Original Article

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Orthopaedics Section

Prevalence of Fracture of Forearm Bones in Obese and Non-obese Children: A Cross-sectional Study

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ABSTRACT

Introduction: Through much history of mankind, the overt manifestation of bodyweight gain in children and adults have been considered as a sign of personal health and family wealth and an indicator of the economic prosperity of the society. As developing societies are industrialised and urbanised, the standards of living continued to rise; obesity and weight gain began to pose a growing threat to the health of the citizens.

Aim: To determine the prevalence of forearm bones fracture in obese and non-obese children between age group of 2-15 years.

Materials and Methods: A cross-sectional study was conducted in the Department of Orthopaedics and Paediatrics at Dr BC Roy Post Graduate Institute of Paediatric Science, Kolkata, West Bengal, India from September 2017 to October 2018. Children were classified into obese and non-obese group according to Body Mass Index (BMI). Calculation of BMI was done by the formula BMI=weight (kg)/{height(m)}^{2}. Obese children were determined by the BMI percentile by plotting the BMI number on the appropriate Centers for Diseases Control and Prevention (CDC) BMI-for-age growth chart. Doubtful cases classification was confirmed by the paediatric surgeon. Injury mechanism was graded into three trauma kinetics (direct trauma, slow motion trauma and high motion trauma). The validated paediatric Physical Activity Questionnaire (PAQ-A and PAQ-C) were used to grade the average daily activities during the week prior to trauma. Statistical analysis was done by using the Chi-square test and p-value of <0.05 was considered to be statistically significant.

Results: Total 583 children were treated during the study period in the hospital including both Outpatient Department (OPD) and Emergency Department. About 433 children were excluded due to below age two years, refracture, chronic illness, and major congenital malformation. Among them only 150 patients met the criteria of present study. Out of 150 children, 69 (46%) were found obese and non-obese were 81 (54%). The distribution by gender was the same in obese group which had 26 (37.68%) female and 43 (62.32%) male, in non-obese group 34 (41.97%) female and 47 (58.03%) male. It was observed that both bones fracture of forearm in obese children was more at risk than non-obese children, p-value of <0.5 which was statistically significant.

Conclusion: Present study shows higher prevalence of forearm bone fracture in obese children than non-obese children. Obesity and other certain factors might have been significant risk factor for fracture required for operation. Both radius-ulna fracture in obese were found significant.

Keywords: Body mass index, Children, Fracture, Obesity, Paediatric comprehensive classification of long bone fractures

INTRODUCTION

The World Health Organisation (WHO), in 1998 designated obesity as a global epidemic [1]. India is also facing the epidemic of obesity and its associated diseases, especially in children and adolescents [2]. Childhood obesity is associated with an increased mortality and morbidity characterised by coronary artery diseases, diabetes mellitus, hypertension and dyslipidemia [3]. The overt manifestation of bodyweight gain in children and adult has been regarded as a symbol of personal health and family wealth for much of human and urbanised, living standards continue to increase, obesity and weight gain have started to pose a rising threat to citizen's health [4-7]. Compared to non-obese children, some studies have shown an increased risk of obese children having fracture [8-12], this risk is not only due to the behaviour of the child (play, fall, traffic accident etc.,), but is also due to the biomechanical properties of the bone and kinetics of the injury. The increased risk of fracture is associated with temporary bone weakness (relative osteopenia) during child development [13]. Both hormonal variations and the diet of children influence the accrual of bone and thereby, affect the biomechanical properties of bones [14]. It is uncertain in obese children if the increased risk is due to reduced accrual of bone or to severe kinetic injury [9]. Obesity was suggested to induce poor balance with some transient coordination disorder of development that could increase the risk of fracture [15]. There is growing evidence that children and adolescents of wealthy families are overweight relative to their counterparts in the past in current circumstances, possibly due to physical activities, sedentary lifestyle, altered eating habits and increased fat content of the diet [3,16].

CDC of the United States of America suggest that BMI is the most appropriate and easily available method to screen for childhood obesity. Age and gender cut-off for BMI are readily available. Obesity is increasing globally taking an epidemic significance with merely half a billion of world's population now considered to be overweight and obese [17,18]. With this background, present study was conducted with an aim to study the prevalence of both bone fracture of forearm in obese and non-obese children between age group of 2-15 years.

MATERIALS AND METHODS

A cross-sectional study was conducted in collaboration between Department of Paediatrics and Orthopaedics at Dr BC Roy Postgraduate Institute of Paediatric Science, Kolkata, West Bengal, India, from September 2017 to October 2018. After approval from the Institutional Ethics Committee (ethical clearance no.: BCH/ME/PR:2352), the study was initiated. All the 583 children who were treated during the study period were included and 433 children were excluded due to below age of two years, refracture, chronic illness, and major congenital malformation. Total 150 patients were included in this study. The parents of all children, attending the institute who fulfilled the inclusion criteria were informed about this study. Written informed consent from the parents of all children was taken. History regarding name, age height, weight, any previous fracture, grade of activity level, type of fracture, kinetics of injury and treatment modalities were recorded.

Inclusion criteria: All children between 2-15 years of ages presenting to the emergencies for an Upper Extremity Long Bones Fracture (ULBF), attending the hospital OPD and those who are giving consent for participation in the present study were all included.

Exclusion criteria: Children having major congenital malformation and those who were suffering from any other chronic co-morbid conditions were excluded. Refractures cases were also excluded which are defined as fractures occurring within one year.

The anthropometric parameter was measured at the time of injury in the emergency department. Children having fractures were classified by using (Arbeitsgemeinschaft für Osteosynthesefragen) AO Paediatric Comprehensive Classification of long bone Fractures (PCCF) [Table/Fig-1] [19]. Calculation of BMI was done by the formula.

BMI=weight (kg)/{height(m)}^{2}

Bone	Segment	Morphology	Severity	Displacement for epiphysis
Humerus=1 Radius=2r Ulna=2u	Proximal/epiphysis or metaphysis=1E or 1M	1 to 9	1 to 2	Type 1 to 4
	Shaft/Diaphysis=2D			
	Distal/epiphysis or metaphysis=3E or 3M			

[Table/Fig-1]: AO Paediatric Comprehensive Classification of long bone fractures (PCCF) [19].
r: Radius; u: Ulna; E: Epiphysis; M: Metaphysis; D: Diaphysis

Obese children were determined by the BMI percentile by plotting the BMI number on the appropriate CDC BMI-for-age growth chart [20]. Overweight and Obese children was determined by the BMI percentile by plotting the BMI number on the appropriate CDC BMI-for-age growth chart. Sex- and age-specific percentile cut points of a reference population (≤85th as normal, 85th-95th percentile for overweight and >95th percentile for obesity) [20]. Doubtful cases of obesity classification were confirmed by the paediatric surgeon. Injury mechanism was graded into three trauma kinetics (direct trauma, slow motion trauma and high motion trauma). The validated PAQ-A and PAQ-C were used to grade the average daily activities during the week prior to trauma [21].

STATISTICAL ANALYSIS

Using the Chi-square test, statistical analysis was conducted and the p-value of <0.05 was considered statistically significant. Statistical Package for the Social Sciences (SPSS) software with version 16 was used.

RESULTS

Out of 150 children 69 (46%) with average age of 7.81 were found obese and non-obese were 81 (54%) with average age of 8.27 and p-value was 0.83 [Table/Fig-2]. The distribution by gender was the same in obese group which included 26 (37.68%) females and 43 (62.32%) males, in non-obese group 34 (41.97%) females and 47 (58.03%) males. We observed that both bones fracture of forearm in obese children was more at risk than non-obese children p-value was 0.014 which was statistically significant.

Fracture of radius and ulna was seen in 33 children in obese patients and 18 children in non-obese patients respectively, which was statistically significant. Previous fracture history 24 (34.78%) and 29 (35.80%) were observed in obese and non-obese children respectively shown in [Table/Fig-2].

In obese patients humerus proximal and humerus diaphysis, humerus metaphysis distal fracture was seen in 2 (2.89%), 2 (2.89%), 6 (8.70%), respectively [Table/Fig-3]. But these were not statistically significant between the two groups [Table/Fig-3]. Images are demonstrated in [Table/Fig-4].

	Obese (n=69)	Non-obese (n=81)	p-value
Age mean±SD (2-15 years)	7.81±2.3	8.27±2.1	0.83
BMI mean±SD (range)	22.7±3.6 (17 to 29.8)	15.92±3.1 (13 to 21.2)	0.001
PAQ Grade mean±SD (range)	2.86±1.12 (2.11 to 4)	2.63±1.32(1.6 to 4.3)	0.68
Previous history of fracture (%)	24 (34.78%)	29 (35.80%)	0.1
Kinetics of Trauma			
Direct (%)	7 (10.14%)	13 (16.05%)	0.32
Slow motion (%)	33 (47.83%)	29 (35.80%)	0.63
High motion (%)	29 (42.03%)	39 (48.15%)	0.30
Fractures			
Radius (%)	23 (33.33%)	38 (46.91%)	0.1
Ulna (%)	3 (4.35%)	8 (9.87%)	0.39
Radius and ulna (%)	33 (47.83%)	18 (22.22%)	0.01
Humerus (%)	6 (8.69%)	15 (18.52%)	0.53
Humerus and radius (%)	4 (5.80%)	2 (2.47%)	0.38
Treatments			
Immobilisation (%)	51 (73.91%)	62 (76.54%)	0.1
Manipulation under general anaesthesia (%)	14 (20.29%)	11 (13.58%)	0.1
Surgical pins (%)	4 (5.80%)	8 (9.87%)	0.86

[Table/Fig-2]: Distribution of age, Body Mass Index (BMI), Physical Activity Questionnaire (PAQ) grade, kinetics of injury, fracture location, treatment modalities and previous history of fracture are shown in table.
Chi-square test was used. Mean±Standard Deviation (SD)

	Obese (n=69)	Non-obese (n=81)	p-value
Humerus and radius proximal	2 (2.89%)	5 (6.17%)	0.27
Humerus and radius diaphysis	2 (2.89%)	2 (2.47%)	0.13
Humerus metaphysis distal	6 (8.70%)	7 (8.64%)	0.34
Humerus epiphysis distal	-	3 (3.70%)	0.23
Radius and ulna proximal	4 (5.80%)	7 (8.64%)	0.39
Radius and ulna diaphysis	8 (11.60%)	6 (7.41%)	0.42
Radius and ulna metaphysis distal	37 (53.62%)	42 (51.85%)	0.34
Radius and ulna epiphysis distal	10 (14.50 %)	9 (11.11%)	0.19

[Table/Fig-3]: Different types of fracture in both groups analysed.
Chi square test was used *In Humerus fracture, humerus and radius which were facture individually was also included; similarly in radius and ulna fracture, ulna fracture and radius fracture separately were also included

[Table/Fig-4]: a) A 10-year-old obese child with distal 1/3rd radius and ulna fracture; b) Both radius and ulna fracture in eight-year-old male patient; c) Six-year-old patient with distal 1/3rd radius and ulna fracture; d)10-year-old obese child with mid shaft radius and ulna fracture; e) Anteroposterior (AP) and lateral view of nine-year-old child with distal 1/3rd radius and ulna fracture; f) AP lateral view of right radius and ulna mid shaft fracture in 11-year-old child.

DISCUSSION

The gender distribution was the same with 26 (37.68%) females and 43 (62.32%) males in obese groups, 34 (41.97%) females and

47 (58.03%) males in non-obese groups. A similar observation has been observed by different researchers [22-24]. In this study, 46% of prevalence of fracture in obese group was observed. This was higher than studies done by Olds T et al., found 15.2% and Lasserre AM et al., reported 15% [25,26]. As reported in this study, the risk of fracture was greater in obese children, with similar findings reported in other research supporting this study [25,26]. Some research indicated that this increased risk may lead to poorer balance, impaired mobility and greater strength at low fall heights [9,27,28]. The presumption that there is a higher incidence of fracture in overweight/obese is derived from a non-obese/non-overweight retrospective analysis on health chart of children by Taylor ED et al., [27].

Higher incidence of limb fracture in obese paediatric patients (55%vs.40%) and high rate of surgical treatment was observed by Rana AR et al., [29]. No significant differences in the incidences of upper limb fracture were reported by Pomerantz WJ et al., [30]. About 157 distal radius fracture were reviewed and obese patients were highlighted because they were likely to require a second reduction (28%vs. 12%) observed by Auer R et al., [31]. The patients with diaphyseal forearm fracture of both radius and ulna were observed an incomplete reduction after cast treatment of conservative treatment reported by Okoroafor UC et al., and DeFrancesco C et al [32,33]. The similar finding was observed in this study. Goulding A et al., fracture tripled (O.R. 3.47% IC 1.69-7.09) in boys, who experienced forearm fractures, unlike this research findings from the high BMI [28]. While there was also an unexplained difference in present study results, Goulding's severe complex fractures and a large number of chronic fracture patients involved analysed the male population as in the girl's study. In children aged 9-16 years, a dose-dependent association was also recorded between TV, video and computer viewing and wrist/forearm fractures [34]. Inactivity can contribute to reduced postural balance and decreased muscle strength and coordination leading to an increased risk of falling. The most powerful surrogate for sedentary lifestyle, TV watching, has been consistently found to be correlated with childhood obesity [35]. In obese and non-obese there was no statistically significant difference in the history of previous fracture, which was in accordance to a recent cross-sectional Canadian study [36]. There is paucity of data on this topic and it is suggested that obesity is associated with various factors like nutrition, hereditary, hormonal, life style and environmental which could play as predisposing factors. Further studies on this and similar are needed to clarify the effect of unclear mechanism.

Limitation(s)

The cost of paediatric fracture management can be minimised without compromising protection. The optimum medical follow-up will also be injury prevention. In reality, they might have been misclassified, the accident might have been occurred when they were moving at very low speed. The information about the movement's skills and physical fitness is important and it must be objectively assessed.

CONCLUSION(S)

Both radius-ulna fractures were found to be significant in obese patients. There is a lack of knowledge and more research is required to examine the relationship between obesity, bone growth and trauma. Child safety devices, regulation and system need further implication and revisited as the prevalence of child obesity increases.

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