

Patterns of distal humeral fractures among Nigerians: A radiologic study

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Abstract

Background: Fractures of the distal humerus constitute between 0.5% and 2% of all fractures, and about one-third of fractures around the elbow joint. This study was aimed at classifying the patterns of distal humeral fractures among Nigerians. **Materials and Methods:** The study was carried out retrospectively at the Department of Medical Records, National Orthopedic Hospital, Igbobi, Lagos State, Nigeria. Plain films of X-ray (both anteroposterior and lateral views) that were taken between 2007 and 2012. The films were from a total number of 144 patients of ages ranging from birth to 100 years (0–100 years), comprising of 88 males and 56 females. Distal humeral fractures were classified according to Müller's classification for the Association for the Study of Internal Fixation. Comparisons of the patterns of distal humeral fractures were made between the sexes, sides affected, age groups, and causes of the fractures. **Results:** The results showed that the most frequent type of distal humeral fractures was extra-articular fractures (50.7% [73/144]) followed by partial articular fractures (31.9% [46/144]), while the least frequent was complete articular fractures (17.4% [25/144]). **Conclusion:** This study shows to a great extent that there is a pattern for distal humeral fractures among Nigerians. This type of epidemiologic studies offers important data that contributes to improvement in fracture management and treatment.

Key words: Distal, fractures, humerus, Nigerians, pattern

INTRODUCTION

Fractures of the distal humerus constitute between 0.5% and 2% of all fractures, and about one-third of fractures around the elbow joint (Webb, 2001). More so, supracondylar fractures of the distal humerus are quite high in children, accounting for about 17.9% of

all pediatric fractures. This makes them the second most common pediatric fracture (Cheng *et al.*, 1999), second only to distal radial fractures.

Past studies had revealed that distal humeral fractures are more common in children. These injuries are most commonly caused by falls, and occur more frequently in the non-dominant arm (Cheng *et al.*, 1999; Cheng *et al.*, 2001; Ezeuko *et al.*, 2014a).

Several authors had proposed different classification systems for distal humeral fractures (Reich, 1936; Riseborough and Radin, 1969; Jupiter and Mehne, 1992; Ring *et al.*, 2003). However, for research purposes, the most widely accepted classification system is that of Müller *et al.* (1990) and Orthopaedic Trauma Association (OTA) (1996). Using alpha-numeric system, Müller *et al.*, (1990) assigned distal humeral fractures into three main types: Type A (extra-articular), Type B (partial articular), and Type C (complete articular). The OTA extended this classification further into sub-types for further fracture details. Although the Muller/OTA system's

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clinical application is limited and is hindered by poor inter-observer reliability beyond identification of the basic three types (Wainwright *et al.*, 2000), it has remained useful for cataloging fractures for research purposes.

There is no literature available on the pattern of fractures of the distal humeral among Nigerians. Hence, this study was aimed at classifying the pattern of distal humeral fractures among Nigerian using the Müller's classification system.

MATERIALS AND METHODS

The study was carried out retrospectively at the Department of Medical Records, National Orthopedic Hospital, Igbobi, Lagos State, Nigeria. Plain films of X-ray (both anteroposterior and lateral views) that were taken between 2007 and 2012. The films were from a total number of 144 patients of ages ranging from birth to 100 years (0–100 years), comprised of 88 males and 56 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 were 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 cutlass). The subjects were socio-economically 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).

Distal 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 tables showing percentage frequencies and fractional frequencies. Comparisons of the patterns of distal humeral fractures were made between the sexes, sides affected, age groups, and causes of the fractures.

RESULTS

Table 1 presents the fracture pattern among the subjects studied. The most frequent type of distal humeral fractures were extra-articular fractures (50.7% [73/144]) followed by partial articular fractures (31.9% [46/144])

while the least frequent was the complete articular fractures (17.4% [25/144]).

Among the extra-articular fracture cases [Table 1], apophyseal avulsion fractures were the most frequent (47.9% [35/73]) followed by the metaphyseal simple fractures (31.5% [23/73]) while the metaphyseal multifragmentary fractures were the least frequent (20.5% [15/73]).

Among the partial articular fracture cases [Table 1], sagittal lateral condyle fractures were the most frequent (65.2% [30/46]) followed by the sagittal medial condyle fractures (30.4% [14/46]) while the frontal fractures were the least frequent (4.3% [2/46]).

Among the complete articular fracture cases [Table 1], articular simple-metaphyseal simple fractures were the most frequent (84.0% [21/25]). The frequency of articular simple, metaphyseal multifragmentary and articular multifragmentary group were equal (8.0% [2/25] each).

Table 2 presents comparison of the pattern of distal humeral fractures between males and females. It showed that there is a similar pattern of distal humeral fractures in both sexes with slight variation in the complete articular fractures. The most frequent type of distal humeral fractures was extra-articular fractures (50.0% [44/88] in males and 51.8% [29/56] in females) followed by partial articular fractures (31.8% [28/88] in males and 32.1% [18/56] in females) while the least frequent type was the complete articular fractures (18.2% [16/88] in males and 16.1% [9/56] in females).

Among the extra-articular fracture cases [Table 2], apophyseal avulsion fractures were the most frequent (43.2% [19/44] in males and 55.2% [16/29] in females), followed by the metaphyseal simple fractures (36.4% [16/44] in males and 24.1% [7/29] in females) while the metaphyseal multifragmentary fractures were the least frequent (20.5% [9/44] in males and 20.7% [6/29] in females).

Among the partial articular fracture cases [Table 2], sagittal lateral condyle fractures were the most frequent (67.9% [19/28] in males and 61.1% [11/18] in females), followed by the sagittal medial condyle fractures (28.6% [8/28] in males and 33.3% [6/18] in females) while the frontal fractures were the least frequent (3.6% [1/28] in males and 5.6% [1/18] in females).

Among the complete articular fracture cases [Table 2], articular simple-metaphyseal simple fractures were the most frequent (81.3% [13/16] in males and 88.9% [8/9] in females). This was followed in males by articular

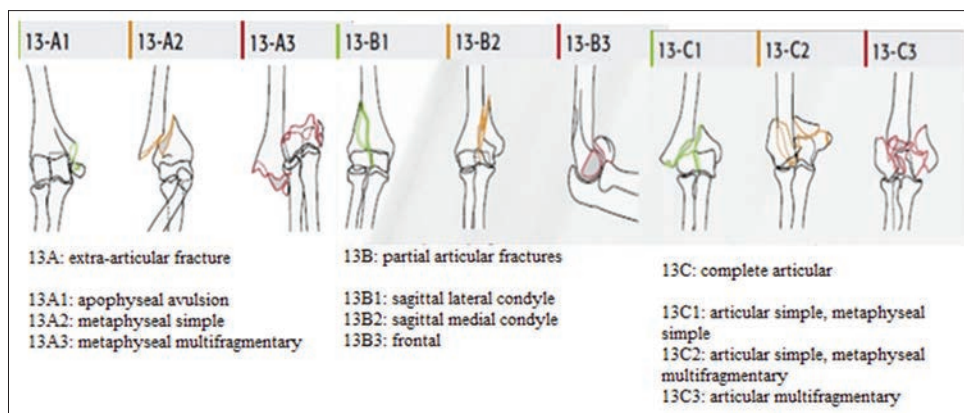


Figure 1: Müller's classification of distal humeral fractures (Müller et al., 1990)

Type	Group	Description
13A	13A1	Apophyseal avulsion
	13A2	Metaphyseal simple
	13A3	Metaphyseal multifragmentary
		Extra-articular fracture
13B	13B1	Sagittal lateral condyle
	13B2	Sagittal medial condyle
	13B3	Frontal
		Partial articular fracture
13C	13C1	Articular simple, metaphyseal simple
	13C2	Articular simple, metaphyseal multifragmentary
	13C3	Articular, multifragmentary
		Complete articular fractures

Table 1: Fracture pattern among the subjects studied

Types	Percentage frequency (fractional frequency)		Groups	Percentage frequency (fractional frequency)	
	Males	Females		Males	Females
13A	50.7 (73/144)		13A1	47.9 (35/73)	
			13A2	31.5 (23/73)	
			13A3	20.5 (15/73)	
13B	31.9 (46/144)		13B1	65.2 (30/46)	
			13B2	30.4 (14/46)	
			13B3	4.3 (2/46)	
13C	17.4 (25/144)		13C1	84.0 (21/25)	
			13C2	8.0 (2/25)	
			13C3	8.0 (2/25)	

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

Types	Percentage frequency (fractional frequency)		Groups	Percentage frequency (fractional frequency)	
	Males	Females		Males	Females
13A	50.0 (44/88)	51.8 (29/56)	13A1	43.2 (19/44)	55.2 (16/29)
			13A2	36.4 (16/44)	24.1 (7/29)
			13A3	20.5 (9/44)	20.7 (6/29)
13B	31.8 (28/88)	32.1 (18/56)	13B1	67.9 (19/28)	61.1 (11/18)
			13B2	28.6 (8/28)	33.3 (6/18)
			13B3	3.6 (1/28)	5.6 (1/18)
13C	18.2 (16/88)	16.1 (9/56)	13C1	81.3 (13/16)	88.9 (8/9)
			13C2	6.3 (1/16)	11.1 (1/9)
			13C3	12.5 (2/16)	0.0 (0/9)

multifragmentary fractures (12.5% [2/16]) and in females by articular simple-metaphyseal multifragmentary fractures (11.1% [1/9]). Articular simple-metaphyseal multifragmentary fractures were the least frequent in males (6.3% [1/16]). In females, there was no incidence of articular multifragmentary group.

Table 3 presents comparison of the pattern of distal humeral fractures between the right and left sides. The most frequent type of distal humeral fractures was extra-articular fractures (44.6% [25/56] on the right humerus and 54.5% [48/88] on the left humerus) followed by partial articular fractures (33.9% [19/56] on the right humerus and 30.7% [27/88] on the left humerus) while the least frequent type was the complete articular fractures (21.4% [12/56] on the right humerus and 14.8% [13/88] on the left humerus).

Among the extra-articular fracture cases [Table 3], apophyseal avulsion fractures were the most frequent (56.0% [14/25] on the right humerus and 43.8% [21/48] on the left humerus), followed by the metaphyseal simple fractures (24.0% [6/25] on the right humerus and 35.4% [17/48] on the left humerus) while the metaphyseal multifragmentary fractures were the least frequent (20.0% [5/25] on the right humerus and 20.8% [10/48] on the left humerus).

Among the partial articular fracture cases [Table 3], sagittal lateral condyle fractures were the most frequent (68.4% [13/19] on the right humerus and 63.0% [17/27] on the left humerus) followed by the sagittal medial condyle fractures (31.6% [6/19] on the right humerus and 29.6% [8/27] on the left humerus). The frontal fractures were the least frequent on the left side (7.4% [2/27]). There was no incidence of frontal fracture on the right humerus.

Among the complete articular fracture cases [Table 3], articular simple-metaphyseal simple fractures were the

most frequent (75.0% [9/12] on the right humerus and 92.3% [12/13] on the left humerus) followed on the right humerus by articular simple-metaphyseal multifragmentary fractures (16.7% [2/12]) and on the left humerus by articular multifragmentary fractures (7.7% [1/13]). Articular multifragmentary fractures were the least frequent on the right humerus (8.3% [1/12]). On the left humerus, there was no incidence of articular simple-metaphyseal multifragmentary fracture.

Table 4 presents comparison of the pattern of distal humeral fractures among the various age groups. The most frequent type of distal humeral fractures was extra-articular fractures (50.0% [46/92] among the children, 42.3% [11/26] among the young ones, 66.6% [12/188] among the middle-aged, and 50.0% [4/8] among the elderly). This was followed, among the children and young by partial articular fractures (37.0% [34/92] among the children, 30.8% [8/26] among the young). Among the elderly, it was followed by complete articular fractures (37.5% [3/8]). The least frequent type among the children and young was the complete articular fractures (13.0% [12/92] among the children, 26.9% [7/26] among the young ones). Among the elderly, the least frequent was partial articular fractures (12.5% [1/8]). Among the middle-aged, partial

articular and complete articular fractures had equal frequency (16.7% [3/18] each).

Among the children with extra-articular fractures [Table 4], apophyseal avulsion fractures were the most frequent (56.5% [25/46]) followed by metaphyseal simple fractures (32.6% [15/46]) while the least frequent were the metaphyseal multifragmentary fractures (10.9% [5/46]). Among the young with extra-articular fractures [Table 4], apophyseal avulsion and metaphyseal simple fractures had the highest but equal frequencies (36.4% [4/11] each) while metaphyseal multifragmentary fractures were the least frequent (27.3 [3/11]). Among the middle-aged with extra-articular fractures [Table 4], metaphyseal multifragmentary fractures were the most frequent (58.4% [7/12]) followed by metaphyseal simple fractures (33.3% [4/12]) while the least frequent were the apophyseal avulsion fractures (8.3% [1/12]). All the elders with extra-articular fractures [Table 4] had apophyseal avulsion fractures (100.0% [4/4]).

Among the children with partial articular fractures [Table 4], sagittal lateral condyle fractures were the most frequent (67.6% [23/34]) followed by sagittal medial condyle fractures (26.5% [9/34]) while the least frequent were the frontal fractures (5.9% [2/34]). Among the young with partial articular fractures [Table 4], sagittal lateral condyle fractures were the most frequent (62.5% [5/8]) followed by sagittal medial condyle fractures (37.5% [3/8]). Among the middle-aged with partial articular fractures [Table 4], sagittal medial condyle fractures were the most frequent (66.7% [2/3]) followed by sagittal lateral condyle fractures (33.3% [2/3]). The only elder with partial articular fracture [Table 4] had a sagittal lateral condyle fracture.

Among the children with complete articular fractures [Table 4], articular simple-metaphyseal simple fractures were the most frequent (83.3% [10/12]) followed by articular simple-metaphyseal multifragmentary fractures (16.7% [2/12]). There was no case of articular multifragmentary fracture. Among

Table 3: Comparison of the pattern of distal humeral fractures between the right (n=56) and left (n=88) sides

Types	Percentage frequency (fractional frequency)		Groups	Percentage frequency (fractional frequency)	
	Right	Left		Right	Left
13A	44.6 (25/56)	54.5 (48/88)	13A1	56.0 (14/25)	43.8 (21/48)
			13A2	24.0 (6/25)	35.4 (17/48)
			13A3	20.0 (5/25)	20.8 (10/48)
13B	33.9 (19/56)	30.7 (27/88)	13B1	68.4 (13/19)	63.0 (17/27)
			13B2	31.6 (6/19)	29.6 (8/27)
			13B3	0.0 (0/19)	7.4 (2/27)
13C	21.4 (12/56)	14.8 (13/88)	13C1	75.0 (9/12)	92.3 (12/13)
			13C2	16.7 (2/12)	0.0 (0/13)
			13C3	8.3 (1/12)	7.7 (1/13)

Table 4: Comparison of the pattern of distal 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)
13A	50.0 (46/92)	42.3 (11/26)	66.6 (12/18)	50.0 (4/8)	13A1	56.5 (26/46)	36.4 (4/11)	8.3 (1/12)	100.0 (4/4)
					13A2	32.6 (15/46)	36.4 (4/11)	33.3 (4/12)	0.0 (0/4)
					13A3	10.9 (5/46)	27.2 (3/11)	58.4 (7/12)	0.0 (0/4)
13B	37.0 (34/92)	30.8 (8/26)	16.7 (3/18)	12.5 (1/8)	13B1	67.6 (23/34)	62.5 (5/8)	33.3 (1/3)	100.0 (1/1)
					13B2	26.5 (9/34)	37.5 (3/8)	66.7 (2/3)	0.0 (0/1)
					13B3	5.9 (2/34)	0.0 (0/8)	0.0 (0/3)	0.0 (0/1)
13C	13.0 (12/92)	26.9 (7/26)	16.7 (3/18)	37.5 (3/8)	13C1	83.3 (10/12)	85.7 (6/7)	100.0 (3/3)	66.7 (2/3)
					13C2	16.7 (2/12)	0.0 (0/7)	0.0 (0/3)	0.0 (0/3)
					13C3	0.0 (0/12)	14.3 (1/7)	0.0 (0/3)	33.3 (1/3)

the young with complete articular fractures [Table 4], articular simple-metaphyseal simple fractures were the most frequent (87.7% [6/7]) followed by articular multifragmentary fractures (14.3% [1/7]). There was no case of articular simple-metaphyseal multifragmentary fracture. All the middle-aged with complete articular fractures [Table 4] had articular simple-metaphyseal simple fractures (100.0% [3/3]). Among the elderly with complete articular fractures [Table 4], articular simple-metaphyseal simple fractures were the most frequent (66.7% [2/3]) followed by articular multifragmentary fractures (33.3% [1/3]). There was no case of articular simple-metaphyseal multifragmentary fracture.

Table 5 presents comparison of the pattern of distal humeral fractures caused by falls and those as caused by RTAs which were the two major causes of distal humeral fractures recorded. The most frequent type of distal humeral fractures was extra-articular fractures (48.5% [48/99] caused by falls and 57.5% [23/40] caused by RTAs) followed by partial articular fractures (34.3% [34/99] caused by falls and 22.5% [9/40] caused by RTAs) while the least frequent type was the complete articular fractures (17.2% [17/99] caused by falls and 20.0% [8/40] caused by RTAs).

Among the extra-articular fractures caused by falls [Table 5], apophyseal avulsion fractures were the most frequent (56.3% [27/48]) followed by metaphyseal simple fractures (33.3% [16/48]) while the least frequent were the metaphyseal multifragmentary fractures (10.4% [5/48]). Among the extra-articular fractures caused by RTAs [Table 5], metaphyseal multifragmentary fractures were the most frequent (39.2% [9/23]) while apophyseal avulsion and metaphyseal simple fractures were equal in frequencies (30.4% [7/23] each).

Among the partial articular fractures caused by falls [Table 5], sagittal lateral condyle fractures were the most frequent (61.8% [21/34]) followed by sagittal

medial condyle fractures (32.4% [11/34]) while the least frequent were the frontal fractures (5.9% [2/34]). Among the partial articular fractures caused by RTAs [Table 5], sagittal lateral condyle fractures were the most frequent (66.7% [6/9]) followed by sagittal medial condyle (33.3 [3/9]).

Among the complete articular fractures caused by falls [Table 5], articular simple-metaphyseal simple fractures were the most frequent (61.8% [21/34]) followed by articular simple-metaphyseal multifragmentary fractures (32.8% [11/34]) while the least frequent were the articular multifragmentary fractures (5.9% [2/34]). Among the complete articular fractures caused by RTAs [Table 5], articular simple-metaphyseal simple fractures were the most frequent (66.7% [6/9]), followed by articular simple-metaphyseal multifragmentary fractures (33.3% [3/9]).

DISCUSSION

The study presents pattern of distal humeral fractures among Nigerians. The most frequent type of distal humeral fractures was extra-articular fractures followed by partial articular fractures while the least frequent was the complete articular fractures. This pattern was seen in both sexes, on both sides, in both causes, and in all age groups except among the elderly in which complete articular fractures were the second most frequent while partial articular fractures were the least frequent.

It had been noted that in children, the supracondylar area is still in the process of remodeling and is therefore thinner with a more slender cortex, predisposing this area to fracture (Skaggs and Pershad, 1997). Fall had been recorded as the most common cause of these fractures (Cheng *et al.*, 1999; Cheng *et al.*, 2001; Ezeuko *et al.*, 2014a). A fall onto an outstretched hand puts a hyperextension load on the arm. The distal fragment displaces posteriorly in over 95% of cases (Skaggs and Pershad, 1997). As the elbow is forced into hyperextension, the olecranon serves as a fulcrum

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

Types	Percentage frequency (fractional frequency)			Groups	Percentage frequency (fractional frequency)		
	Falls	RTA	Others		Falls	RTA	others
13A	48.5 (48/99)	57.5 (23/40)	40.0 (2/5)	13A1	56.3 (27/48)	30.4 (7/23)	50.0 (1/2)
				13A2	33.3 (16/48)	30.4 (7/23)	0.0 (0/2)
				13A3	10.4 (5/48)	39.1 (9/23)	50.0 (1/2)
13B	34.3 (34/99)	22.5 (9/40)	60 (3/5)	13B1	61.8 (21/34)	66.7 (6/9)	100 (3/3)
				13B2	32.4 (11/34)	33.3 (3/9)	0.0 (0/3)
				13B3	5.9 (2/34)	0.0 (0/9)	0.0 (0/3)
13C	17.2 (17/99)	20.0 (8/40)	0.0 (0/5)	13B1	61.8 (21/34)	66.7 (6/9)	0.0 (0/0)
				13B2	32.4 (11/34)	33.3 (3/9)	0.0 (0/0)
				13B3	5.9 (2/34)	0.0 (0/9)	0.0 (0/0)

RTA: Road traffic accident

and focuses the stress on the distal humerus causing fracture (Abraham *et al.*, 1982). The rare flexion-type supracondylar fracture is often the result of a fall directly onto a flexed elbow.

This study also shows that among the extra-articular fracture cases, apophyseal avulsion fractures were the most frequent. This was the case in both sexes, on both sides, in fractures caused by falls and in all age groups with the exception of the middle-aged. Anatomically, apophyses of the distal humerus include the lateral epicondyle which is the common extensor origin of the forearm muscles and the medial epicondyle which is the common flexor origin of the forearm muscles. The high frequency of apophyseal avulsion fractures noted in this study could be attributed to the fact that apophyses are located at the site of attachment of major muscle tendons to bone and are subjected primarily to tensile forces (Caine *et al.*, 2006). However, acute or chronic injuries affecting apophyses are not generally associated with disruption of longitudinal bone growth. This is because the apophyses contribute to bone shape but not to longitudinal growth (Garland, 1987).

Schatzker (2005) had noted that avulsion fracture of the lateral epicondyle is an extremely rare injury in adults that may occur as part of a posterolateral or posterior dislocation of the elbow. In the latter case, it is frequently associated with a fracture of the medial epicondyle. In children where the lateral epicondyle is avulsed with varying portions of the capitulum, it may turn on itself through 180° and turn the fracture surface outward, and the outcome may be a nonunion and deformity. This complication is not seen in adults. When the elbow is reduced, the epicondylar fragment reduces and heals in place, usually by bone, although occasionally by fibrous tissue (Schatzker, 2005).

On the contrary, fractures of the medial epicondyle are most common in children, but may be seen in adults either as a result of a direct injury or as an avulsion (Schatzker, 2005). The fragments may vary in size, displacement, and degree of comminution. Small and undisplaced fragment does not usually require surgical treatment. However, fragments that are displaced and caught in the joint, as may occur in the reduction of a lateral dislocation of the elbow, require surgical reduction, and fixation. Suture to the adjacent soft tissue is most often applied to comminuted fragments (Schatzker, 2005). Occasionally, the fragment may be quite large and displaced. Whenever displaced or comminuted, it is openly reduced and stabilized by internal fixation to prevent the onset of ulnar palsy using a medial approach. As a precaution, the ulnar nerve is identified and protected before the reduction is attempted (Schatzker, 2005).

The fact that among the middle-aged with extra-articular had metaphyseal multifragmentary fractures as the most frequent coupled with the fact that extra-articular fractures caused by RTAs had metaphyseal multifragmentary fractures as the most frequent could be attributed to the high level of mobility among this age group and their higher predisposition to RTAs. Other studies had noted that this age group 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.*, 2014b).

In contrast to the more frequent apophyseal avulsion of the medial and epicondyles, lateral sagittal condyle fractures, fracture of the capitulum which were all noted to have good prognosis, the less frequent extra-articular metaphyseal simple and multifragmentary fracture as well as complete articular fractures of the distal humerus, all have poor prognosis (Schatzker, 2005). Failure of treatment of these fractures result in stiffness and pain in the elbow. Varus or valgus deformity, frequently seen following improperly treated supracondylar fractures in children, is not as significant a problem in adults as is stiffness (Schatzker, 2005).

CONCLUSION

This study shows to a great extent that there is a pattern for distal humeral fractures among Nigerians irrespective of the sex or the side affected. This type of epidemiologic studies offers important data that contributes to improvement in fracture management and well-being of the patient. It also goes a long way in equipping surgeons, not only for enhancement of intrinsic stability fractures, but also to allow resources to be allocated on the basis of projected frequency of different types of distal 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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