen, totaling 14 patients (93.3% of the cases). The frontozygomatic region (FZ) was fixed in 13 patients (86% of the cases), and the infraorbital rim (IO) in 5 patients (33.3% of the cases). The combination of the fixation sites followed the following statistics, 9 patients (60%—FZ and ZM), 3 patients (20%—FZ, ZM and IO), and 1 patient (6.6%) for each group left over (FZ and IO; IO and ZM; only ZM). Although there are reports of stability of fractures fixed only in one point [7,12,13] chose, whenever possible to put fixation in the two pillars of the ZMC.

The internal fixations carried out in the patients in this study, according to the integrity of the osseous pillars, presented combinations among them, being that in 11 patients (73.3%) two points of fixation were used, in 3 cases (20%), there was the need for osteossynthesis in three pillars and in only 1 patient (6.6%) one fixation point was used.

Davidson *et al*. [14] analyzed, in an *in vitro* study, several forms of fixation, combining steel wires, plates and screws, obtaining a total of 25 different combinations. By means of traction that simulated the action of the masseter muscles they calculated the rotation and the dislocation after the application of the forces on the different planes. The means of fixation that received the best results were: fixation with steel wires in three points and fixation with plates and screws in three points. However, the stability reached by fixation with plates and screws in two points was similar to the previous fixations, highlighting the zygomatic pillar as the strategic point for the opposition of the forces of the masseter muscle.

In relation to the combinations and the choice of osseous pillars, the combination between the frontozygomatic region and the zygomatic maxillary making up a total of nine (60%) of the fifteen patients treated.

The zygomatic maxillary pillar should be the region of choice for unstable fractures of the zygomatic bone, for it acts as a direct antagonist to the action of traction provoked by the masseter muscle [15].

Strong and Sykes [16] propose a combination of systems of mini-plates and micro-plates in the different pillars of support of the ZMC. They recommend the use of microplates of 1.0 or 1.2 mm in the infra-orbital border, 1.5 or 1.7 mm in the frontozygomatic region and 2.0 mm in the zygomatic maxillary pillar region.

The data obtained from this study are in agreement with the results obtained in other studies [17]. The differences obtained, for the perimeter as well and for the area of the operated side and the opposite side of the Treated Group were not statistically significant.

The good stability obtained from the fixation in two points gains force when compared with the sides obtained from the Control Group, in other words, the patients who did not have fractures of the ZMC. In those we verified that the differences in the values obtained between the right side and the left side, in referring to the perimeter and, as well as the area, were also not statisticcally significant.

The distance from the NP to the ZP was also another variable that was analyzed in this study with the aim to determine a possible zygomatic asymmetry between the opposite side and the treated side (**Figure 3**). The results showed a significant difference between the sides in the treated group, although the clinical analysis of this data has not been made evident.

In the patients from the Treated Group a case of asymmetry classified as "discreet" (6.6%) was found, presenting dystopia, but with no complaints from the patient. Data that corroborates an incidence from 2% to 9% of facial asymmetry in patients treated by a system of internal rigid fixation [18,19]. However, in these, the system used was of 2.0 mm, that structurally guarantees the smallest rate of deflection, when compared to the system of 1.5 mm.

The esthetic-functional items evaluated in this study showed a significant improvement, principally related to the "bother from the use of the plate", related by the use of the system 2.0 mm. One case was reported with discomfort in the region of the zygomatic pillar, however, associated with a symptomatology of disestesia in the region of the mucosa near the region with teeth and not perceptible to palpation.

6. CONCLUSIONS

In this study the treatment of the unilateral fractures of the zygomatic maxillary complex with the use of plates and screws of the 1.5 mm system presented good esthetic results and low rates of complications.

7. CONFLICT OF INTEREST STATEMENT

The authors haven't any financial and personal relationships with other people or organizations that could inappropriately influence this work.

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