Original Article

A retrospective insight into patterns of humeral shaft fractures among Nigerians from radiological viewpoint

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Abstract

Background: Fractures of the humeral shaft account for 1–3% of all fractures in adults and for 20% of all humeral fractures in some populations. **Objective:** This study was aimed at classifying the pattern of humeral shaft fractures among Nigerian using the Müller's AO classification system. **Materials and Methods:** The study was carried out retrospectively at the Department of Medical Records, National Orthopedic Hospital, Igbobi, Lagos State, Nigeria, using plain films from a total number of 206 patients comprising 140 males and 66 females. Humeral shaft fractures were classified according to Müller's classification into three main types with three groups in each type. **Results:** The result showed that the most frequent type of humeral shaft fractures was simple fractures (76.7% [158/206]) followed by wedge fractures (20.4% [42/206]), whereas the least frequent was the complex fractures (2.9% [6/206]).Among the simple diaphyseal humeral fractures, simple spiral fractures were the most frequent (41.8% [66/168).Among the wedge diaphyseal humeral fractures, spiral wedge fractures were the most frequent (90.5% [38/42]).All the complex diaphyseal humeral fractures were of irregular complex group (12C3; 100% [6/6]). **Conclusion:** This study showed to a great extent that there is a pattern for diaphyseal humeral fractures among Nigerians. It goes a long way in equipping surgeons, to allow resources to be allocated on the basis of projected frequency of different types of diaphyseal humeral fractures.

Key words: Diaphyseal, fractures, humeral, Nigeria, pattern

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INTRODUCTION

The humeral diaphysis or shaft is the expanse between the proximal limit pectoralis major insertion and the distal

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metaphyseal flare of the humerus (Walker *et al.,* 2011). Fractures of the humeral diaphysis account for 1–3% of all fractures in adults and for 20% of all humeral fractures in some populations (Emmett and Breck, 1958; Rose *et al.,* 1982; Schemitsch *et al.,* 2008).

Several authors had proposed different classification systems for humeral fractures (Oestern and Tscherne, 1984; Gustilo and Anderson, 1976; Gustilo *et al.,* 1984). However, for research purposes, the most widely accepted classification system is those of Müller *et al*. (1990) and Orthopaedic Trauma Association Committee for Coding and Classification (1996). Müller *et al*. (1990) using alpha-numeric system assigned humeral shaft fractures into three main types: Type A (simple), Type B (wedge), and Type C (complex). The Orthopaedic Trauma Association (OTA) Committee for Coding and Classification extended this classification further into subtypes for further fracture details (Orthopaedic Trauma Association Committee for Coding and Classification, 1996).

Müller/OTA system is limited in clinical applicability. Furthermore, beyond identification of the three basic fracture types, it has poor interobserver reliability. However, it has remained useful for cataloging fractures for research purposes (Wainwright *et al.,* 2000).

Unfortunately, the epidemiology of fractures of the humeral shaft has received little attention in Nigeria and as such there is no literature available on the pattern of fractures of the humeral shaft among Nigerians. Hence, this study was aimed at classifying the pattern of humeral shaft fractures among Nigerian using the Müller's AO classification system.

This study could be useful in facilitating the planning of treatment, defining priorities in training, and gaining an understanding of orthopedic traumatology (Tytherleigh-Strong *et al.,* 1998), especially in developing countries where poor health-care system had led to the loss of lives and incapacitations of the citizens.

MATERIALS AND METHODS

The study was carried out retrospectively at the Department of Medical Records, National Orthopedic Hospital, Igbobi, Lagos State, Nigeria, using plain films of X-ray (both anteroposterior and lateral views) that were taken between 2009 and 2014 from a total number of 206 patients of ages from birth to 95 years (0–95 years), comprising 140 males and 66 females.

The plain films that were selected for the study were strictly those of Nigerians based on the information given by the subjects and filled in their case notes.

Information that was gathered from the patients' case notes included age of the patients, gender of the patients, side affected, and cause of the fracture. The causes were grouped into three: Those that occurred as a result of the fall, those occurred as a result of road traffic accident (RTA), and those that occurred as a result of other causes (these included birth injuries, pathological, industrial machines, and machete cut). The subjects were socioeconomically grouped according to their ages into children (17 years and below), young (18–39 years), middle age (40–64 years), and elderly (65 years and above).

Diaphyseal humeral fractures were classified according to Müller *et al.* (1990) into three main types with three groups in each type as shown in Figure 1.

The results were presented in tabular formats showing percentage frequencies and fractional frequencies. Comparisons of the patterns of diaphyseal humeral fractures were made between the sexes, sides affected, age groups, and causes of the fractures.

RESULTS

Table 1 presents the humeral diaphyseal fracture pattern among the subjects studied. The most frequent type of diaphyseal humeral fractures was simple fractures (12A; 76.7% [158/206]) followed by wedge fractures (12B; 20.4% [42/206]), whereas the least frequent was the complex fractures (12C; 2.9% [6/206]).

Among the simple diaphyseal humeral fracture cases [Table 1], simple spiral fractures was the most frequent (12A2; 41.8% [66/168]) followed by simple transverse fractures (12A3; 36.7% [58/158]), whereas simple oblique fractures was the least frequent (12A1; 21.5% [34/158]).

Among the wedge diaphyseal humeral fracture cases [Table 1], spiral wedge fractures were the most frequent (12B2; 90.5% [38/42]), whereas bending

Table 1: Diaphyseal humeral fracture pattern among the subjects studied

Types	Percentage frequency (fractional frequency)	Groups	Percentage frequency (fractional frequency)
12A	76.7 (158/206)	12A1	41.8 (66/158)
		12A2	21.5 (34/158)
		12A3	36.7 (58/158)
12B	20.4 (42/206)	12B1	90.5 (38/42)
		12B2	4.8 (2/42)
		12B3	4.8 (2/42)
12C	2.9 (6/206)	12C1	0.0 (0/6)
		12C2	0.0 (0/6)
		12C3	100 (6/6)

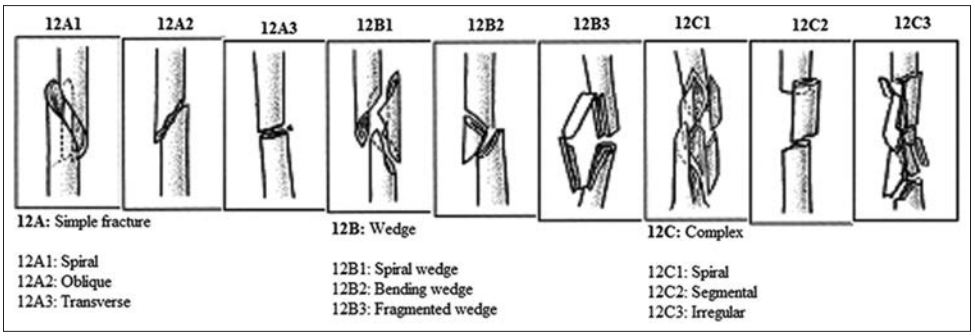

Figure 1: Müller AO classification of diaphyseal humeral fractures (Müller *et al.*,1990)

wedge (12B1) and fragmented wedge (12B3) fractures had equal frequency (4.8% [2/42] each).

All the complex diaphyseal humeral fracture cases [Table 1] were of irregular complex group (12C3; 100% [6/6]).

Table 2 presents a comparison of the pattern of diaphyseal humeral fractures between males and females. The most frequent type of diaphyseal humeral fractures was simple fractures (80.0% [112/140] in males and 69.7% [46/66] in females) followed by wedge fractures (17.1% [24/140] in males and 27.3% [18/66] in females), whereas the least frequent type was the complex fractures (2.9% [4/140] in males and 3.0% [2/66] in females).

Among the simple diaphyseal humeral fracture cases [Table 2], simple spiral fractures were the most frequent in males (41.1% [46/112]) followed by simple transverse fractures (33.9% [38/122]), whereas simple oblique fractures were the least frequent (25.0% [28/112]). In females, both simple spiral and simple transverse fractures had higher but equal frequencies (43.5% [20/46]) compared to simple oblique fractures (13.0 [6/46]).

Among the wedge diaphyseal humeral fracture cases [Table 2], spiral wedge fractures were the most frequent in males (91.7% [22/24]) followed by bending wedge fractures (8.3% [2/24]); there was no incidence of fragmented wedge. In females, spiral wedge fractures were the most frequent in males (88.9% [16/18]) followed by fragmented wedge (11.1% [2/18]); there was no incidence of bending wedge.

All the complex diaphyseal humeral fracture cases [Table 2] were of irregular complex group both in males (4/4) and females (2/2).

Table 3 presents a comparison of the pattern of diaphyseal humeral fractures between the right and left sides. The most frequent type of diaphyseal humeral fractures was simple fractures (79.5% [70/88] on the right humerus and 74.6% [88/118] on the left

Table 2: Comparison of the pattern of diaphyseal humeral fractures between males and females

Types	Percentage frequency (fractional frequency)		Groups	Percentage frequency (fractional frequency)	
	Males	Females		Males	Females
12A	80.0 (112/140)	69.7 (46/66)	12A1	41.1 (46/112)	43.5 (20/46)
			12A2	25.0 (28/112)	13.0 (6/46)
			12A3	33.9 (38/112)	43.5 (20/46)
12B	17.1 (24/140)	27.3 (18/66)	12B1	91.7 (22/24)	88.9 (16/18)
			12B2	8.3 (2/24)	0.0 (0/18)
			12B3	0.0 (0/24)	11.1 (2/18)
12C	2.9 (4/140)	3.0 (2/66)	12C1	0.0 (0/4)	0.0 (0/2)
			12C2	0.0 (0/4)	0.0 (0/2)
			12C3	100.0 (4/4)	100.0 (2/2)

humerus) followed by wedge fractures (18.2% [16/88] on the right humerus and 22.0% [26/118] on the left humerus), whereas the least frequent type was the complex fractures (2.3% [2/88] on the right humerus and 3.4% [4/118] on the left humerus).

Among the simple diaphyseal humeral fracture cases [Table 3], simple spiral fractures were the most frequent (37.1% [26/70] on the right humerus and 45.5% [40/88] on the left humerus) followed by the simple transverse fractures (34.3% [24/70] on the right humerus and 38.6% [34/88] on the left humerus), whereas simple oblique fractures were the least frequent (28.6% [20/70] on the right humerus and 15.9% [14/88] on the left humerus).

Among the wedge diaphyseal humeral fracture cases [Table 3], spiral wedge fractures were the most frequent (75.0% [12/16] on the right humerus and 100.0% [26/26] on the left humerus). On the right humerus, both bending wedge and fragmented wedge fracture had lower but equal frequencies (12.5% [2/16] each).

All the complex diaphyseal humeral fracture cases [Table 3] were of irregular complex group both on the right (2/2) and left (4/4) sides.

Table 4 presents a comparison of the pattern of diaphyseal humeral fractures among the various age

Table 3: Comparison of the pattern of diaphyseal humeral fractures between the right and left sides

Types	Percentage frequency (fractional frequency)		Groups	Percentage frequency (fractional requency)	
	Right	Left		Right	Left
12A	79.5 (70/88)	74.6 (88/118)	12A1	37.1 (26/70)	45.5 (40/88)
			12A2	28.6 (20/70)	15.9 (14/88)
			12A3	34.3 (24/70)	38.6 (34/88)
12B	18.2 (16/88)	22.0 (26/118)	12B1	75.0 (12/16)	100.0 (26/26)
			12B2	12.5 (2/16)	0.0 (0/26)
			12B3	12.5 (2/16)	0.0 (0/26)
12C	2.3 (2/88)	3.4 (4/118)	12C1	0.0 (0/2)	0.0 (0/4)
			12C2	0.0 (0/2)	0.0 (0/4)
			12C3	100.0 (2/2)	100.0 (4/4)

groups. The most frequent type of diaphyseal humeral fractures was extra-articular fractures (85.0% [34/40] among the children, 85.4% [70/82] among the young ones, 65.5% [38/58] among the middle-aged, and 61.5% [16/26] among the elderly). This was followed by wedge fractures (15.0% [6/40] among the children, 12.2% [10/82] among the young, 27.6% [16/58] among the middle-aged, and 38.5% [10/26] among the elderly). The least frequent among the young (2.4% [2/82]) and middle-aged (6.9% [4/58]) was complex fractures. There was no incidence of complex fractures among the children and the elderly.

Among the children with simple diaphyseal humeral fractures [Table 4], simple spiral fractures were the most frequent (64.7% [22/34]), while simple oblique and simple transverse fractures both had equal frequencies (17.6% [6/34] each). Among the young with simple diaphyseal humeral fractures [Table 4], simple spiral fractures (42.9% [30/70]) were the most frequent followed by simple transverse fractures (40.0% [28/70]), whereas simple oblique fractures (17.1% [12/70]) were the least frequent. Among the middle-aged with simple diaphyseal humeral fractures [Table 4], simple transverse fractures (42.1% [16/38]) were the most frequent followed by simple spiral fractures (31.6% [12/38]), whereas simple oblique fractures (26.3% [10/38]) were the least frequent. Among the elderly with simple diaphyseal humeral fractures [Table 4], simple transverse fractures (50.0% [8/16]) were the most frequent followed by simple oblique fractures (37.5% [6/16]), while simple spiral fractures (12.5% [2/16]) were the least frequent.

All the children, young and elderly with wedge diaphyseal humeral fractures [Table 4] had spiral wedge fractures (6/6 for the children, 10/10 for the young, and 10/10 for the elderly). Among the middle-aged with wedge diaphyseal humeral fractures [Table 4], spiral wedge fractures were the most frequent (75.0% [12/16]), whereas bending wedge and fragmented wedge fractures both had equal frequencies (12.5% [2/16] each).

There was no incidence of complex diaphyseal humeral fractures among the children and the elderly. Furthermore, all the young and middle-aged that had complex diaphyseal humeral fractures [Table 4] had irregular complex fractures (2/2 for the young and 4/4 for the middle-aged).

Table 5 presents a comparison of the pattern of diaphyseal humeral fractures caused by falls and those as caused by RTAs, which were the two major causes of diaphyseal humeral fractures recorded. The most frequent type of diaphyseal humeral fractures was simple fractures (87.1% [54/62] caused by falls and 72.9% [86/118] caused by RTAs) followed by wedge fractures (12.9% [8/62] caused by falls and 23.7% [28/118] caused by RTAs), whereas the least frequent type was complex fractures (0.0% [0/62] caused by falls and 3.4% [4/118] caused by RTAs).

Among the simple diaphyseal humeral fractures caused by falls [Table 5], simple spiral fractures were the most frequent (51.9% [28/54]) followed by simple transverse fractures (25.9% [14/54]), whereas the least frequent was simple oblique fractures (22.2% [12/54]). Among the simple diaphyseal humeral fractures caused by RTAs [Table 5], simple transverse fractures were the most frequent (46.5% [40/86]) followed by simple spiral fractures (32.6% [28/86]), whereas the least frequent was simple oblique fractures (20.9% [18/86]).

All the wedge diaphyseal humeral fractures caused by falls [Table 5] were spiral wedge fractures (8/8). Among the wedge diaphyseal humeral fractures caused by RTAs [Table 5], whereas spiral wedge was the most frequent (85.8% [24/28]), bending wedge and fragmented wedge fractures had equal frequencies (7.1% [2/28] each).

No complex humeral diaphyseal fractures were caused by falls, whereas all the complex humeral diaphyseal fractures caused by RTAs were irregular complex fractures (4/4) [Table 5].

DISCUSSION

Epidemiological study of the diaphyseal humeral fracture has received no attention in Nigeria. The study presents a pattern of diaphyseal humeral fractures among Nigerians. The most frequent type of diaphyseal humeral fractures was simple fractures followed by wedge fractures, whereas the least frequent was complex fractures. This pattern was seen in both sexes, on both sides, in both causes and in all age groups. This pattern is similar with the earlier studies by Tytherleigh-Strong *et al*. (1998) in the United Kingdom and Ekholm *et al*. (2006) in Sweden.

Table 4: Comparison of the pattern of diaphyseal humeral fractures among the various age groups

Types	Percentage frequency (fractional frequency)				Groups	Percentage frequency (fractional frequency)			
	Children (17 years and below)	Young (18-39 years)	Middle age (40-64 years)	Elderly (65 years and above)		Children (17 years and below)	Young (18-39 years)	Middle age (40-64 years)	Elderly (65 years and above)
12A	85.0 (34/40)	85.4 (70/82)	65.5 (38/58)	61.5 (16/26)	12A1	64.7 (22/34)	42.9 (30/70)	31.6 (12/38)	12.5 (2/16)
					12A2	17.6 (6/34)	17.1 (12/70)	26.3 (10/38)	37.5 (6/16)
					12A3	17.6 (6/34)	40.0 (28/70)	42.1 (16/38)	50.0 (8/16)
12B	15.0 (6/40)	12.2 (10/82)	27.6 (16/58)	38.5 (10/26)	12B1	100.0 (6/6)	100 (10/10)	75.0 (12/16)	100.0 (10/10)
					12B2	0.0 (0/6)	0.0 (0/10)	12.5 (2/16)	0.0 (0/10)
					12B3	0.0 (0/6)	0.0 (0/10)	12.5 (2/16)	0.0 (0/10)
12C	0.0 (0/40)	2.4 (2/82)	6.9 (4/58)	0.0 (0/26)	12C1	0.0 (0/0)	0.0 (0/2)	0.0 (0/4)	0.0 (0/0)
					12C2	0.0 (0/0)	0.0 (0/2)	0.0 (0/4)	0.0 (0/0)
					12C3	0.0 (0/0)	100.0 (2/2)	100.0 (4/4)	0.0 (0/0)

Table 5: Comparison of the pattern of diaphyseal humeral fractures between the main causes

Types	Percentage frequency (fractional frequency)			Groups	Percentage frequency (fractional frequency)		
	Falls	RTA	Others		Falls	RTA	Others
12A	87.1 (54/62)	72.9 (86/118)	69.2 (18/26)	12A1	51.9 (28/54)	32.6 (28/86)	55.6 (10/18)
				12A2	22.2 (12/54)	20.9 (18/86)	22.2 (4/18)
				12A3	25.9 (14/54)	46.5 (40/86)	22.2 (4/18)
12B	12.9 (8/62)	23.7 (28/118)	23.1 (6/26)	12B1	100.0 (8/8)	85.8 (24/28)	100.0 (6/6)
				12B2	0.0 (0/8)	7.1 (2/28)	0.0 (0/6)
				12B3	0.0 (0/8)	7.1 (2/28)	0.0 (0/6)
12C	0.0 (0/62)	3.4 (4/118)	7.7 (2/26)	12C1	0.0 (0/0)	0.0 (0/4)	0.0 (0/2)
				12C2	0.0 (0/0)	0.0 (0/4)	0.0 (0/2)
				12C3	0.0 (0/0)	100.0 (4/4)	100.0 (2/2)

RTA: Road traffic accident

This study also showed that among the simple fracture cases, simple spiral fractures were the most frequent followed by simple transverse fractures, whereas simple oblique fractures were the least frequent. This is the noted observed in both males and females, on both right and left sides, in children and young and in diaphyseal humeral fractures caused by falls. This pattern also agrees with studies by Tytherleigh-Strong *et al*. (1998) and Ekholm *et al*. (2006).

Among the middle-aged with simple fractures and in simple fractures caused by RTAs, a different pattern was observed; the most frequent was simple transverse fractures followed by simple spiral fractures, whereas the least was simple oblique fractures. This similarity in patterns between diaphyseal humeral fractures caused by RTAs and middle-aged could be attributed to the high level of mobility among this age group and their higher predisposition to RTAs. This is catchy when considering an earlier study that had established RTAs as the most frequent cause of humeral shaft fractures among Nigerians and that humeral shaft fractures occur most frequently between 21 and 40 years (Ezeuko *et al.,* 2015). Other studies had noted that middle age consists of agile, active, and very mobile age range associated with increase transit from place to place, increase in risk-taking, and it is the age range associated with increased use of alcohol and drug intoxication (Kumar *et al.,* 2008; Silas *et al.,* 2012; Ezeuko *et al.,* 2014).

Among the elderly with simple fractures, the most frequent was simple transverse fractures followed by simple oblique fractures, whereas the least frequent was simple spiral fractures. This variation in the pattern of diaphyseal humeral fractures could perhaps be due to the alteration of biomechanical properties seen in elderly bone (Tytherleigh-Strong *et al*., 1998).

This study shows that among the wedge diaphyseal humeral fracture cases, spiral wedge fractures were the most frequent. Studies by Tytherleigh-Strong *et al*. (1998) and Ekholm *et al*. (2006) noted that spiral wedge was the most frequent of wedge fractures followed by bending wedge while fragmented wedge was the least frequent.

All the complex diaphyseal humeral fracture cases noted in this study were of irregular variety. This is at variance with the studies by Tytherleigh-Strong *et al*. (1998) and Ekholm *et al*. (2006) who in their respective findings indicated that complex spiral fractures were the most frequent form of complex fractures followed by complex segmental fractures, whereas complex irregular fractures were the least frequent.

CONCLUSION

This study showed to a great extent that there is a pattern for diaphyseal humeral fractures among Nigerians. This type of epidemiologic studies offers important data that

contribute to improvement in fracture management. It also goes a long way in equipping surgeons, not only for an intrinsic but also to allow resources to be allocated on the basis of projected frequency of different types of diaphyseal humeral fractures. The ability to predict the level of admissions to a trauma center is valuable for administrative and training purposes.

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Conflicts of Interest

There are no conflicts of interest.

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