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Occurrence and pattern of mandibular fractures in maxillofacial trauma of Kerala population: A one year retrospective study

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Abstract---Objectives: Fracture of the mandible may affect a single anatomic site or frequently several sites concurrently and road traffic accidents (RTA) play a prominent role. The aim of this study was to analyze the patient demographics, etiology, pattern, and types of mandibular fractures in three northern districts of Kerala. Methodology: 81 patients with sustaining mandibular fractures who visited the Emergency Department of the Oral and Maxillofacial

Surgery, Government Dental College, Thrissur, Kerala were recruited and evaluated retrospectively. The variables analyzed in the study were age, gender, etiology, fracture site, pattern, and types of fractures. The data were statistically analyzed using the Chi-square test to determine the association between the variables. Results: The study included 104 fractures in 81 patients. The ratio of males to females was 7.1:1. The highest fracture prevalence were observed in adults (88.9%) and the least in children under 12 years of age. RTA was the common cause (60.5%) followed by assault (27.2%). The most commonly reported fracture site was parasymphysis (24%), and the condyle (20.2%). The compound fractures were frequently observed (72%) and comminuted fractures (4%) were the least. A highly significant association was identified between the anatomic site and the severity of fracture types.Conclusion: The findings of the study reveal that mandibular fractures were more prevalent in males, especially in adulthood. The parasymphysis was the most often fractured region, while RTA was the most frequent cause of fractures, followed by falls. Parasymphysis was most frequently linked to angle and condyle fractures among multiple mandibular fractures.

Keywords---assault, comminuted, compound fracture, mandibular fractures, parasymphysis, road traffic accident.

Introduction

Among the maxillofacial bones, the mandible is one of the most conspicuous bones. Fracture of the mandible may affect a single anatomic site or frequently several sites concurrently.[1,2,3] According to studies, between 36% and 59% of all maxillofacial fractures are caused by mandibular fractures and are twice as common as midfacial fractures.[4-6] Although maxillofacial fractures are frequently studied, it is impossible to reach a consensus on their patterns because all the epidemiologic surveys vary depending on the population density of the specific geographical area, mode of injury, educational level, and socioeconomic condition of its residents.[4,5,7]Road Traffic Accidents (RTA), industrial trauma, injuries sustained while participating in sports, assault, and falls are the leading causes of mandibular fractures.[1,8,9] The amount of energy needed to fracture the mandible is in the range of 44.6 to 74.4 kg/m, which is similar to the energy required to fracture the zygoma and almost half of that required to fracture the frontal bone. Mandibular fractures necessitate four times the force of maxillary fractures.[3] The mandible in children is more elastic and stable than it is in adults due to factors like the absence of pneumatization, a higher cancellous-to-cortical bone proportion, and a mixed stage of dentition. As a result, children experience fewer facial or mandibular fractures compared to adults.[10]

Mandibular fractures that are poorly managed might result in facial asymmetry, malocclusion, temporomandibular joint (TMJ) disorders, and Osteomyelitis as well as other functional and cosmetic consequences.[6,8] There are only a few epidemiological studies of maxillofacial trauma in the population of Kerala, despite numerous reports concerning the occurrence, diagnosis, and treatment of

the mandibular fracture. These studies would help to identify the causative factors and gauge the severity of different patterns of mandibular fractures. The Department of Oral and Maxillofacial Surgery (OMFS), Government Dental College and Hospital (GDC), Thrissur is the major maxillofacial trauma center serving the Northern districts, including Thrissur, Malappuram, and Palakkad. The demographic profile of the mandibular fractures that occur in these districts is determined by examining the patients reporting to the Emergency Department of GDC, Thrissur. This information will help medical professionals to plan and evaluate the management of maxillofacial trauma. The aims of the present study were to determine the gender distribution of mandibular fractures, to establish the age group in which these fractures most frequently occur, to identify the anatomic site of the fracture, the kind, and the pattern of mandibular fractures, and to examine into the potential contributing factors such as RTA, fall, and assault among patients who visited GDC Thrissur over the course of a year.

Materials and Methods

Procedure

In the present retrospective study, 81 patients with sustaining mandibular fractures who visited the Emergency Department of the OMFS, GDC, Thrissur, Kerala, between April 2021 and March 2022 were recruited after obtaining informed consent. This study included all mandibular fracture patients throughout this timeframe, regardless of whether they were inpatients who underwent surgery or outpatients who received non-surgical treatment. Insufficient medical records were excluded. The medical records of all the study participants were examined after receiving approval from the Institution Ethics Committee(IEC 008/Govt Dental College Thrissur dtd 21-02-2022). The information on age, gender, etiology, anatomic site, type of fracture, and unilateral or bilateral fractures was recorded using a standardized proforma for Maxillofacial trauma. Each patient in this study underwent a complete clinical examination after documenting their history in order to determine the diagnosis. Patients with a history of trauma, regardless of a clinical diagnosis of fracture, received radiological evaluation to correlate with the clinical findings. According to the severity of fractures, they are categorized into simple, compound, comminuted, and complex/complicated fractures.[11] Further, based on the anatomical location, mandibular fractures were categorized as fractures in condyle, coronoid, ramus, angle, body, symphysis, parasymphysis, and dentoalveolar process. Patients were then classified into four age groups: children (those under 12 years of age), adolescents (those between 13 and 18), adults (between 19 and 59), and senior adults (those over 60 and above).[12] RTA, assaults, and unintentional falls/accidents were identified as the etiologies of the fracture in the present study. The data were evaluated using descriptive statistics and analyzed based on the following factors: age, gender, etiology of the trauma, the anatomical site of fractures, and its types.

Statistical analysis

The statistical analysis was performed using the 2019 release of IBM SPSS Statistics for Windows, Version 26.0. IBM Corporation, Bangalore, South Asia.

Statistical significance was defined as a p-value<0.05. The Chi-Square test was used to determine the statistically significant association between various age groups, the types of fracture and its etiological factors.

Results

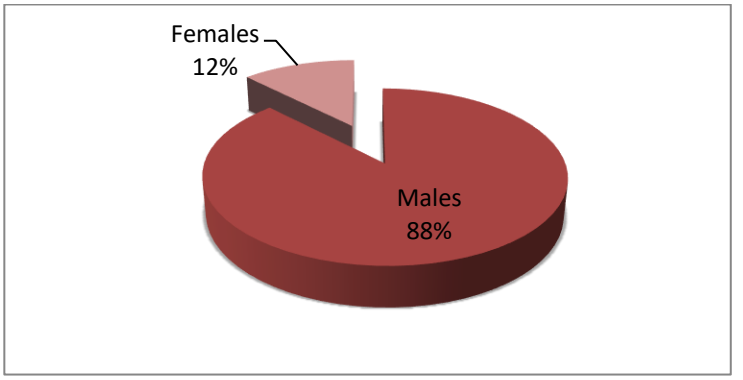
The study included 81 patients with 104 mandible fractures in total, 71 of them were males (88%) and 10 of whom (12%) were females. Male to female ratio is 7.1:1 (Graph 1). Patients ranged in age from 6 to 85 years, with a mean age of 33.31±14.23. Graph 2 represents the distribution of various age groups of the study population; around three-fourths of the study sample (72/81, 88.9%) were in the adult group. The age group older than 60 years reported the lowest incidences of cases in this study (4/81, 4.9%). A comparison of various age groups and gender (Graph 3) revealed a statistically significant difference (p=0.001).

The association between the gender and anatomic site of the fracture by applying the Chi-square test revealed a statistically insignificant difference (Graph 4). Graph 5 shows that the compound fractures were more frequently observed (58/81, 72%) than the simple fractures (16/81, 20%). Comminuted fractures (3/81, 4%) were the least common. The distribution of unilateral (72.8%) and bilateral fractures (27.2%) is shown in Graph 6. Among the 104 fracture sites noted in the present study, the parasymphysis region accounted for the majority of patient fractures (25/104, 24%), followed by the condyle (21/104, 20.2%), body (17/104, 16.3%), dentoalveolar (15/104, 14.4%), angle (11/104, 10.6%), and ramus (8/104, 7.7%). Symphysis (4/104, 3.8%) and coronoid (3/104, 2.9%) fractures were the least common (Graph 7).

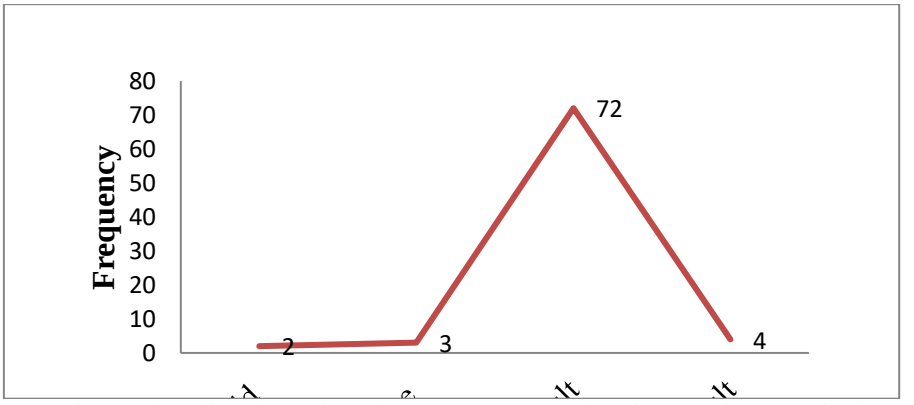
Combination of parasymphysis and condyle fracture (6.2%) was the commonest followed by angle+parasymphysis (4.9%), angle+body (2.5%), and body+condyle (2.5%). Various other combinations of fractures were also noticed in different anatomic sites as shown in Graph 8. The distribution of anatomic sites of single and multiple fractures was depicted in Graph 9 and found to be statistically significant (p=0.002). Two-thirds of the adolescence had fractures due to RTA. Among the adult population, RTA (45/72, 62.5%) was the most prevalent followed by assault (18/72, 25%), and falls (9/72, 12.5%). 91.8% and 90% of fractures due to RTA and falls respectively were comprised of adults. Children comprised 2.5% (2/81) of the study sample and reportedly had fractures due to assault (Graph 10). Table 1 reveals that in all age categories except the senior adults, compound fractures (58/81, 71.6%) were more prevalent than simple fractures (16/81, 19.8%). Comminuted (3/81, 3.7%), and complex (4/81, 4.9%) fractures were less common. 75% of the senior adults had simple fractures. Table 2 shows that 54.3% of males and 6.2% of females had mandibular fractures due to RTA. Fractures due to falls/accidents were not reported among females in the study population. 61.7% of males and 9.9% of females had compound fractures. Complex fractures (4.9%) were found only among the males (Table 3).

The principal cause of the mandibular fractures was RTA which accounted for 60.5% (49/81) of study subjects. Assault (22/81, 27.2%) was the second most frequent cause, followed by falls (10/81, 12.3%). 71.6% of the total fractures were

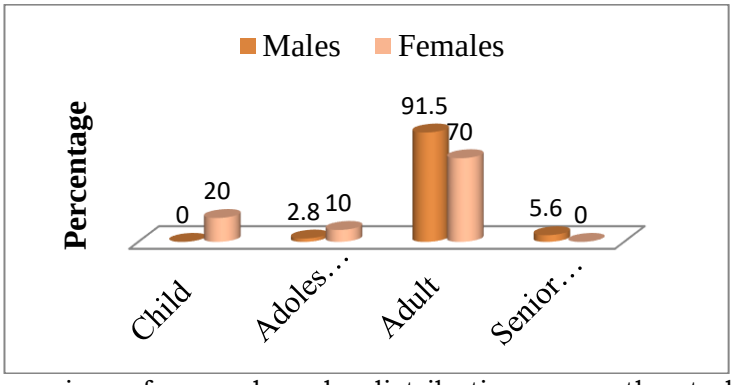
compound fractures. The most common reason for compound fractures was RTA (35/58, 60.3%), followed by assault (16/58, 27.6%), and falls (7/58, 12.1%). There was a statistically insignificant difference (p=0.30) observed between the etiology and type of fractures (Graph 11). Compound unilateral fractures were more common (40/59, 67.8%) followed by simple unilateral fractures (13/59, 22%). 31% (18/58) of the compound fractures were bilateral. The Chi-square test revealed an insignificant difference (p=0.54) between the severity of fracture types and unilateral/bilateral fractures (Graph 12). Graph 13 depicts that the dentoalveolar (15/59, 25.4%), condyle (14/59, 23.7%), parasymphysis (12/59, 20.3%), and body (11/59, 18.6%) were the most frequently fractured regions in instances with unilateral fractures and found to be statistically significant (p=0.03). Graph 14 discloses that overall fractures at the parasymphysis (20/70, 28.6%), condyle (14/70, 20%), body (13/70, 18.6%), angle (8/70, 11.4%), and ramus (7/70, 10%) were observed due to RTA. Among 104 fractures, 14.4% (15/104) of total fractures account for dentoalveolar fracture and was reported common due to assault (8/15, 53.3%). Most of the fractures in the study population were compound fractures (77/104, 74%) in which parasymphysis (22/77, 28.6%), followed by dentoalveolar (15/77, 19.5%), and body (14/77, 18.2%) were frequently afflicted. A highly significant association was identified between the anatomic site and the severity of fracture types (Graph 15).



Graph 1. Gender distribution of the study sample

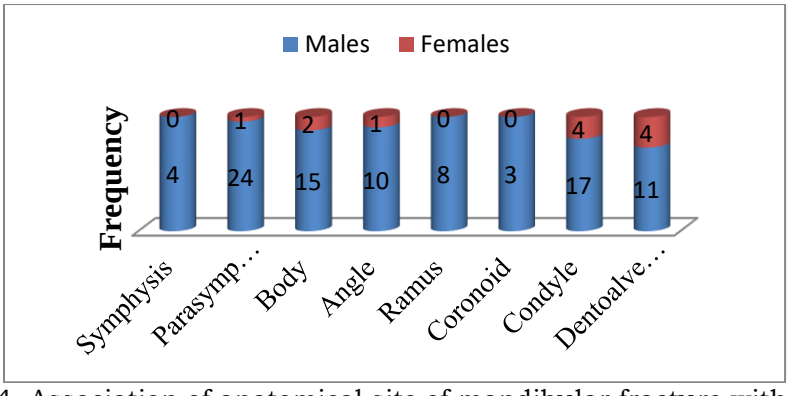


Graph 2. Distribution of various age groups in the study population



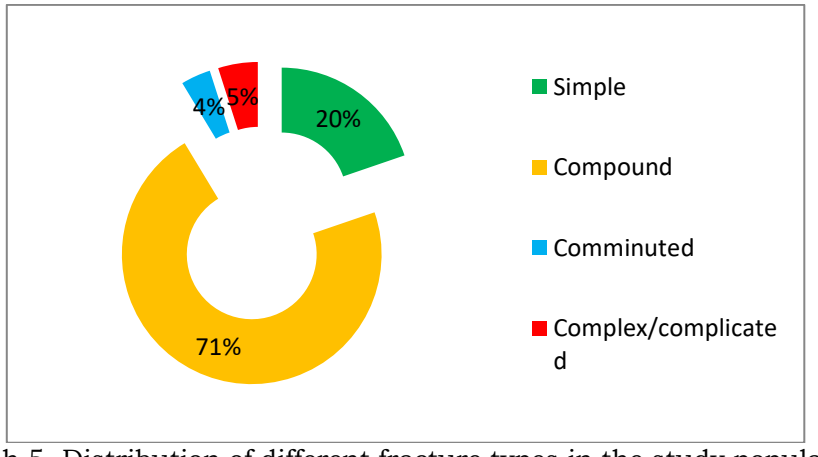
Graph 3. Comparison of age and gender distribution among the study population

$\chi 2 = 16.44$; p=0.001**
** highly significant

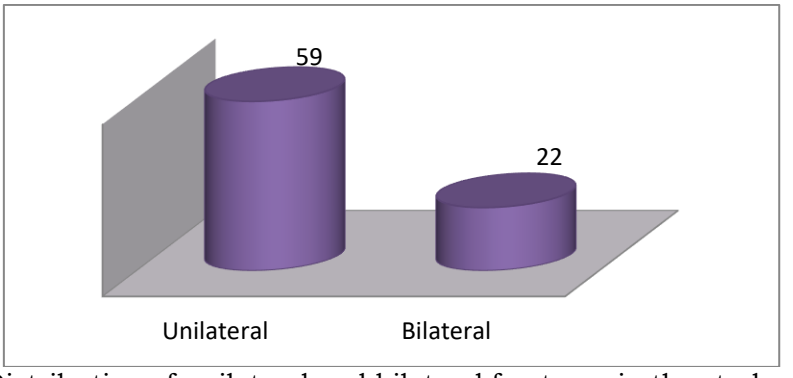


Graph 4. Association of anatomical site of mandibular fracture with gender

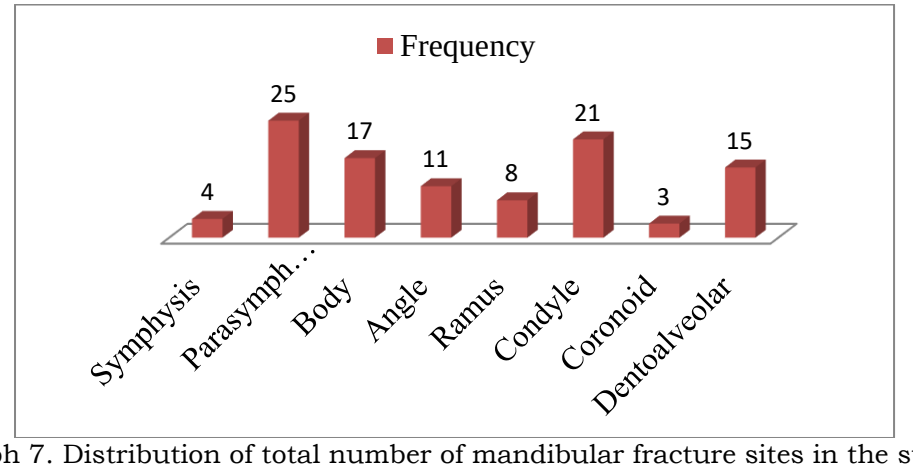
$\chi 2 = 7.94$; p=0.34



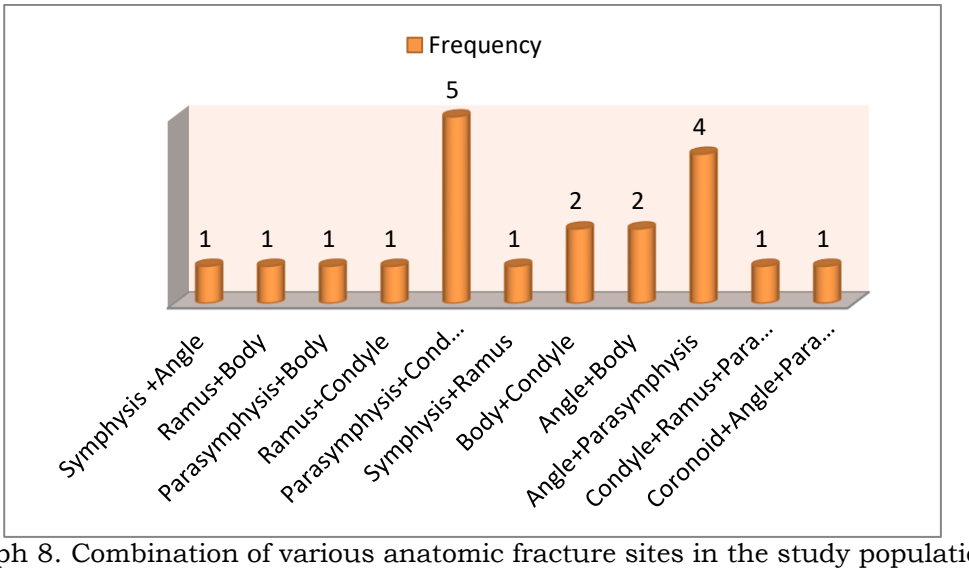
Graph 5. Distribution of different fracture types in the study population



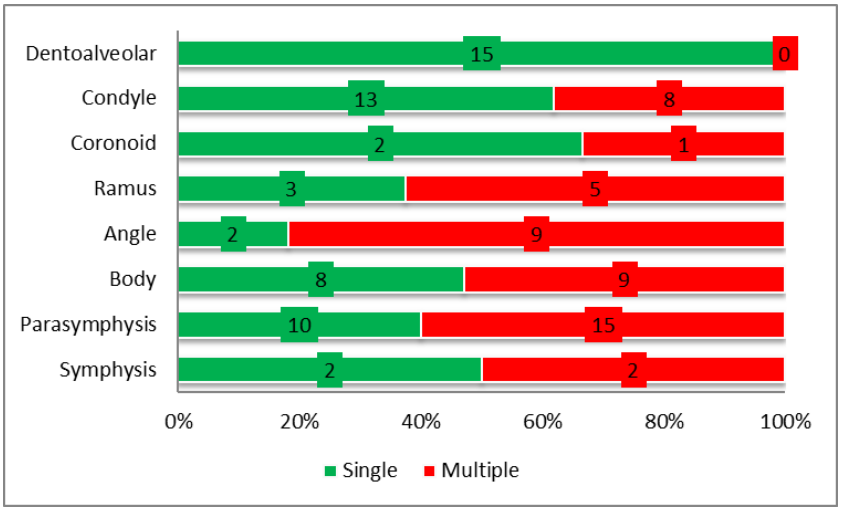
Graph 6. Distribution of unilateral and bilateral fractures in the study population



Graph 7. Distribution of total number of mandibular fracture sites in the study population

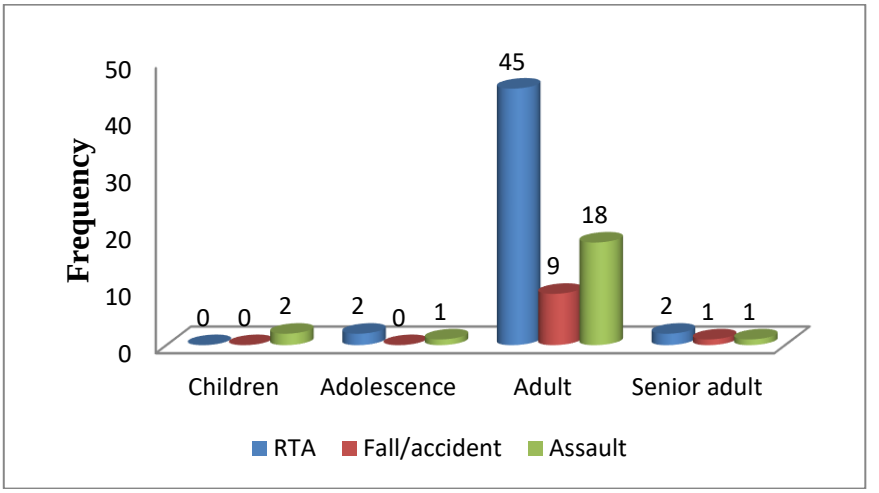


Graph 8. Combination of various anatomic fracture sites in the study population



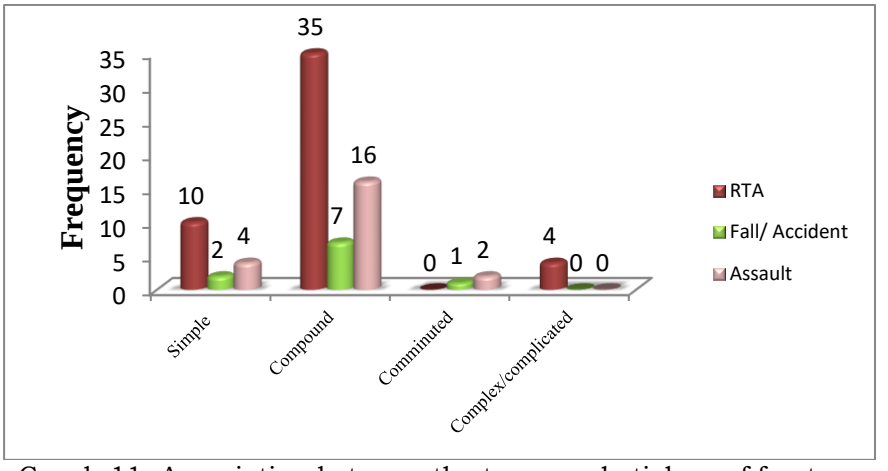
Graph 9: Distribution of anatomic sites of single and multiple mandibular fractures

$\chi 2$ = 22.27; p-vlaue = 0.002**
** highly significant



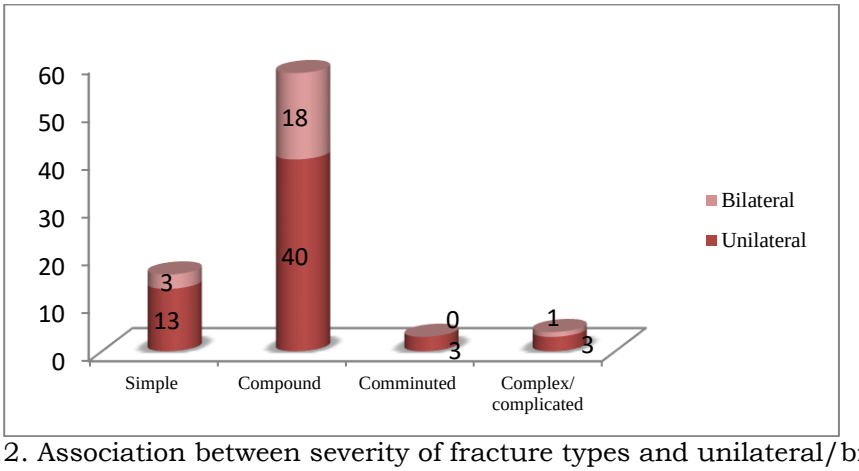
Graph 10. Comparison of etiology of fracture in various age groups in the study population

$\chi 2$ = 6.57; p-vlaue = 0.36



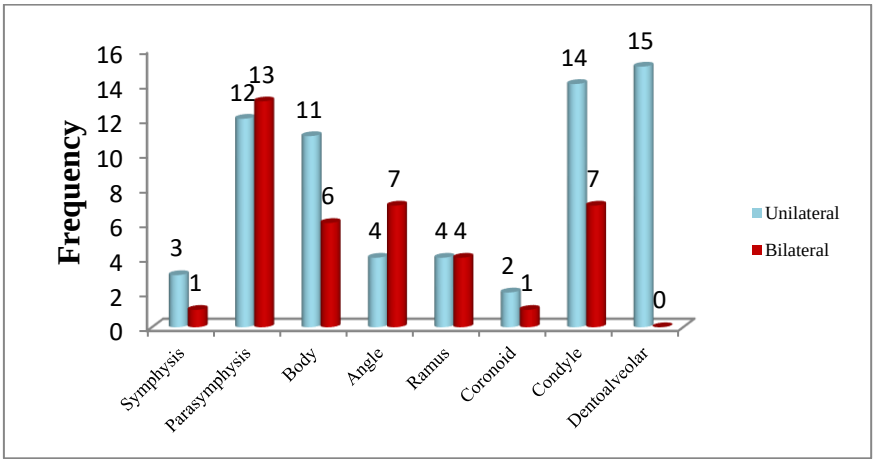
Graph 11. Association between the types and etiology of fracture

$\chi 2 = 7.27$; p-vlaue = 0.30



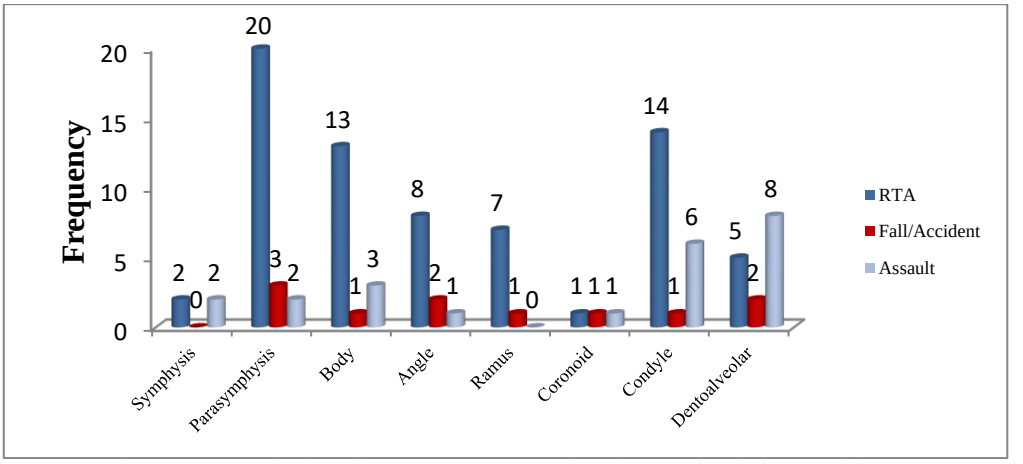
Graph 12. Association between severity of fracture types and unilateral/bilateral fractures

$\chi 2 = 2.14$; p-vlaue = 0.54



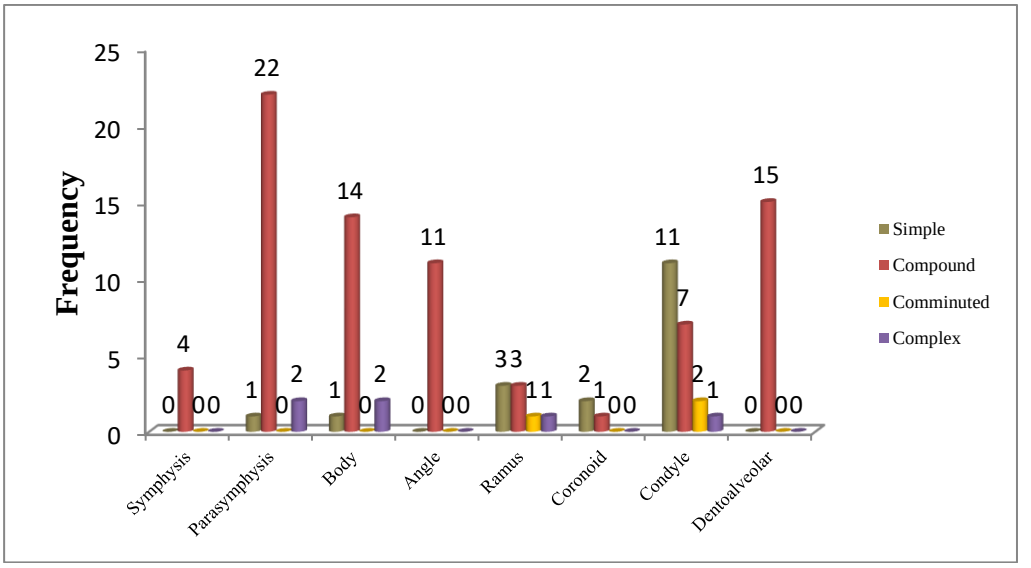
Graph 13. Association between anatomic site and unilateral/bilateral fracture

$\chi 2 = 15.46$; p-vlaue = 0.03*
*significant



Graph 14. Association between anatomic site and etiology of fracture

$\chi 2 = 21.91$; p-vlaue = 0.08



Graph 15. Association between anatomic sites and fracture types

$\chi 2 = 52.21$; $p = 0.001$**
**highly significant

Table 1
Association between fracture types and age in the study population

Age group		Simple	Compound	Comminuted	Complex / Complicated	Total	χ2	p-value
Children	Count	0	2	0	0	2		
	% within Age	0%	100.0%	0%	0%	100.0%		
	% within fracture type	0%	3.4%	0%	0%	2.5%		
	% of Total	0%	2.5%	0%	0%	2.5%		
Adolescence	Count	1	2	0	0	3		
	% within Age	33.3%	66.7%	0%	0%	100.0%		
	% within fracture type	6.2%	3.4%	0%	0%	3.7%		
	% of Total	1.2%	2.5%	0%	0%	3.7%		
Adults	Count	12	54	2	4	72		
	% within Age	16.7%	75.0%	2.8%	5.6%	100.0%		
	% within fracture type	75.0%	93.1%	66.7%	100.0%	88.9%	16.17	0.06
	% of Total	14.8%	66.7%	2.5%	4.9%	88.9%		
Senior adults	Count	3	0	1	0	4		
	% within Age	75.0%	0%	25.0%	0%	100.0%		
	% within fracture type	18.8%	0%	33.3%	0%	4.9%		
	% of Total	3.7%	0%	1.2%	0%	4.9%		
Total	Count	16	58	3	4	81		
	% within Age	19.8%	71.6%	3.7%	4.9%	100.0%		
	% within fracture type	100.0%	100.0%	100.0%	100.0%	100.0%		
	% of Total	19.8%	71.6%	3.7%	4.9%	100.0%		

Table 2
Association between gender and etiology of fracture

Etiology		Males	Females	Total	χ2	p-value
RTA	Count	44	5	49	3.81	0.15
	% within etiology	89.8%	10.2%	100.0%		
	% within sex	62.0%	50.0%	60.5%		
	% of Total	54.3%	6.2%	60.5%		
Fall/accident	Count	10	0	10		
	% within etiology	100.0%	0.0%	100.0%		
	% within Age	14.1%	0.0%	12.3%		
	% of Total	12.3%	0.0%	12.3%		
Assault	Count	17	5	22		
	% within etiology	77.3%	22.7%	100.0%		
	% within Age	23.9%	50.0%	27.2%		
	% of Total	21.0%	6.2%	27.2%		
Total	Count	71	10	81		
	% within etiology	87.7%	12.3%	100.0%		
	% within Age	100.0%	100.0%	100.0%		
	% of Total	87.7%	12.3%	100.0%		

Table 3
Association between fracture type and gender

Gender		Simple	Compound	Comminuted	Complex / complicated	Total	χ2	p-value
Males	Count	15	50	2	4	71		
	% within gender	21.1%	70.4%	2.8%	5.6%	100.0%		
	% within fracture type	93.8%	86.2%	66.7%	100.0%	87.7%		
	% of Total	18.5%	61.7%	2.5%	4.9%	87.7%		
Females	Count	1	8	1	0	10		
	% within gender	10.0%	80.0%	10.0%	0%	100.0%		
	% within fracture type	6.2%	13.8%	33.3%	0%	12.3%		
	% of Total	1.2%	9.9%	1.2%	0%	12.3%		
Total	Count	16	58	3	4	81		
	% within gender	19.8%	71.6%	3.7%	4.9%	100.0%		
	% within	100.0%	100.0%	100.0%	100.0%	100.0%	2.45	0.49

	fracture type							
	% of Total	19.8%	71.6%	3.7%	4.9%	100.0%		

Discussion

In the current study, mandibular fractures reported over the course of a year in three districts of northern Kerala were retrospectively analyzed. Numerous comparable studies were shown to have provided in-depth understandings of the etiological variables and the anatomic sites of fractures. The findings of this study were consistent with earlier publications in terms of age, and gender distribution. Data on gender distribution revealed a 7.1:1 male predominance which was found to be consistent with earlier studies in this domain.[8,13,14] While Nellissery et al.[15] reported a larger male preponderance of 23:1. Barde et al.[16] and Lin et al.[17] found a lower male:female ratio of 3.7:1 and 1.8:1 respectively. The increased levels of socialization, motor-vehicle driving, drug and alcohol misuse, and physical sports may contribute to the male preponderance. The incidence of mandibular fractures surged with adulthood and then declined in the senior adult group which concurs with the findings of Natu et al.,[3] and Ragupathy et al.[8] Younger age groups experience fewer fractures, which is primarily due to adequate parental supervision protecting them from serious traumas and the elastic structure of bone making them less vulnerable to fracture. Intense involvement in social and cultural activities, contact sports, and interpersonal violence mandibular fractures are more common in adults.[5]

The parasymphysis was the most frequently fractured site in this investigation, which is consistent with other earlier studies.[5,8] The anatomical placement of the parasymphysis region in the horseshoe form of the mandible makes it more susceptible to fracture when external stress is applied. Since their resistance to compressive pressures is greater, bones fracture at the location of tensile strain. The region lateral to the mental protuberance, the mental foramen, the mandibular angle, and the condylar neck show signs of weakening.[6,8] As it transmits pressure to the TMJ and the base of the skull, the thickening on the inner side of the condylar neck or crest of the neck appears to function as a major buttress of the mandible.[3,6]. Parasymphysis with angle and parasymphysis with condyle were the two most frequent combinations of mandibular fractures in this investigation which was in accordance with the findings of Vyas et al.[18] and Natu et al.,[3] respectively. A higher prevalence of fracture of the mandibular body and condyle were documented by Martini et al.,[19] and Andreas et al.[20] in their studies respectively. Nevertheless, the findings of Barde et al.,[16] Bither et al.,[21] King et al.,[22] and Vyas et al.[18] who indicated that the parasymphysis fracture is the most prevalent site of mandibular fractures and is consistent with the observation of the present study.

The study population experienced parasymphysis and ramus fractures 30.9% and 9.9% respectively. Even though ramus fractures are relatively uncommon among mandibular fractures, they frequently occur in conjunction with other facial fractures and are rarely solitary. The management of it is much more difficult from a technical and anatomical standpoint than that of other mandibular fractures. Agarwal et al. presented a new classification scheme to highlight the

mandibular buttress of the ramus and to distinguish its fractures for better management.[4] Moreover, maxillofacial fractures result in severe physiological injuries that require a multidisciplinary treatment. They also place a significant burden on society due to the accompanying morbidity, mortality, facial deformity, loss of function, and also financial costs.[23,24] Yamamoto et al.[25] described a rare instance of postoperative dysphagia in a patient with severe intellectual disability due to a delay in the treatment of a severe mandibular body fracture.

According to the results of this study, RTA continues to be the primary cause of trauma, which is in agreement with results from previous studies by Vyas et al.[18] and Barde et al.[16] RTA and falls were previously identified by epidemiological studies as the two main causes of mandibular fractures in developing nations. However, the main etiological causes in affluent countries are assaults and interpersonal violence.[26,27] Sojat et al.[7] documented the prevalence, etiology, and management of mandibular fractures at a tertiary health center for a 4-year period and disclosed that violent attacks, falls, sports activities, and trauma accounted for the majority of fractures. Except for dentoalveolar and tooth fractures, which were consistent with the findings of Yada et al.[28] sports-related injuries were not identified in the current study.

The cause of injury and the anatomic site of the fracture should be substantially correlated to establish the maxillofacial trauma diagnoses.[6,16] While condylar fractures were very likely to occur due to falls, RTA was found to be more likely to cause parasymphysis fractures. It is stated that the mandibular body and the angle fractures were most frequently reported in victims of violent assaults.[16] The different clinical consequences are caused by the direction and strength of the force, the type of object that made contact, and the unique properties of the bone.[6] The direction of the impact can aid the clinician in determining whether there is a concurrent fracture. Condylar fractures can occur bilaterally in the event of an anterior blow to the chin. Condylar or angle fractures can occur contralaterally in the event of an oblique blow to the parasymphysis.[16,29] The senior adults in their sixth decades, children and adolescents in the first and second decades respectively experienced fractures from falls.

The adults in their third, fourth, and fifth decades were primarily victims of RTA.[29] In developing nations, RTA-related mandibular trauma is primarily caused by a lack of road safety awareness among the general population, poor road conditions, lack of adherence of driving norms, vehicle usage at higher speed rates, and lower use of safety measures like seat belts, airbags, and helmets. Additionally, the use of intoxicating substances while driving demonstrates negligence, and widespread disregard for traffic laws.[17,29,30] In developed nations, assault-related mandibular trauma is considered to be caused due to upper socioeconomic standards, and substance abuse.[8] Patient age and fracture type have a strong correlation with regard to characteristic features of mandibular fractures. Mandibular fractures require a different treatment strategy than elsewhere in the skeleton since the teeth are its crucial anatomic element.[31]

To the best of our knowledge, this would be the first study to explain the fracture types in terms of the various age groups and etiologies of fractures, with respect to simple, compound, comminuted, and complex fractures. Although there was a

statistically insignificant association between fracture type and etiology in the current investigation, there was a statistically significant association between anatomic site and fracture type. As the current study was a retrospective one, certain patient history data might be missing or not be detailed enough to be collected. The possibility that the patients fail to reveal the information regarding the circumstances of their injuries in order to avoid legal repercussions was also not ruled out.

Conclusion

From the aforementioned findings of the study, it was deduced that mandibular fractures were more prevalent in males, with the highest percentage occurring in adulthood. The parasymphysis was the most often fractured region, while RTA was the most frequent cause of fractures, followed by falls. Parasymphysis was most frequently linked to angle and condyle fractures among multiple mandibular fractures. There is a need to educate the population about road safety measures to reduce accidents and falls.

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