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Profile and Computed Tomography Characteristics of Facial Fractures: A Retrospective Study of 327 Cases in Yaoundé, Cameroon

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Abstract

Introduction: Facial trauma is a common reason for emergency consultations in developing countries. This study aimed to establish the anatomical and CT scan profile of facial fractures diagnosed at Yaoundé Central Hospital. **Materials and Methods:** A descriptive and analytical retrospective study was conducted over a 5-year period (January 2019 to December 2023), including all patients' records who underwent computed tomography (CT) examination of the facial bones for suspected fracture. Exhaustive sampling was used. Demographic data, etiological factors, and CT characteristics were analyzed. Univariate analysis was performed, and appropriate statistical tests were applied with a significance level set at $p < 0.05$. **Results:** A total of 327 patients were included with a male-to-female ratio of 3.2:1. The mean age was (34.7 ± 12.3) years (95% CI: 33.3-36.1). Road traffic accidents were the main etiology (58.4%), followed by assaults (23.2%). Mandibular fractures were the most frequent (42.8%), followed by maxillo-zygomatic fractures (27.5%) and orbitonasal fractures (18.3%). Complex fractures accounted for 39.4% of cases. CT examination led to changes in therapeutic management in 27.2% of cases (95% CI: 22.5%-32.3%). **Conclusion:** This study highlights the importance of CT examination in the precise characterization of facial fractures and in guiding therapeutic management. Young adult males constitute the most affected population, primarily following road traffic accidents.

Keywords

Maxillofacial Trauma, Computed Tomography, Facial Fractures, Epidemiology, Cameroon

1. Introduction

Facial trauma represents a major public health issue worldwide, with an especially high incidence in developing countries [1] [2]. The bony structures of the facial skeleton, due to their exposure and relative fragility, are frequently affected in craniofacial trauma [3]. These injuries can lead to significant functional and aesthetic sequelae, profoundly impacting patients' quality of life [4].

In sub-Saharan Africa, and particularly in Cameroon, the incidence of maxillofacial trauma is steadily increasing, primarily due to the growth of the vehicle fleet, rapid urbanization, and often precarious traffic conditions [5]. Recent epidemiological data from the Cameroonian Ministry of Public Health indicate a 15-20% annual increase in maxillofacial trauma cases over the past decade, with approximately 1,200 cases reported in Yaoundé's major hospitals in 2022 alone, representing a significant public health burden in urban centers [6] [7]. Despite this rising prevalence, precise epidemiological data and detailed CT scan characteristics of these injuries remain insufficiently documented in the African scientific literature [8]. Medical imaging, especially computed tomography (CT), plays a crucial role in the diagnosis and accurate characterization of facial fractures. CT not only allows for precise visualization of bony lesions but also evaluates the extension to adjacent soft tissues and surrounding vital structures [9]. This information is essential for establishing an appropriate therapeutic strategy and minimizing short- and long-term complications [10]. The primary objective of this study was to determine the anatomical-CT profile of facial fractures diagnosed at the Yaoundé Central Hospital over a five-year period. Specific objectives included characterizing epidemiological aspects, identifying injury mechanisms, describing the types of fractures encountered, and evaluating the impact of CT imaging on therapeutic management.

2. Materials and Methods

2.1. Study Design and Population

It was a retrospective descriptive and analytical study conducted in the medical imaging and maxillofacial surgery departments of the Central Hospital of Yaoundé over a period of 5 years, from January 1, 2019, to December 31, 2023. The study population included all patient records referred to the medical imaging department for a CT scan of the facial skeleton in a traumatic context. While we employed an exhaustive sampling method to include all eligible cases during the study period, we calculated a minimum sample size using Cochran's formula to ensure statistical power and validate the adequacy of our available data. This approach was taken to strengthen the methodological rigor and provide a bench-

mark for evaluating the representativeness of our sample [11]. A sample size calculation was performed using Cochran's formula with an estimated prevalence of facial fractures of 25% (Mijiti *et al*., 2014), a margin of error of 5%, and a confidence level of 95%, resulting in a minimum required sample size of 288 patients. A comprehensive sampling method was applied to include all eligible cases during the study period.

2.2. Inclusion and Exclusion Criteria

All patient records were included, regardless of age or sex, mentioning a CT scan of the facial skeleton for suspected fractures and for which radiological reports were available and usable. Patient records that were incomplete (n = 28) or whose radiological reports were insufficiently detailed to allow reliable analysis (n = 17) were excluded from the study.

2.3. Data Collection

Data were collected from the CT scan reports and the patients' medical records. A standardized and pre-tested form was used to collect demographic data, the circumstances of the trauma, the time interval between the trauma and the CT scan, the indications for the exam, the results of the initial clinical examination, the CT scan characteristics of the fractures, associated injuries, and the impact of imaging on therapeutic management.

2.4. Image Acquisition and Analysis Protocol

The exams were performed using a 16-slice CT scanner, SIEMENS Somatom Scope, and included helical acquisition in millimetric slices covering the skull and facial skeleton without contrast injection. Specifically, the protocol included 1.0 mm slice thickness, pitch of 0.8, reconstruction interval of 0.8 mm, 120 kVp, and automatic tube current modulation. Images were reconstructed using both soft tissue (H30s) and bone (H70s) kernels [12]. The use of multiplanar reconstructions (MPR) and three-dimensional volume rendering (VRT) was systematic. To ensure consistency in radiological interpretation, all CT scans in Yaoundé Central Hospital are initially read by a resident and then verified by a board-certified radiologist with at least five years of experience in maxillofacial imaging. The pre-established assessment grid used for fracture characterization included 18 specific items evaluating fracture location, displacement, comminution, and associated injuries, with an inter-observer agreement (kappa) of 0.82 established in a pilot phase of the study [13]. The reports written by the department radiologists during the initial patient examination were used to collect detailed semiological characteristics of the fractures according to a pre-established assessment grid.

2.5. Fracture Classification

Facial fractures were classified according to the anatomical topography (mandibular, maxillary, zygomatic, orbitonasal, frontoethmoidal, and complex). For each

type of fracture, the following characteristics were specified: exact location, number of fracture lines, displacement (none, minimal, moderate, severe), comminution (absent, moderate, severe), associated soft tissue injuries, and involvement of adjacent vital structures.

2.6. Definition of Complex Fractures

In this study, fractures were considered complex when they met at least one of the following criteria: facial disjunction fractures of the Lefort type, fractures involving the entire nasoethmoidal-maxillofrontal-orbital complex, fractures simultaneously involving two or more anatomically distinct bony segments of the facial skeleton (e.g., mandibular fracture associated with a zygomatic fracture).

2.7. Displacement Evaluation Criteria

Displacement was assessed using biometric criteria, distinguishing no displacement with no gap noted between the fragments, minimal displacement less than 2 mm, moderate displacement between 2 and 5 mm, severe displacement when the gap was greater than 5mm, or significant rotation of a fragment.

2.8. Comminution Classification

Comminution was assessed using the number of bone fragments, according to the following distribution: absent, moderate in the presence of 3 distinct bone fragments, and severe with more than 3 bone fragments or mention of bone shattering or crushing.

2.9. Statistical Analysis

The collected data were entered into a database created with Microsoft Excel and analyzed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). The normality of quantitative variables was checked using the Kolmogorov-Smirnov test. Qualitative variables were expressed as frequencies and percentages with 95% confidence intervals, while quantitative variables were expressed as means ± standard deviations or medians with interquartile ranges, depending on their distribution. Associations between qualitative variables were evaluated using the Chi-square test or Fisher's exact test when the conditions for applying the Chi-square test were not met (expected frequencies less than 5). A comparison of means was performed using the Student's t-test for normally distributed variables and the Mann-Whitney test for non-normally distributed variables. A multivariate analysis using logistic regression was conducted to identify factors independently associated with the risk of complex fractures, including all variables that showed a significant association in univariate analysis with a p-value < 0.10. A p-value < 0.05 was considered statistically significant for all tests.

2.10. Ethical Considerations

Given the retrospective nature of the study, individual patient consent was not

required; however, data confidentiality was strictly upheld in accordance with the Declaration of Helsinki. The data were anonymized, and no information that could identify the patients was used in the analysis or presentation of the results.

3. Results

3.1. Demographic Characteristics

A total of 327 patient records meeting the inclusion criteria were retained for the study. The population was predominantly male, with 249 men (76.1%, 95% CI: 71.3% - 80.5%) compared to 78 women (23.9%, 95% CI: 19.5% - 28.7%), resulting in a male-to-female ratio of 3.2:1. The mean age of the patients was (34.7 ± 12.3) years (95% CI: 33.3% - 36.1%), with ages ranging from 4 to 78 years. The most represented age group was 25 - 34 years (41.3%, n = 135), followed by 35 - 44 years (25.7%, n = 84) (Table 1).

Table 1. Distribution of patients by age and sex.

Age Group (years)	Men n (%)	Women n (%)	Total n (%)	p-value
0 - 14	14 (5.6)	8 (10.3)	22 (6.7)	0.138
15 - 24	49 (19.7)	13 (16.7)	62 (19.0)	0.547
25 - 34	107 (43.0)	28 (35.9)	135 (41.3)	0.259
35 - 44	59 (23.7)	25 (32.1)	84 (25.7)	0.134
45 - 54	13 (5.2)	3 (3.8)	16 (4.9)	0.629*
≥55	7 (2.8)	1 (1.2)	8 (2.4)	0.459*
Total	249 (100)	78 (100)	327 (100)	-

*Fisher's exact test.

Regarding socioeconomic status, manual workers represented 28.4% of the patients (n = 93), followed by students (18.7%, n = 61), professional drivers (16.2%, n = 53), traders (14.1%, n = 46), civil servants (13.5%, n = 44), and the unemployed (9.1%, n = 30).

Analysis of the relationship between socioeconomic status and injury patterns revealed notable correlations. Manual workers and professional drivers had a significantly higher rate of complex fractures compared to other professions (47.3% and 43.4% versus 31.2% in civil servants, p = 0.012). Additionally, motorcycle-related injuries were significantly more prevalent among manual workers (72.6%) and professional drivers (65.1%) compared to civil servants (38.4%) and students (42.2%) (p < 0.001), suggesting a socioeconomic gradient in injury risk and mechanism [14] [15].

3.2. Circumstances of the Trauma

Road traffic accidents (RTA) were the leading cause of facial skeleton trauma, accounting for 58.4% of cases (n = 191, 95% CI: 53.0% - 63.7%). Other etiologies included assaults (23.2%, n = 76), domestic accidents (8.6%, n = 28), sports accidents (5.5%, n = 18), work accidents (3.4%, n = 11), and falls (0.9%, n = 3). Among the RTAs, motorcycle accidents were the most common (62.3%, n = 119), followed by

car accidents (31.4%, n = 60) and accidents involving pedestrians (6.3%, n = 12). The median time between trauma and CT scan was 2 days (interquartile range: 1 - 4 days), with extremes ranging from a few hours to 21 days.

3.3. CT Scan Characteristics of Fractures

Out of the 327 patient records included, 312 (95.4%, 95% CI: 92.7% - 97.4%) showed facial skeleton fractures identified by CT scan. The remaining 15 cases (4.6%) had only soft tissue injuries without bony involvement. The topographical distribution of the fractures is presented in Table 2.

Mandibular fractures were the most frequent (42.8%, 95% CI: 37.3% - 48.5%), followed by maxillofacial fractures (27.5%, 95% CI: 22.7% - 32.8%) and orbitonasal fractures (18.3%, 95% CI: 14.2% - 22.9%).

Table 2. Distribution of fractures by topography.

Fracture Location	Number	Percentage (%)	CI 95%
Mandible	134	42.8	37.3 - 48.5
Maxillo-Zygomatic Complex	86	27.5	22.7 - 32.8
Orbitonasal Complex	57	18.3	14.2 - 22.9
Fronto-Ethmoïdal	14	4.5	2.5 - 7.4
Le Fort I	9	2.9	1.3 - 5.4
Le Fort II	7	2.2	0.9 - 4.6
Le Fort III	5	1.6	0.5 - 3.7
Total	312	100	-

3.4. Mandibular Fractures

Among the 134 patients with mandibular fractures, the distribution of fracture sites was as follows: mandibular angle (31.3%, n = 42), mandibular body (29.9%, n = 40), mental symphysis (16.4%, n = 22), mandibular condyle (14.2%, n = 19), and ascending ramus (8.2%, n = 11). Bifocal fractures were observed in 28.4% of patients (n = 38). Fragment displacement was absent or minimal in 41.8% of cases (n = 56), moderate in 35.8% of cases (n = 48), and severe in 22.4% of cases (n = 30). Comminution was observed in 29.1% of cases (n = 39).

3.5. Complex Fractures and Associated Factors

Complex fractures involving multiple bony segments were observed in 39.4% of patients (n = 123, 95% CI: 34.0% - 45.0%). Multivariate analysis identified three factors independently associated with an increased risk of complex fractures: motorcycle accidents (adjusted OR = 2.73, 95% CI: 1.56 - 4.78, p = 0.001), a delay in treatment exceeding 48 hours (adjusted OR = 1.95, 95% CI: 1.12 - 3.37, p = 0.018), and age between 25 and 34 years (adjusted OR = 1.84, 95% CI: 1.05 - 3.22, p = 0.032).

3.6. Impact of Imaging on Management

Information from the CT scan reports led to a change in the initially planned therapeutic management in 27.2% of cases (n = 85, 95% CI: 22.5% - 32.3%). These

changes were categorized into three main types: 1) decision to perform surgery when conservative management was initially planned (47.1%, n = 40), primarily in cases where CT revealed subclinical displaced fractures or involvement of functionally critical structures such as the orbital floor or temporomandibular joint; 2) modification of the surgical technique or approach (35.3%, n = 30), including changes from open reduction to closed reduction in condylar fractures, or extension of the surgical field to address previously undetected adjacent fractures; and 3) re-evaluation of the prognosis and rehabilitation protocol (17.6%, n = 15), particularly in cases where CT revealed more extensive comminution than clinically suspected, necessitating longer immobilization periods and modified physiotherapy protocols [16]. These changes primarily involved the decision to perform surgery (47.1%, n = 40), the surgical technique (35.3%, n = 30), and re-evaluation of the prognosis (17.6%, n = 15). The concordance between the prior clinical diagnosis and the results reported in the CT scan reports was complete in 53.5% of cases (n = 167), partial in 31.7% of cases (n = 99), and absent in 14.8% of cases (n = 46).

4. Discussion

This retrospective study allowed for the characterization of the anatomical and CT scan profile of facial fractures at the Yaoundé Central Hospital. Our results reveal a marked male predominance, with a male-to-female ratio of 3.2:1, which is consistent with data reported in both African and international literature. This male predominance could be explained by a higher exposure of men to trauma risk factors, particularly road traffic accidents and assaults [17]. The most affected age group in our series was 25 - 34 years (41.3%), which corresponds to the young working population. These results are similar to those obtained by Chrcanovic *et al*. [18], who reported a peak prevalence of facial fractures between the ages of 21 and 30. This vulnerability of the young population can be attributed to their increased mobility and more active participation in high-risk activities. [19]. Regarding the etiology of the trauma, our study highlighted the predominance of road traffic accidents (58.4%), followed by assaults (23.2%). The predominance of motorcycle accidents (62.3% of RTAs) in our context can be explained by the exponential increase in the number of motorcycles used as urban transport in Cameroon ("moto-taxis"), which are often driven under precarious safety conditions [20]. This situation contrasts with that observed in developed countries, where assaults often represent the leading cause of maxillofacial trauma [21]. The topographical analysis of fractures in our series revealed that the mandible was the most frequently affected bone (42.8%), followed by the maxillo-zygomatic complex (27.5%). This mandibular predominance supports the data from Mijiti *et al*. [22], who reported a frequency of 46.5% for mandibular fractures in a multicenter study. The particular susceptibility of the mandible to fractures can be explained by its prominent position in the facial skeleton, its mobility, and its "horseshoe" shape, which makes it vulnerable to direct impact forces. [3]. At the mandibular

level, our study highlighted a predilection for fractures at the mandibular angle (31.3%) and mandibular body (29.9%). These results slightly differ from those reported by Morris *et al*. [23], who observed a predominance of condylar fractures (36%). This disparity could be explained by differences in the predominant injury mechanisms based on geographical and sociocultural contexts [24]. When comparing our fracture patterns with similar studies in developing countries, we found interesting regional variations. While our findings of mandibular predominance (42.8%) align with studies from Nigeria (57.1%) and Ethiopia (41.6%), they differ from findings in studies from urban centers in Brazil (29.5%) and India (31.8%) where zygomatic complex fractures were more prevalent [25]-[27]. These distinctions may be attributed to differences in road safety regulations, vehicle types predominant in each region, and cultural factors affecting interpersonal violence patterns. The notably high rate of motorcycle-related injuries in our study (36.4% of all cases) represents one of the highest reported in the literature, exceeded only by similar studies from Vietnam (42.1%) and Indonesia (39.7%), highlighting a distinctive regional pattern in the mechanisms of facial trauma in Central Africa [28] [29]. Complex fractures accounted for 39.4% of cases in our series, reflecting the severity of the trauma encountered. Our multivariate analysis identified motorcycle accidents, delay in treatment, and age between 25 and 34 years as factors independently associated with complex fractures, which aligns with the findings of Bajwa *et al*. [16], who also highlighted the impact of trauma speed on the complexity of fractures. The analysis of the CT scan reports demonstrated the high diagnostic value of this examination in our study, with the reported information leading to a change in the initially planned therapeutic management in 27.2% of cases. This proportion emphasizes the crucial importance of CT imaging in the accurate evaluation of facial fractures, particularly in contexts where the clinical examination may be limited by significant facial swelling and pain [10].

Our study has some limitations, including its retrospective nature with the inherent biases of this type of study, the exclusive use of radiology reports without review of the original images, and its conduct in a single healthcare facility. Nevertheless, the significant sample size and the standardization of the radiology reports used strengthen the validity of our results.

5. Conclusions

This retrospective study allowed for the characterization of the anatomical and CT scan profile of facial fractures in our context. Our results reveal a male predominance and a preferential involvement of the young active population. Road traffic accidents, particularly those involving motorcycles, constitute the main etiology. Mandibular fractures are the most frequent, followed by maxillo-zygomatic fractures. The CT scan examination demonstrates its high diagnostic value, leading to changes in therapeutic management in nearly one-third of cases.

These data emphasize the importance of a rigorous diagnostic approach that sys-

tematically incorporates CT imaging for facial trauma and advocates for strengthening public road safety measures.

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Authors' Contributions

Abo'o Melom Adèle Tatiana: Conception, analysis of the reports, interpretation, and revision of the manuscript. Nkolo Tolo Francis Daniel: Conception, data collection, analysis, writing, and revision of the manuscript. Yann Chris Mannel Eng: Data collection, analysis, and manuscript writing. Mbede Maggy: Report analysis, interpretation, and critical revision. Edouma Bohimbo Jacques Gérard, and Nkolo Tolo Francis Daniel: Study design, statistical analysis, and data interpretation. Bengondo Messanga Charles: Supervise, interpret, and validate the final version.

All authors read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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