

Epidemiology of hand fractures at a tertiary care setting in Saudi Arabia

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ABSTRACT

Objectives: To examine the epidemiology of hand fractures including common bones affected, causes, interventions, outcomes, and complications.

Methods: This retrospective records-based study included patients who were admitted to King Saud Medical City, Riyadh, Kingdom of Saudi Arabia, with traumatic metacarpal or phalangeal fractures between January 2016 and September 2017. Carpal fractures, wrist fractures, and all pathological fractures were excluded.

Results: A total of 82 patients (90.2% of them men with an average age of 27.6±13.4 years) with 101 fractures were included. The fifth (25.5%) and first (24.5%) rays were the most commonly affected ones. The fifth finger (27.8%) and first metacarpal (28.9%) were the most commonly affected finger and metacarpal bone. Approximately 32.7% of the fractures were open fractures. The most frequent causes of hand fractures included falls (40.5%), road traffic accidents (20.3%), crushing injuries (9.5%), and machinery injuries (9.5%). Approximately 90.1% of the patients underwent operative interventions including open reduction (50.5%) and closed reduction (34.3%). The majority of fractures (79.2%) healed, and only 14.7% of fractures developed complications.

Conclusion: In this study of hand fractures, patients were predominantly males and the main causes of fractures were falls and road traffic accidents.

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The hands are more vulnerable to fractures than other parts of the body. They constitute approximately 5-20% of all fractures and approximately 40% of upper limb fractures.^{1,2} The underlying causes of these injuries vary considerably according to demographic characteristics.^{2,3} A majority of hand fractures can be treated conservatively; however, some require surgical interventions.⁴

Trauma is a leading cause of morbidity and mortality in Kingdom of Saudi Arabia (KSA).^{5,6} Road traffic accidents and falls are the leading causes of trauma.^{6,7} Despite the high traumatic burden, epidemiologic data of different fractures including hand fractures in Saudi patients are scarce. For example, an old study examined the causes of hand injuries in children and adolescents but it did not specifically assess hand fractures.⁸ Additionally, a recent study reported the frequencies of upper and lower limb fractures, without segregating those of hand fractures.⁹ Another recent study examined hand fractures but only included children less than 18 years of age.¹⁰ Therefore, we sought to describe the epidemiology of only hand fractures in patients of all ages at our hospital. This included the distribution of the bones affected, causes of injuries, interventions, outcomes, and complications.

Methods. We conducted a PubMed search to ensure that there were no previous studies on the epidemiology of hand fractures in tertiary care center in Riyadh, KSA.

The current study was conducted at King Saud Medical City (KSMC) Riyadh, Saudi Arabia. King Saud Medical City is a publicly funded 1,400-bed tertiary care and teaching complex that includes 5 hospitals or centres. The hospital provides free primary-to-tertiary healthcare services for Saudi and eligible non-Saudi patients. According to the hospital protocol, all cases of hand fractures that require admission are managed by the Plastic Surgery Department.

All patients admitted with traumatic metacarpal or phalangeal fractures as per the diagnostic code of KSMC were included in the study. All diagnoses and exclusions were based on a review of the X-ray reports. Trauma patients with injuries of the hands, fingertips, tendons, joints, or blood vessels without metacarpal or phalangeal fractures were excluded. Additionally, carpal bone fractures, wrist fractures, and all pathological fractures were excluded. There were no exclusions based on the age or gender.

This retrospective review study was performed between January 2016 and September 2017. The Ethical approval was obtained from the Ethical Review Committee Board of KSMC, Riyadh, KSA.

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Requirement for consent was waived since the analysis was considered a non-human subject study, and the work was conducted according to the principles of the Helsinki Declaration.

A structured data collection sheet was developed and used to collect the socio-demographic characteristics of the patients along with the diagnoses at admission, comorbidities and fracture characteristics. The fracture characteristics included the affected bone site, side, fracture classifications, underlying causes, joint involvement, management, complications, and outcomes.

Statistical analysis. Data are presented as frequencies and percentages for categorical data and mean and standard deviation (SD) or median and interquartile range (IQR) for continuous data. Significant differences in the fracture characteristics according to demographic data and other fracture characteristics were evaluated using chi-square test or Fisher's exact test. All *p*-values were 2-tailed and *p*<0.05 were considered significant. Statistical Package for the Social Science version 25.0 (IBM, Corp., Armonk, NY, USA) was used for the statistical analyses.

Results. A total 82 patients were included; the average age was 27.6±13.4 years, with 23.2% of the patients were children up to 18 years old, while 41.5% were adults over 30 years old. (Table 1). Approximately 90% of the patients were males. Of those with documented occupations, 35.1% were students and 32.4% were manual workers. Approximately 19.7% of the patients had one or more comorbidities. More than one-third (36.4%) of the patients were current smokers. The 82 patients had 101 hand fractures. Most of the patients (82.9%) had single fractures, while the rest (17.1%) had multiple 2-4 fractures.

Fractures of the right hand were more frequent than those of the left hand (61.4% versus 38.6%; *p*=0.028). This was true for both metacarpal (59.6% versus 40.4%) and phalangeal (63.0% versus 37.0%) bones. Phalangeal fractures were slightly more frequent than metacarpal fractures (53.5% versus 46.5%). Overall, the little finger (14.9%) and first metacarpal (13.9%) were the most commonly affected bones. Additionally, the little (25.5%) and thumb (24.5%) rays were the most affected rays. Regarding the overall phalangeal fractures, the fifth (27.8%) and fourth (22.2%) fingers were the most commonly affected fingers and the proximal phalanges were the most commonly affected phalanges (42.6%), especially the proximal phalanx of the thumb (16.7%). Regarding the overall metacarpal fractures, those of the first (28.9%) and fifth metacarpals (23.4%)

Table 1 - Demographic and clinical characteristics of patients with hand fractures (N=82).

Characteristics	n (%)
Age (years) mean±SD	27.6±13.4
Range	1-69
Age	
≤18	19 (23.2)
19-30	29 (35.4)
31-45	34 (41.5)
Gender	
Male	74 (90.2)
Female	8 (9.8)
Occupation	
Student	13 (35.1)
Manual worker	12 (32.4)
Pre-school child	7 (18.9)
Office worker	4 (10.8)
Military worker	1 (2.7)
Comorbidity	
No	61 (80.3)
Yes	15 (19.7)
Type of comorbidity	
Diabetes	4 (5.3)
Hypertension	3 (3.9)
Bronchial asthma	3 (3.9)
Other fractures	5 (6.6)
Other comorbidities	4 (5.3)
Other behaviours	
Current smoking	28 (36.4)
Alcohol use	1 (1.3)
Drug abuse	1 (1.3)
Multiplicity of fractures	
Single	68 (82.9)
Multiple	14 (17.1)
Number of fractures	101
Time between pre- and post-management x-rays	
Median (interquartile range)	2.0 (1.0-4.75)

SD - standard deviation.

were the most common. In both hands, the most common individual bone fracture was that of the first metacarpal (13.9%), followed by the fifth metacarpal (10.9%), fourth metacarpal (8.9%), proximal phalanx of the thumb (8.9%), second metacarpal (6.9%), and middle phalanx of the little finger (6.9%).

Approximately two-thirds (67.3%) of the fractures were closed and one-third were open (32.7%) (Table 2). Transverse fractures (48.1%) were the most common type (48.1%), followed by oblique (21.2%), comminuted (19.2%), spiral (7.7%), and Bennett (3.8%) fractures. Approximately 25.7% of the fractures involved joints with fracture extension, especially in the little finger (46.7%) and thumb (45.5%). Approximately 20.8% of the fractures involved joints with dislocation, especially in the ring finger (41.7%) and thumb (36.4%). All female fractures were those of the phalanges and none were metacarpal (16.7% versus

Table 2 - Distribution of hand fractures (N=101) according to demographic and other fracture characteristics.

Factors	Overall (N=101)	I-Thumb (n=14)	II-Index (n=7)	Metacarpal			Total (n=47)	Thumb (n=11)	Index (n=9)	Phalangeal			Total (n=54)	P-value*
				III- Middle (n=6)	IV-Ring (n=9)	V-Little (n=11)				Middle (n=7)	Ring (n=12)	Little (n=15)		
<i>Age (years)</i>														
≤18	21 (20.8)	3 (21.4)	1 (14.3)	2 (33.3)	1 (11.1)	1 (9.1)	8 (17.0)	3 (27.3)	4 (44.4)	0	4 (33.3)	2 (13.3)	13 (24.1)	
19–30	37 (36.6)	6 (42.9)	3 (42.9)	0	4 (44.4)	3 (27.3)	16 (34.0)	4 (36.4)	4 (44.4)	6 (85.7)	2 (16.7)	5 (33.3)	21 (38.9)	
>30	43 (42.6)	5 (35.7)	3 (42.9)	4 (66.7)	4 (44.4)	7 (63.6)	23 (48.9)	4 (36.4)	1 (11.1)	1 (14.3)	6 (50.0)	8 (53.3)	20 (37.0)	
<i>Gender</i>														
Male	92 (91.1)	14 (100)	7 (100)	6 (100)	9 (100)	11 (100)	47 (100)	8 (72.7)	7 (77.8)	7 (100)	11 (91.7)	12 (80.0)	45 (83.3)	3
Female	9 (8.9)	0	0	0	0	0	0	3 (27.3)	2 (22.2)	0	1 (8.3)	3 (20.0)	9 (16.7)	
<i>Side of fracture</i>														
Right	62 (61.4)	6 (42.9)	2 (28.6)	4 (66.7)	8 (88.9)	8 (72.7)	28 (59.6)	8 (72.7)	5 (55.6)	4 (57.1)	8 (66.7)	9 (60.0)	34 (63.0)	
Left	39 (38.6)	8 (57.1)	5 (71.4)	2 (33.3)	1 (11.1)	3 (27.3)	19 (40.4)	3 (27.3)	4 (44.4)	3 (42.9)	4 (33.3)	6 (40.0)	20 (37.0)	
<i>Type of fracture-1</i>														
Open	33 (32.7)	4 (28.6)	2 (28.6)	1 (16.7)	0	0	7 (14.9)	5 (45.5)	6 (66.7)	5 (71.4)	8 (66.7)	2 (13.3)	26 (48.1)	2,3
Closed	68 (67.3)	10 (71.4)	5 (71.4)	5 (83.3)	9 (100)	11 (100)	40 (85.1)	6 (54.5)	3 (33.3)	2 (28.6)	4 (33.3)	13 (86.7)	28 (51.9)	
<i>Type of fracture-2</i>														
Transverse	25 (48.1)	4 (57.1)	3 (50.0)	0	2 (28.6)	5 (83.3)	14 (48.3)	3 (50.0)	2 (66.7)	0	4 (80.0)	2 (22.2)	11 (47.8)	3
Oblique	11 (21.2)	1 (14.3)	1 (16.7)	1 (33.3)	3 (42.9)	1 (16.7)	7 (24.1)	2 (33.3)	0	0	1 (20.0)	1 (11.1)	4 (17.4)	
Spiral	4 (7.7)	0	0	2 (66.7)	2 (28.6)	0	4 (13.8)	0	0	0	0	0	0	
Comminuted	10 (19.2)	0	2 (33.3)	0	0	0	2 (6.9)	1 (16.7)	1 (33.3)	0	0	6 (66.7)	8 (34.8)	
Bennett	2 (3.8)	2 (28.6)	0	0	0	0	2 (6.9)	0	0	0	0	0	0	
<i>Joints with fracture extensions</i>														
No	75 (74.3)	10 (71.4)	7 (100)	6 (100)	9 (100)	9 (81.8)	41 (87.2)	6 (54.5)	7 (77.8)	5 (71.4)	8 (66.7)	8 (53.3)	34 (63.0)	3
Yes	26 (25.7)	4 (28.6)	0	0	0	2 (18.2)	6 (12.8)	5 (45.5)	2 (22.2)	2 (28.6)	4 (33.3)	7 (46.7)	20 (37.0)	
<i>Joints with dislocations</i>														
No	80 (79.2)	11 (78.6)	7 (100)	5 (83.3)	8 (88.9)	10 (90.9)	41 (87.2)	7 (63.6)	7 (77.8)	6 (85.7)	7 (58.3)	12 (80.0)	39 (72.2)	
Yes	21 (20.8)	3 (21.4)	0	1 (16.7)	1 (11.1)	1 (9.1)	6 (12.8)	4 (36.4)	2 (22.2)	1 (14.3)	5 (41.7)	3 (20.0)	15 (27.8)	

*1 - significant differences between the five metacarpal bones, 2 - significant differences between the five phalangeal bones, 3 - significant differences overall metacarpal and phalangeal bones

0%, $p=0.003$). Open fractures were more common in the phalangeal than metacarpal bones (48.1% versus 14.9%, $p<0.001$). Additionally, open phalangeal fractures were the commonest in the middle finger and least common in the little finger (71.4% versus 13.3%, $p=0.016$). Comminuted fractures were more frequent in the phalanges than they were in the metacarpals (34.8% versus 6.9%, $p=0.031$). Joints with fracture extensions were more frequent in the fractures of the phalanges than in those of the metacarpals (37.0% versus 12.8%, $p=0.005$) (Table 2).

Falls on the hands were the most frequent cause of hand fractures (40.5%), followed by road traffic accidents (20.3%), crush injuries (9.5%), and machinery injuries (9.5%). Although falls on hands tended to be more frequent in children than in adults, in females than in males, and in metacarpals than in phalanges, the causes of hand fractures were not significantly different according to the age groups, gender, or distribution of fracture.

Most of the patients had only one hospital visit (89.0%) and underwent surgical interventions (90.1%), which mostly involved a single surgery (93.2%) under general anaesthesia (83.3%). Open reduction and internal fixation (ORIF) and ORIF (50.5%) with Kirshner wires (K-wire [44.4%]) were the most commonly performed interventions,

followed by closed reduction and internal fixation (CRIF: 34.3%). Interestingly, 5.1% of the fractures were managed conservatively and 3.0% received no treatment. Of the 77 fractures with available outcome data, 61 (79.2%) healed and the rest either did not heal (13.0%), had amputation (6.5%), or had mal-union (1.3%). Only 14.7% of the fractures managed developed complications, which included stiffness (71.4%), infection (14.3%), shortening (7.1%), or re-surgery (7.1%). As shown in Table 3, ORIF was more frequently performed than CRIF in adults aged 19-30 years ($p=0.023$), females ($p=0.684$), and patients with phalangeal fractures ($p=0.004$). However, the difference between the genders was not significant due to the small number of patients. Complications were significantly higher with younger age ($p=0.018$) and in females ($p=0.015$). Healing was slightly better in younger adults and males; however, neither difference reached statistical significance (Table 3).

Discussion. We reported on the epidemiology of hand fractures in patients of all ages admitted to a tertiary care hospital in KSA. As expected, most patients were young adult males which may reflect the traditional male predominance in activities such as driving, sports, work, and fighting.⁹ Male predominance to different degrees has been observed in almost all previous studies of hand

Table 3 - Management and outcomes of hand fractures *(N=82).

Factors	Overall	Age groups (years)			Gender		Distribution		P-value**
		≤18	19–30	>30	Male	Female	Metacarpal	Phalangeal	
<i>Number of visits</i>									
One	73 (89.0)	17 (89.5)	25 (86.2)	31 (91.2)	66 (89.2)	7 (87.5)	36 (87.8)	37 (90.2)	
Multiple	9 (11.0)	2 (10.5)	4 (13.8)	3 (8.8)	8 (10.8)	1 (12.5)	5 (12.2)	4 (9.8)	
<i>Underwent surgery</i>									
No	8 (9.9)	2 (10.5)	2 (6.9)	4 (12.1)	8 (11.0)	0	5 (12.5)	3 (7.3)	
Yes, on time	71 (87.7)	17 (89.5)	25 (86.2)	29 (87.9)	63 (86.3)	8 (100)	33 (82.5)	38 (92.7)	
Yes, delayed	2 (2.5)	0	2 (6.9)	0	2 (2.7)	0	2 (5.0)	0	
<i>Number of surgeries</i>									
One	68 (93.2)	15 (88.2)	26 (96.3)	27 (93.1)	60 (92.3)	8 (100)	32 (91.4)	36 (94.7)	
Multiple	5 (6.8)	2 (11.8)	1 (3.7)	2 (6.9)	5 (7.7)	0	3 (8.6)	2 (5.3)	
<i>Surgical anaesthesia</i>									
General	60 (83.3)	17 (100)	20 (80.0)	23 (76.7)	54 (84.4)	6 (75.0)	30 (88.2)	30 (78.9)	
Local	12 (16.7)	0	5 (20.0)	7 (23.3)	10 (15.6)	2 (25.0)	4 (11.8)	8 (21.1)	
<i>Intervention*</i>									
No treatment	3 (3.0)	2 (9.5)	1 (2.7)	0	3 (3.3)	0	2 (4.4)	1 (1.9)	1,3
Conservative	5 (5.1)	0	1 (2.7)	4 (9.8)	5 (5.6)	0	3 (6.7)	2 (3.7)	
ORIF	50 (50.5)	11 (52.4)	24 (64.9)	15 (36.6)	43 (47.8)	7 (77.8)	15 (33.3)	35 (64.8)	
K-wire	44 (44.4)	9 (42.9)	22 (59.5)	13 (31.7)	37 (41.1)	7 (77.8)	12 (26.7)	32 (59.3)	
Lag screw	1 (1.0)	0	0	1 (2.4)	1 (1.1)	0	1 (2.2)	0	
Screw and plate	3 (3.0)	1 (4.8)	2 (5.4)	0	3 (3.3)	0	2 (4.4)	1 (1.9)	
Suture 2/0 pds	1 (1.0)	1 (4.8)	0	0	1 (1.1)	0	0	1 (1.9)	
Cerclage wire	1 (1.0)	0	0	1 (2.4)	1 (1.1)	0	0	1 (1.9)	
CRIF with K-wire	34 (34.3)	7 (33.3)	11 (29.7)	16 (39.0)	32 (35.6)	2 (22.2)	23 (51.1)	11 (20.4)	
Others	7 (7.1)	1 (4.8)	0	6 (14.6)	7 (7.8)	0	2 (4.4)	5 (9.3)	
<i>Outcome*</i>									
Healed	61 (79.2)	14 (93.3)	23 (71.9)	24 (80.0)	56 (81.2)	5 (62.5)	30 (81.1)	31 (77.5)	
Not healed	10 (13.0)	0	5 (15.6)	5 (16.7)	8 (11.6)	2 (25.0)	6 (16.2)	4 (10.0)	
Mal-union	1 (1.3)	1 (6.7)	0	0	1 (1.4)	0	1 (2.7)	0	
Amputation	5 (6.5)	0	4 (12.5)	1 (3.3)	4 (5.8)	1 (12.5)	0	5 (12.5)	
<i>Complications*</i>									
No	81 (85.3)	12 (63.2)	33 (89.2)	36 (92.3)	77 (88.5)	4 (50.0)	39 (86.7)	42 (84.0)	1,2
Yes	14 (14.7)	7 (36.8)	4 (10.8)	3 (7.7)	10 (11.5)	4 (50.0)	6 (13.3)	8 (16.0)	
<i>Complication types*</i>									
Stiffness	10 (71.4)	4 (57.1)	4 (100)	2 (66.7)	6 (60.0)	4 (100)	4 (66.7)	6 (75.0)	
Infection	2 (14.3)	1 (14.3)	0	1 (33.3)	2 (20.0)	0	1 (16.7)	1 (12.5)	
Shortening	1 (7.1)	1 (14.3)	0	0	1 (10.0)	0	1 (16.7)	0	
Re-surgery	1 (7.1)	1 (14.3)	0	0	1 (10.0)	0	0	1 (12.5)	

Values are presented as number and percentage (%). *Number of fractures rather than patients was used, ** 1 - significant differences between age groups, 2 - significant differences between gender, 3 - significant differences between distribution of the fracture, ORIF - open reduction and internal fixation, CRIF - closed reduction and internal fixation, PDS - polydioxanone suture, K-wire - Kirshner wires

fractures as well as overall fractures. For example, males represented 65-80% of hand fractures in patients of all ages in international studies and children represented 80.6% of hand fractures in KSA.^{2,10}

Our findings demonstrated that hand fractures are more frequent in the right hand than in the left hand (61.4% versus 38.6%), which could be explained by the higher engagement and exposure of the predominant hand (usually right hand). Similar findings have been reported by some studies, while others have reported contrasting results.^{1,3,10} Our findings also demonstrated that little and thumb rays accounted for 50% of all hand fractures, with the little finger being the most commonly affected finger and the first metacarpal, the

most commonly affected metacarpal bone. The high frequency of fractures of the little finger or ray has been previously reported in both adults and children.^{1,3,10,11} This may be due to the use of the ulnar border of the hand as a protective mechanism during a fall. Similar to our findings, fractures of the thumb or ray have been reported as the second most common ones after those of the little finger in some studies in children.^{3,11} Additionally, our findings demonstrated that proximal phalanges were the most commonly affected phalanges, which was also reported in previous studies in children.¹¹

We found that falls and road traffic accidents were the most common mechanism of injury. Different studies have reported different mechanisms of injury in

hand fractures, which also largely reflect the variance in the activities according to the age, gender, and geographic locations of the population. In KSA, road traffic accidents, followed by falls, are responsible for a majority of all cases admitted for fractures as well as traumatic patients seen at the Emergency Department.^{6,7,9} However, the common causes of hand fractures in children included falls, injury by a door, and sports-related injuries.¹⁰ Additionally, crush injuries caused by doors at home were responsible for a majority of hand injuries in children, irrespective of the types of fractures.⁸ Internationally, hand fractures are most commonly caused by accidental falls and violence in United States of America's patients of all ages.² A majority of the patients in the current study were treated operatively. The higher rate of surgical interventions in the current study was probably due to the higher rate of open fractures: >30% compared with <10% in previous studies.^{12,13} Additionally, 17.1% of our patients had multiple fractures; of those, 20.8% included joints with dislocation, and 19.2%, comminuted fractures. Management of hand fractures in our patients was successful only 15% of fractures developed complication during management. Out of the total outcome, healing rate was 80%. For example, the infection rate in the current study was 2.0% compared with the pooled average infection rate of 2.9-4.2% in multiple studies that were examined in systematic reviews.^{14,15} Additionally, the rates of stiffness (10%) and re-surgery (1 percent) in the current study were compared with the pooled averages of 10.3% and 8.4% in studies that used both ORIF and CRIF in treating phalangeal fractures.¹⁵

Study limitations. Being a single-centre study, the current findings should be interpreted cautiously. Inclusion of in-patients only may have excluded the cases that were transferred to other hospitals because of the unavailability of beds and less severe cases that were treated conservatively. The retrospective design may have contributed to missing relevant information. Finally, the relatively small sample size may have masked some of the associations in our sub-analyses. The current study may need to be replicated in a larger prospective sample, preferably from multiple hospitals, to better describe the factors that affect the epidemiology of hand fractures in KSA.

In conclusion, we reported a high frequency of young adult males among patients of all ages admitted with hand fractures at a tertiary care hospital in Kingdom of Saudi Arabia. Falls on hands and road traffic accidents were responsible for a majority of hand fractures.

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