

A CLINICO-RADIOLOGICAL STUDY OF TRAUMATIC FRACTURES OF THE NOSE, THE PARANASAL SINUSES AND THE ZYGOMATIC BONE IN A TERTIARY CARE CENTRE

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Abstract

Background: Traumatic injury to a person usually involves the face and its related structures such as the nose, the paranasal sinuses (PNS) and the zygomatic bone. Brain injury and cervical spine injury often co-exist with facial fractures. A combination of axial and coronal CT scans provides the most complete diagnostic information. Our study aims to determine the etiological factors and to study the mode of clinical presentation and the different radiological findings following traumatic fractures to the nose, the PNS and the zygomatic bone. **Materials and Methods:** The study was carried out in the Department of Otorhinolaryngology of our institute during the period of July 2017 to August 2019. All patients suspected of having fractures of nose, PNS and zygoma were studied. **Result:** A total of 96 patients confirmed radiologically of having fractures were selected for the study which included 71 cases of fracture nasal bones, 21 cases of fracture maxilla and 4 cases of fracture zygoma. The male: female ratio was 4:1. The most common age range fell in 21-30 years for male and 31-40 years for female. Upper class population represented the highest number of cases (48.96%), followed by lower class (27.08%), while the middle-class population represented the least number of cases (23.96%). Road traffic accidents (44.79%) represent the highest mode of injury, followed by Altercation/ Assault (27.08%), personal accident (25%), games and sports (2.08%) and animal injury (1.04%). The commonest presentation of all types of fractures was local pain (97.92%), followed by epistaxis (87.5%), deformity (75%), local swelling (73.96%), nasal obstruction (72.92%), periorbital ecchymosis (61.46%), headache (59.38%), sub-conjunctival haemorrhage (59.38%), trismus (31.25%), paranasal sinus (PNS) tenderness (27.08%) and smell disturbance (23.96%). On X-rays PNS Waters view and lateral view of nasal bones, 71 cases presented with nasal bone fractures i.e. 73.95% of total 96 samples studied. According to CT scan, out of the 21 cases of fracture maxilla, 7 cases (33.33%) represent plain fractures (other than Le Fort). There were 3 cases (14.28%) of Le Fort I and 2 cases (9.52%) of LE Fort II in the CT scan findings. No case of Le Fort III was reported during the study period. Zygomatic bone involvement along with fracture maxilla was seen in 5 cases (23.86%) of left side and 3 cases (14.28%) of right side. Out of the 4 zygomatic bone fractures, 1 case (25%) each shows Tripod fracture and arch fracture, 2 cases (50%) show involvement of left maxilla. **Conclusion:** Proper history taking and accurate physical examination are highly essential for the diagnosis. Simple plain X-rays are found to be very cheap and effective diagnostic tool, and are highly essential for proper diagnosis and treatment of the lesions, whereas CT scans are costly and are usually reserved for complicated cases.

INTRODUCTION

The term “Traumatic injury” refers to the physical effects of force and is generally used by surgeons and emergency physicians. The face is one of the most

exposed parts of our body. As such traumatic injury to a person usually involves the face and its related structures such as the nose, the paranasal sinuses(PNS) and the zygomatic bone. Perhaps one of the most challenging areas in traumatology is that

of injuries to the face and its related structures, given the complexity of the facial skeleton and surrounding soft tissues, the potential for post-traumatic functional deficit and deformity, and psychosocial stigmata attached to facial distortions. Gwyn PP et al (1971) found that two-thirds of the patients with facial injury sustain injury to other organ systems¹. Brain injury and cervical spine injury often co-exist with facial fractures. A non-contrast Computed Tomography (CT) scan is the modality of choice for the most complete evaluation of the facial skeleton, soft tissues, brain, and dural spaces in the trauma patient. A combination of axial and coronal CT scans provides the most complete diagnostic information. We have conducted this study in view of the immense essentiality to have a thorough knowledge about traumatic injuries to the facial structures as well as the rising incidence of accidents in both in the developing and the developed countries. The aim of this study was to determine the etiological factors and to study the mode of clinical presentation and the different radiological findings following traumatic fractures to the nose, the PNS and the zygomatic bone.

MATERIALS AND METHODS

The study was carried out in the Department of Otorhinolaryngology of our institute during the period of July 2017 to August 2019. Patients suspected of having fractures of nose, PNS and zygoma were studied. A total of 96 patients were confirmed radiologically of having fractures and then selected for the study, which were done irrespective of age, sex, religion, occupation, ethnic/ racial background and socio-economic status. The important instruments used for clinical examination to aid diagnosis of fracture were Karl Storz –

Endoscope light source, Karl Storz Telecam SL Camera system, cable light carrier, TV monitor and Karl Storz 0°, 30°, 70° endoscopes.

Detailed history of each case regarding the responsible object of the fracture, the direction of force, the timing of injury, presenting symptoms and previous history of surgery/ injury were recorded carefully. General physical examination, systemic and local examinations were carried out specifically. Each case was carefully assessed to rule out for any cervical spine injury, any airway obstruction and for any accompanying head injury. Any suspected case of fractures of the nose, the paranasal sinuses and the zygoma were clinically examined carefully. Signs of fractures like swelling, severe tenderness, crepitus, deformities, epistaxis, ecchymoses, deviated nasal septum (DNS) etc were noted. The cases confirmed radiologically by X-ray and CT scan were included in the study. For age and sex distribution, t-test was used to compare the means of the two samples (males or females) and F-test to compare the variables. The mean \pm Standard Deviation of all types of fractures i.e. nose, maxilla and zygoma were calculated. Two-sided Shapiro-Wilks p-value of <0.05 was considered to be statistically significant.

RESULTS

Altogether, 96 patients of radiologically confirmed cases of fractures of the nose, the paranasal sinuses and the zygoma were studied. The study sample included 71 cases of fracture nasal bones, 21 cases of fracture maxilla and 4 cases of fracture zygoma. The youngest patient in the series was 5 years old male child and the oldest 73 years old lady. There was one rare case of a female child of 6 years old due to animal injury in the series.

Table 1: Age and Sex

Age in years	Sex								Total	%
	Male				Female					
	N	M	Z	Total	N	M	Z	Total		
Below 10	3	1	-	4	1	-	-	1	5	5.21
10-20	6	3	-	9	-	-	-	-	9	9.37
21-30	23	5	2	30	4	1	-	5	35	36.45
31-40	13	4	-	17	9	1	-	10	27	28.12
41-50	8	2	-	10	1	2	-	3	13	13.54
51-60	2	1	-	3	1	-	-	1	4	4.16
61 and above	-	1	1	2	-	-	1	1	3	3.12
Total	55	17	3	75	16	4	1	21	96	100
Shapiro-Wilks p-value	p*=-0.1338				p**=0.0609					

Table 2: Mode of Injury

Mode of Injury	Number of Cases			Total	%	Shapiro-wilks P-value
	N	M	Z			
Road traffic accidents	23	16	4	43	44.79	p*=0.71
Altercation/ assault	24	2	-	26	27.08	p**=0.14
Personal accident	21	3	-	24	25	p***=0.253
Games and sports	2	-	-	2	2.08	P1=0.000
Animal injury	1	-	-	1	1.04	P2=0.000
Total	71	21	4	96	100	

Table 3: Clinical Presentation

Clinical Presentation	Number of Cases			Total	%
	N	M	Z		
Epistaxis	70	12	2	84	87.50
Deformity	59	11	2	72	75.00
Nasal obstruction	53	15	2	70	72.92
Headache	36	17	4	57	59.38
Local pain	66	24	4	94	97.92
Swelling	45	23	3	71	73.96
Trismus	10	17	3	30	31.25
Periorbital ecchymosis	36	20	3	59	61.46
Subconjunctival haemorrhage	36	18	3	57	59.38
PNS tenderness	3	20	3	26	27.08
Smell disturbance	19	3	1	23	23.96

Table 4: Site of involvement of the nose, maxilla and zygoma in X-Ray PNS, and nasal bones in lateral view X-Ray

Type of investigation		Number of cases			%	
X-Ray	PNS water's view showing fracture	Nose	R	26	36.62	
			L	30	38.02	
		Nose+Maxilla	11	15.49		
		Nose + Maxilla +ethmoid	4	5.63		
		Maxilla	R	8	38.09	
			L	13	61.90	
		Zygoma		2	50	
			2	50		
	Nasal bone's lateral view showing fracture	R	28	39.44		
		L	38	53.52		
Bilateral		5	7.04			

Table 5: Types of Fracture Nasal Bones According to Clinical and Radiological Findings

Type	Side	Number of Cases	Total	%	
Type I	RIGHT	26	56	36.62	78.87
	LEFT	30		42.25	
	BIL	-		0.00	
Type II	RIGHT	1	11	1.41	15.49
	LEFT	5		7.04	
	BIL	5		7.04	
Type III	RIGHT	1	4	1.41	5.63
	LEFT	3		4.22	
	BIL	-		0.00	
Total		71	71	100	

Table 6: Showing Different Sites of Fracture Maxilla in CT scan

Type of investigation	Number of cases			Total	%	
CT Scan/ MRI	Fracture Maxilla	PLAIN FRACTURE	R	1	1	4.76
			L	5	5	23.86
			BIL	1	1	4.76
		LE FORT I	R	2	2	14.28
			L	1	1	
		LE FORT II	R	1	1	9.52
			L	1	1	
		LE FORT III	R	-	-	-
			L	-	-	
		WITH ZYGOMA	R	3	3	14.28
			L	5	5	23.86
		WITH ZYGOMA + NOSE	R	-	-	4.76
			L	1	1	
Total		21	21	100		

Table 7: Showing Different Sites of Fracture Zygoma in CT scan

Type of Investigation	Number of Cases			Total	%	
CT scan/ MRI	Fracture Zygoma	Arch fracture	R	1	1	25
			L	-	-	
			BIL	-	-	
		Tripod fracture	1	1	25	
		Tetrapod fracture	-	-		
		With maxilla	R	-	-	
			L	2	2	50
Total		4	4	100		

Age and sex distribution runs a t-test to compare the means of the two samples (male or female) and F-test to compare the variable [Table 1]. The mean \pm S.D. of all types of fractures i.e. nose, maxilla and zygoma for male was 10.714 ± 9.962 and that of female was 3 ± 3.625 . The male:female ratio was 4:1.

Comparison of Means

Null hypothesis: difference = 0

t-statistic = 1.96095. Two-sided p-value = 0.0876

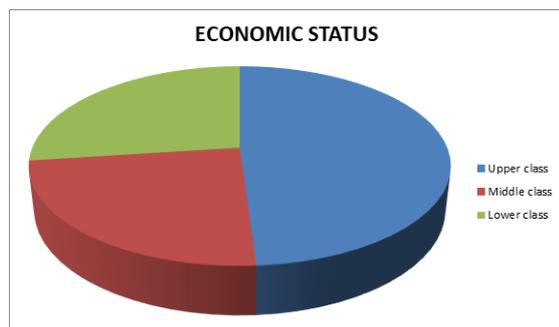
Comparison of Variance

Null hypothesis: ratio = 1

F-statistic = 7.55072. Two sided p-value = 0.0266

Since the p-value for the t-test is greater than 0.05, there is no statistically significance level, which means the samples are drawn from a normal population. Since $p^* > p^{**}$ we conclude that males have greater chance of having fracture of nasal bones, maxilla and zygoma. The male:female ratio for nasal bone fracture was 3.4:1, maxillary fracture 4.2:1 and that of zygoma was 3:1. The most common age range fell in 21-30 years for male and 31-40 years for female.

The number of Hindu patients dominated the samples with 81.25%, while the Christians maintained 6% and the remaining 5% belonged to Muslims. It may not be significant as the study was hospital based and unlikely to include the entire population of the Christians who are residing more in the rural areas.



p-value upper class, $p^*=0.7082$

p-value middle class, $p^{**}=0.1939$

p-value lower class, $p^{***}=0.3839$

It is observed that upper class population represented the highest number of cases (48.96%), followed by lower class (27.08%), while the middle-class population represented the least number of cases (23.96%), also shown by p-values of the study population i.e. $p^* > p^{***} > p^{**}$.

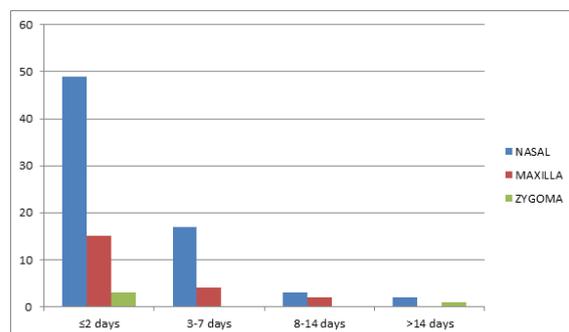
The student community (26.04%) was the most affected, followed by cultivator (19.79%), sedentary duty worker (17.7%), household worker (13.54%), driver and mechanics (9.37%), police and army personnel (7.29%), Industries/ brick field worker (5.21%) and sports person (1.04%).

Road traffic accidents (44.79%) represent the highest mode of injury, followed by Altercation/ Assault (27.08%), personal accident (25%), games and sports (2.08%) and animal injury (1.04%). Their respective p-values are as shown, $p^*=0.71$, $p^{**}=0.14$, $p^{***}=0.253$, $p_1=0.000$, $p_2=0.000$ [Table 2].

Age of Injury

Most of the patients (69.29%) reported on or before 2 days, 21.87% and 5.21% reported between 3-7 days and 8-14 days respectively and the remaining 3.21% reported later than 14 days, making p-values of $p^*=0.4855$, $p^{**}=0.4335$, $p_1=0.4233$ and $p_2=0.4125$ respectively.

The commonest presentation of all types of fractures was local pain (97.92%), followed by epistaxis (87.5%), deformity (75%), local swelling (73.96%), nasal obstruction (72.92%), periorbital ecchymosis (61.46%), headache (59.38%), sub-conjunctival haemorrhage (59.38%), trismus (31.25%), paranasal sinus (PNS) tenderness (27.08%) and smell disturbance (23.96%). Epistaxis was the commonest presentation of fracture of the nose alone [Table 3].



On X-rays PNS Waters view and lateral view of nasal bones, 71 cases presented with nasal bone fractures i.e. 73.95% of total 96 samples studied. Out of the 71 cases, 26 cases (36.62%) presented as isolated right sided nasal bone fracture, 30 cases (38.02%) presented as left sided, 11 cases (15.49%) involved maxilla besides the nasal bone fractures and 4 cases (5.63%) involved nasal bone, maxilla and ethmoid labyrinth. The PNS X-ray (waters view) also shows 21 cases (21.875%) of maxillary fractures out of 96 samples studied. Out of these, 8 cases (38.09%) presented as isolated right sided fractures whereas 13 cases (69.90%) presented as left sided fractures. There were 4 cases (4.16%) of fractures of the zygoma out of the 96 samples, of which 2 cases (50%) were of right side and the other 2 cases (50%) were of left side.

Out of the 71 cases of fracture nasal bones, lateral views of X-ray nasal bones show 28 cases (39.44%) as right sided fractures and the remaining 38 cases (53.52%) as left sided. 5 cases (7.04%) were found to be bilateral fractures.

CT scan was done only in 4 cases of nasal bone fractures, showing not much difference with the X-ray findings, whereas CT scan of maxilla and zygoma shows different patterns with that of plain X-ray.

Type I nasal fractures were seen in 56 cases (78.87%) out of 71 nasal bones fractures, out of which 30 cases (42.25%) were left sided and 26 cases (36.62%) were right sided. 11 cases (15.49%) were found to be Type II nasal fractures; 1 case (1.41%) was right sided, 5 cases (7.04%) were left sided and another 5 cases (7.04%) were bilateral. There was 1 case (1.41%) of

right sided Type III fracture and 3 cases (4.22%) of left sided Type III fractures.

According to CT scan, out of the 21 cases of fracture maxilla, 7 cases (33.33%) represent plain fractures (other than Le Fort); 5 cases (23.80%) were left sided, 1 case (4.76%) was right sided and another 1 case (4.76%) was bilateral. There were 3 cases (14.28%) of Le Fort I and 2 cases (9.52%) of LE Fort II in the CT scan findings. No case of Le Fort III was reported during the study period. Zygomatic bone involvement along with fracture maxilla was seen in 5 cases (23.86%) of left side and 3 cases (14.28%) of right side. In one case (4.76%) of left side, the nose was also involved along with maxillary and zygomatic bone fractures.

Out of the 4 zygomatic bone fractures, 1 case (25%) each shows Tripod fracture and arch fracture, 2 cases (50%) show involvement of left maxilla.

DISCUSSION

The study sample consisted of 78.13% males and 21.87% females making male: female ratio of 4:1, which tallies the study of Moosa Zargar et al (2004) showing male: female ratio as 4.5:1 and the most common age group between 21-30 years.^[1,2] The age of the patients ranged from 5 to 73 years which is quite similar to another finding of 4 to 80 years.^[3] In most of the literatures, male : female ratio in nasal bone fracture was 2:1, whereas in our study it was found to be 3.4:1 which was similar to a study conducted by Rhee et al,^[4] (2004) who gave the male : female ratio as 4.2:1. The male : female ratio for maxillary fracture was 4.2:1 which was similar to 4:1 conducted by Richard A and Robert HM,^[5] (1991) and male : female ratio of fracture zygoma was 3:1 which was similar to the study conducted by Zingg M et al (1992),^[6] who found the ratio as 4:1. The most frequent age group presenting with fracture of the nose, maxilla and zygoma was found to be 21-30 years. This was similar to the study done by Harrison DH,^[7] (1979) on fracture nasal bones, Richard A and Robert HM,^[5] (1991) in case of fracture maxilla and by Zingg M et al,^[6] (1992) in case of fracture zygoma. Murray JAM and Maram AGD,^[8] (1980) and Hussain K et al,^[9] (1994) found that there is no specific economic status and occupation which were more involved, but varies according to the makeup and locality of the study population with alcohol often having contributory role. Whereas in our study, the upper class population and student community were affected most. The reason might be because of the higher number of vehicles used by the upper class population, and tight scheduled daily activities of the student communities who were trying to adjust their activities accurately within time limits.

According to one study, the incidence of nasal bone fracture caused by traffic accidents decreased compared with that of nasal bone fracture caused by other mechanisms (Kim KS et al, 2018).^[10] In contrast to this, the commonest mode of injury in our

study was road traffic accident followed by altercation/ assault and personal accident which is similar to a study by Dutta SRB, 2018.^[3] However, in fracture nasal bones alone, altercation/ assault (33.80%) was the commonest, which is quite similar to Hwang K et al,^[11] (2009) who gave the figure at 34% and also that of study done by Maran AGD (1987),^[12] who mentioned assault was the commonest mode of injury. In the literatures by Richard A and Robert HM 1991,^[5] Aksoy E et al 2002,^[13] and Moosa Zargar et al 2004,^[2] road traffic accident was the most common cause of fracture maxilla and zygoma, which is similar to the present study which showed the highest figure among the modes of injury.

It is observed that local pain was the commonest clinical presentation among the three types of fracture studied, whereas epistaxis (72.92%) was the commonest clinical presentation in case of fracture nasal bones, which tallies with the study done by Sargent LA et al (1999),^[14] who also found that epistaxis was sometimes the only clinical finding in some nasal fractures. But in another study, nasal crepitation was the most common clinical finding in nasal bone fractures.^[15] Some other clinical findings like local deformity, PNS tenderness, oedema/ swelling, epistaxis and ecchymosis were observed in the study on maxillofacial trauma by Liu W et al (2008).^[16] However they mentioned that these features could be present, or they may be transient.

In cases of fracture maxilla, some of the features like epistaxis, periorbital ecchymosis and facial oedema were also found in the study done by Simon Holmes and Michael Gleeson (2008),^[17] though some of the clinical findings like surgical emphysema, lengthening of the face, infraorbital anaesthesia, anterior open bite in Le Fort II and III fractures, haematoma at the junction of hard and soft palate and floating palate and teeth in Le Fort I fractures were not found in the present study.

Jackson (1989),^[18] found that the most common symptoms in case of zygomatic fractures were local pain, swelling/ oedema and periorbital ecchymosis which tallies with our findings.

From the X-ray in the present study, it is observed that left side is fractured more often than the right side, presumably due to the high incidence of assault as the cause of fractures and due to the preponderance of right handedness in assailants. Bryan M and Driscoll B (1996),^[19] described similar findings. It is also observed from X-ray findings and case histories that lateral impact injuries were most common type of nasal injuries leading to fracture which is similar to the findings of Illium P et al (1983).^[20] Hwang K et al,^[21] (2006) found that though X-ray could not detect all the cases, 82% of fracture nasal bones could be detected by plain X-ray, compared to CT scan. This was supported by another systematic review, where the accuracy, sensitivity and specificity of CT scan was significantly higher than that of plain X-ray (Hwang K et al, 2018).^[22] In our study, all the cases were detected by plain X-ray. The present study

classified nasal fractures according to clinical and radiological findings into type I, type II and type III fractures according to involvement of surrounding facial bones and septum. Type I nasal fracture was most common. The study also shows that bilateral involvement is very common in Type II nasal fractures. These findings were not described in other literatures.

The different diagnosis of fracture maxilla and zygoma were made according to the clinical presentations and radiological findings. The features of Le Fort fractures were not shown completely in the series. Out of 3 cases of Le Fort I fractures, 2 cases were well defined on the right side and another one case on the left. Whereas out of the 2 cases of Le Fort II, 1 case was well defined on the left and another 1 case was well maintained on the right side. No case of Le Fort III was found in the series. There were 8 cases of fracture maxilla involving left side in 5 cases and right side in 3 cases, another 1 case of fracture maxilla involving both the zygoma and the nose on the left side. There were also 7 cases of fracture maxilla which could not be fitted in any of the Le Fort types. In our series we call it as plain fractures which involve left side in 5 cases and 1 case on the right and another bilaterally. Manson PN (1986)²³ also described that Le Fort types are not well maintained in majority of the cases.

Zygomatic fractures are usually caused by direct blow to the malar eminence or cheek.^[24,25] Fractures of the zygomatic arch compromise 10-15% of all the facial fractures²⁴. But our study shows 25% arch fracture of all fracture zygoma cases.

CONCLUSION

The present study comprising of 96 patients were diagnosed as fracture nasal bones, fracture maxilla and fracture zygoma and revealed that these conditions were more common in males than in females, with the most common age group between 21 to 30 years. The student community and upper class population were mostly affected. The commonest mode of injury in overall study was road traffic accident whereas for nasal bones alone, assault/altercation was the commonest. The commonest clinical presentation overall was local pain, but epistaxis was the commonest presentation in case of fracture nasal bones. X-ray PNS and X-ray nasal bones lateral view were used as the main diagnostic tool for diagnosis of fracture nasal bones and was found that left side was more involved than right side. CT scan findings were used to describe the different patterns of fracture maxilla and zygoma in which the exact patterns of Le Fort and Tripod fractures were hardly followed. The study found that proper history taking and accurate physical examination are highly essential for the diagnosis. Simple plain X-rays are found to be very cheap and effective diagnostic tool, and are highly essential for proper diagnosis and treatment of the lesions,

whereas CT scans are costly and are usually reserved for complicated cases.

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