RESEARCH ARTICLE

RELATIONSHIP OF THE BONY CORTEX THICKNESS WITH THE CHARACTERISTICS OF THE THORACIC EXTREMITY FRACTURES, EVALUATED IN PATIENTS ATTENDED IN THE GENERAL HOSPITAL NAVAL OF HIGH SPECIALTY

[1]Dr. Maikold Contreras Aguilera, [2]Dr. Jose Antonio Rivas Montero and [3,*]Dr. Cindy Bandala

[1]TTE FRAG SSN MCN, Resident of Fourth Year of the Specialty of Traumatology and Orthopedics, Naval General Hospital of High Specialty (HOSGENAES), Secretaría de Marina Armada de México (SEMAR),School of Postgraduate Naval Health (ESCPOSNAV), Calle Manuela Sáenz, edificio, 242, Interior 102, Colonia CTM Culhuacán VI, C.P. 04480, Delegación Coyoacán, Ciudad de México

[2]TTE NAV SSN MC, Specialist in Traumatology and Orthopedics. High specialty in Hand Surgery, Naval General Hospital of High Specialty (HOSGENAES), Ciudad de México, Secretaría de Marina Armada de México (SEMAR), CDMX, México

[3]Division of Neurosciences, National Institute of Rehabilitation (INR), SSA, Calzada, México-Xochimilco No. 289, Col. Arenal de Guadalupe, Del. Tlalpan, C.P. 14389, CDMX, México, Teléfono: (+52) (55), 59991999, ext. 19307

ARTICLE INFO

ABSTRACT

OBJECTIVE: To identify the distribution and topographic frequency of thoracic extremity fractures and its association with bone cortex thickness, mechanism of injury, age and gender.

PATIENTS AND METHODS: A retrospective study was performed in patients older than 18 years old treated at the Traumatology and Orthopedics Service of the Hospital General Naval de Alta Especialidad with diagnosis of fracture of the thoracic limb.

RESULTS: 99 patients with a diagnosis of upper limb fracture were studied. 54.4% of the cases were female. The overall mean age was 46.22 +16.36 years with a range of 56 years (21 to 77 years), therefore age intervals were constructed; This type of affectation was more frequent in the ages of 21 to 34 years (32.3%), followed by 35 to 48 years (26.3%), 63 to 77 years and 49 to 62 years, with percentages of 24.2% and 17.2%, respectively. No difference was found between the mean age between sex (p> 0.05). The most common anatomical sites of the thoracic segment were the distal radius and the diaphysis of both the radius and the humerus. The most frequent mechanism of injury were falls.

CONCLUSION: Population groups of young active military men and older women are risk groups for thoracic extremity fractures in which measures can be taken to reduce the incidence of fractures.

INTRODUCTION

Fractures of the thoracic extremity occur at all stages of life, characteristics, anatomical site and degrees of severity vary depending on the factors; By their impact constitute one of the most important pathological events in the life of the human being. The origin of a fracture depends on the direct interaction of the trauma with the characteristics of the bone. The presence of fractures can be determined by various circumstances, such as the intrinsic characteristics of the individual, pathologies and nutritional, metabolic, occupational or endocrinological factors (Canale, 2004).

---

*Corresponding author: Dr. Cindy Bandala,
Division of Neurosciences, National Institute of Rehabilitation (INR), SSA, Calzada, México-Xochimilco No. 289, Col. Arenal de Guadalupe, Del. Tlalpan, C.P. 14389, CDMX, México, Teléfono: (+52) (55), 59991999, ext. 19307.

Due to the impact of thoracic extremity fractures in humans, epidemiological studies have been carried out in different parts of the world to evaluate their incidence and prevalence and to know other descriptive factors to analyze their conditions; All with the purpose of identifying population groups at risk to take preventive measures and reduce their incidence. The universes can be variable from one country to another, according to the age composition of the population and the presence of trauma or levels of violence. Fractures have become a public health problem worldwide due to the increased incidence of pathologies such as osteoporosis and increased exposure to risky activities (Rockwood & Green, 2005). In Mexico, the problem of fractures has not been carefully evaluated; It is necessary to carry out studies to determine the indicators that allow to establish the magnitude of the problem.

On the other hand, the epidemiological information of the fractures will allow to identify the most frequent etiopatogenic factors. Clark and colleagues have studied fractures from the epidemiological point of view, but only focusing on osteoporosis and the risk of axial skeletal injuries in the population with or at risk of fracture (mostly females)(Sanchez & Mejia, 2014). The objective of this study was to observe the relationship between the thickness of the cortical bone measured in two radiographic projections of the structures of the thoracic limb and the demographic characteristics of the population with a diagnosis of fracture at some level of the thoracic limb, To identify the distribution and topographic frequency of fractures with association with cortical thickness, type of mechanism of injury and age.

PATIENTS AND METHODS

A retrospective, observational study was performed. Patients treated at the Division of Hand Surgery and Thoracic Extremity of the Naval General Hospital of High Specialty (Secretary of Marine, Mexico City) were included. The location of the subjects was performed through a search in the income for the emergency department of clinical records with diagnosis of fracture of a segment of the Thoracic Extremity of patients treated for the first time. Cases from January 2015 to June 2016 were reviewed. Inclusion criteria were patients of any sex, over 18 years of age, treated at the Hand Surgery and Thoracic Extremity Service of the General Naval General Hospital, with a diagnosis of fracture at some level of the thoracic limb. Exclusion criteria were patients whose files did not have the complete information and cases that did not have results of documented radiological studies or without definitive diagnosis described. Duplicate files were removed. The Hospital General of Naval High Specialty has an electronic hospital information system (HIS) and a Statistics Area, which were asked to list patients for admission for the first time with a diagnosis of thoracic extremity fractures of the period (2015-2016).

The lists were reviewed and the records of patients meeting the selection criteria were collected. We proceeded to review the clinical records and were recorded in a questionnaire designed for this research. In all cases, the diagnosis of admission with radiographic plates was corroborated to perform the radiological measurements through the Intrahospital Radiology system (RIS, MagicWeb, Visaje Imaging 2010)

STATISTIC ANALYSIS

Means and standard deviations (quantitative variables), frequencies and percentages (qualitative variables) were determined. We used the tests of Smirnov- Kolmogorov (calculate distribution), Chi square (association 2 qualitative variables), Student's T / Mann Whitney U (compare two independent means), ANOVA / Kruskall Wallis (compare more than 2 independent averages), Spearman correlation (relationship between 2 quantitative variables). The analysis of the data was carried out with the program SPSS v19. A value of $p < 0.05$ was taken as significant (IBM, Chicago, IL).

RESULTS

We studied 99 patients with fracture of the upper limb. 54.4% of the cases were female. The mean cortical thickness in the radiological measurements was 0.27 ± 0.08 cm (range 0.16-0.46 cm). The mean global age was $46.22 + 16.36$ years with a range of 56 years (21 to 77 years), therefore age intervals were constructed. This type of condition was more frequent at ages ranging from 21 to 34 years (32.3%), followed by 35 to 48 years (26.3%), 63 to 77 years and 49 to 62 years, with percentages of 24.2% and 17.2%, respectively. No difference was found between the mean age between sex ($p > 0.05$). Regarding the affiliation of the patients, 49.5% were military personnel, the remainder corresponded to beneficiaries. The average age was higher in the patients entitled to the military ($56.14 + 15.29$ vs $36.1 + 10.03$ years, $p = 0.0001$); No significant relationship ($p > 0.05$) was found with the sex of the patients included in the study.

Table 1. Relation of the antecedent of previous fractures with different clinical-pathological parameters in patients with fractures of the upper limb

	Yes (n=17)	No (n=82)	p	OR (IC95%)
Age ≥40 years old	94.1% (16)	51.2% (42)	0.01*	15.23 (1.93-120.19)
Female	58.8% (10)	42.7% (35)	0.22	1.91 (0.66-5.53)
Rigth-holder	94.1% (16)	41.5% (34)	0.0001*	22.58 (0.006-0.35)
Comorbidity	76.5% (13)	29.3% (24)	0.0001*	7.85 (2.32-26.53)
Cast	76.5% (13)	8.5% (7)	0.0001	34.81 (8.9-135.98)
BMI	30.85+3.66	27.87+3.2	0.001*	-
Heigth	165.76+5.4	171.85+8.14	0.001*	-
BMI: Body mass index				

Source: Data obtained from the present study.

Table 2. Frequencies of the characteristics of upper limb fractures of patients

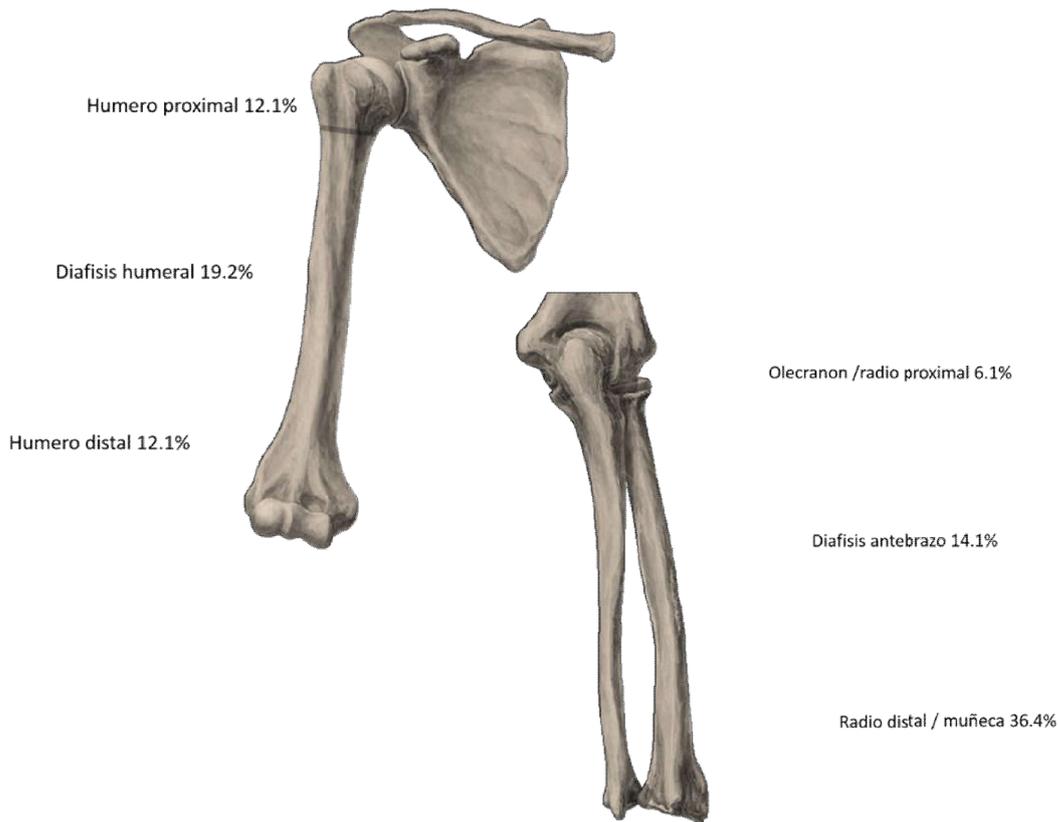| Mechanism		Type of trace	
	Frecuency		Frecuency
Direct	62.6% (62)	Transverse	46.5% (46)
Indirecto	14.1% (14)	Oblicuous	13.1% (13)
High energy	18.2% (18)	Fragmented	33.3% (33)
FAP	5.1% (5)	Comminute	7.1% (7)
FAP = Firearm projectile			

Source: Data obtained from the present study.

Table 3. Percentage of fractures according to the anatomical site of the thoracic limb

	Frecuency	Percentaje
Distal radius	36	36,4
Diaphysial radius		
Proximal radius/olecranon	14	14,1
Distal humerus Diaphysis humerus Proximal humerus Total	6	6,1
	12	12,1
	19	19,2
	12	12,1
	99	100,0

Source: Data obtained from the present study.

Humero proximal 12.1%

Diafisis humeral 19.2%

Humero distal 12.1%

Olecranon /radio proximal 6.1%

Diafisis antebrazo 14.1%

Radio distal / muñeca 36.4%

Source: Data obtained from the present study

Figura 1. Porcentajes del sitio anatómico donde so localizó la fractura

**Table 4. Relationship of bone cortical thickness (cm) to
the type of upper limb fracture line taking into account gender**

	Both gender (Media $\pm$ D.E.)	Female (Media $\pm$ D.E.)	Male (Media $\pm$ D.E.)
Transverse	0.28$\pm$0.08	0.27$\pm$0.09	0.29$\pm$0.06
Oblicuous	0.29$\pm$0.05	0.25$\pm$0.03	0.31$\pm$0.05
Fragmented	0.26$\pm$0.09	0.20$\pm$0.02	0.31$\pm$0.09
Comminuted	0.25$\pm$0.02	-	0.25$\pm$0.02
	p=0.06	p=0.001*	p=0.19

Source: Data obtained from the present study.

The mean body mass index (BMI) was 28.38 + 3.45 kg / m2 (range 21.52 to 37.69 kg / m2); no difference was found in BMI in relation to sex (p> 0.05). 37.4% of the patients had at least one associated disease; Patients aged> 40 years had 8.86 (3-25.8) times greater risk of having comorbidity (86.5%, p = 0.0001). 17.2% had at least one previous fracture; The patients with age> 40 years had 15.23 (1.93-120.29) times more risk of presenting this antecedent (94.1%, p = 0.001).

47.5% of the fractures occurred in the public highway, 41.4% in the home and 11.1% in the workplace; Most of the women had fractured at home (53.3%), while men on the public road (53.7%, p = 0.07). Regarding the treatment, the initial management was in 76.8% an immobilization and the rest with external fixation; The definitive management was conservative in 20.2% of the cases, while the surgical one in 79.8%.

DISCUSSION

In Mexico, in recent years, prevalences of fractures ranging from 12 to 18% have been reported (INEGI, 2010). The most frequent fractures reported at the national level are located in the hip (transtrocanteric) and knee (tibial plateau) with 34 and 18% respectively, whereas upper thoracic limb fractures represent 8%. Probably, due to their low prevalence compared against fractures of the lower extremity, reported in the general population (Espino & Avendaño, 2002), We do not know several important aspects that characterize this type of patients. From our experience, at the General Hospital Naval of High Specialty (HOSGENAES), thoracic extremity fractures present a high prevalence, it is through this empirical finding that different questions arose to know in more depth diverse characteristics of these patients, as well as their Possible relationship with cortical thickness. In our study, the mean age was around 45 years, however, the range ranged from young adults to older adults, being different from that reported in the literature, where it has been mentioned that patients older than 65 years are The most affected with this type of events (Najera, Fuenmayor, & Barcena, 1995); in our population, the fact that the average age of patients with upper extremity fractures is less than 50 years is probably due to the fact that almost 50% of the cases are active military and the type of activities they perform tend To affect this part of the body. Regarding sex, several studies have revealed that fractures are more frequent in women, especially postmenopausal patients since it has been related to a decrease in bone mineral density of hormonal aetiology (Devlin & Horner, 2007). In our study, the frequency of upper extremity fractures were very similar in both women and men, in a 1: 1 ratio.

Like other studies, we observed several factors associated with fractures such as the presence of comorbidities (Sanchez & Mejia, 2014), The antecedent of previous fractures as well as being military in the active. Several studies have mentioned that a BMI greater than 30 kg / m2 has a negative correlation with Bone Mineral Density (Valtueña, 2002), Due to the proinflammatory effect of adipokines such as leptin and adiponectin affect the homeostasis of human energy and slow down bone metabolism (Correa, 2013); These findings are consistent with our results (Rho = -0.29, p <0.05), emphasizing that our correlation was performed between BMI and cortical thickness. These results make sense in the Mexican population, since it occupies the 1st. World-wide place in obesity so much infantile as in adults (Davila & Gonzalez, 2015). On the other hand, within the characteristics of upper thoracic extremity fractures, the direct mechanism and type of transverse tracing were more frequent, which is similar to several studies carried out on lower limb fractures in the Mexican population. The distal radius portion was the most affected in about a third of the total fractures in this area, this coincides with that reported by such author in such population. We also observed that the anatomic site was related to the fracture mechanism (Sanchez - Monzo & Vaamonde, 2010). In relation to cortical thickness, women, younger than 40 years and patients with previous fracture history had lower averages, however, no correlation was found with age; Different studies carried out in the Caucasian population mention an average of 25 mm and 30 mm relating the difference of thickness with the size and the body mass index, as well as the high carbohydrate diet and little sedentary lifestyle (Ekholm & Adams, 2006).

In the Latin population, from a subjective point of view, no reports have been made, however, cortical thickness in some studies has been taken into account to calculate estimates as Singh index and the corticodiaphysial index (Lozada, Infante, & Silva, 2007) (Najera, Fuenmayor, & Barcena, 1995). The cortical thickness in our study was significantly related to the type of tracing, to the anatomical site of the fracture, being thinner in the proximal humerus region and the distal radius region, the lower cortical thickness, the lower corticodiaphysial index And greater risk and greater complexity of the fracture (Sanchez - Monzo & Vaamonde, 2010). On the other hand, cortical thickness was lower in patients with a history of previous fracture, this may be related to poor bone quality; Our findings have similarities with various studies, where they consider the gold standard "DEXA" (Double Emition Xray Assesment) to measure bone mineral density (Carranza & Lanuza, 2014), However, most of these studies are performed in patients over 60 years of age.

The type of tracing in our study was related to the thickness of the cortical, the more complex the fracture line was, the smaller the cortical thickness, which is similar to what has been reported in other studies, Where the lower bone mineral density, the greater the complexity of the fracture (Genant, Engelke, & Fuerst, 1996), Although cortical thickness is a different parameter to bone mineral density, it is logical to think that there is a positive correlation between both parameters. (Najera, Fuenmayor, & Barcena, 1995). In the present study it was observed that the most frequent mechanism of injury was the direct trauma 62.6% followed by the high energy in 18.2%. The mean age was higher in the patients entitled to the military (56.1 vs 36.1 years), with a tendency to female in 54.4%.

Conclusion

With the results of this investigation, we conclude that in patients with a fracture of the thoracic limb, cortical thickness is associated with fracture characteristics such as type of tract, fracture complexity and anatomical site, being important the mechanism that provoked the Traumatic event. Likewise, we observed that women and patients with obesity / overweight have a lower cortical thickness of the bones constituting the thoracic extremity, which decreases in relation to age in both sexes. Cortical thickness may be a useful parameter in the prevention of fractures in the thoracic extremity, but more robust studies are required.

REFERENCES

Canale, T. 2004. *Campbell, Cirugia Ortopedica.* Mosby.

Carranza, & Lanuza. 2014. Comparacion del riesgo de fractura calculado con la herramienta FRAX con y sin densitometria osea en un grupo de mujeres mexicanas. *Ginecologia y Obstetricia Mexicana*, 591-594.

Correa, T. 2013. *Dislipidemia como un factor asociado a fracturas en pacientes diabeticos.* Lima, Peru.

Davila, & Gonzalez. 2015. Panorama de la obesidad en México. *Revista Medica Instituto Mexicano del Seguro Social*, 240-249.

Devlin, H., & Horner, K. 2007. Correlacion radiologica entre el indice cortico diafisiario y la densidad mineral osea en el

diagonstico de la osteoporosis. *Acta Ortopedica Mexicana*, 77-83.

Ekholm, & Adams. 2006. Fractures of the shaft of the humerus: an epidemiological study of 401 fractures. . *Journal of Bone and Joint Surgery*, 262-265.

Espino, A., & Avendaño, E. 2002. Incidencia de Fracturas de Extremidad Superior en el Estado de Mexico. *Acta Ortopedica Mexicana*, 34 - 37.

Genant, Engelke, & Fuerst. 1996. Non invasive assesment of bone mineral and structure: State of the art. *Journal of Bone Mineral Research*, 707-730.

Lozada, Infante, & Silva. 2007. Correlacion radiologica entre el indice corticodiafisiario y la densidad mineral osea en el diagnostico de osteoporosis. *Acta Ortopedica Mexicana*, 77-84.

Najera, Fuenmayor, & Barcena. 1995. Indices cortico diafisiario y de Singh en poblacion adulta y sana de la ciudad de México. *Revista Mexicana de Ortopedia y Traumatologia*, 71 - 74.

Rockwood, & Green. 2005. *Fractures in adults*. Philadelphia: Lippincot, Williams & Wilkins. Sanchez - Monzo, & Vaamonde. (2010). Factores de riesgo en las fracturas de extremidad proximal de humero. *Revista Española de Cirugia Osteoarticular*, 119-129.

Sanchez, M., & Mejia, D. 2014. Comorbilidades en pacientes operados por fractura transtrocanterica. *Revista de Especialidades Medico Quirurgicas*, 145 - 151.

Valtueña, S. 2002. Obesidad y osteoporosis: efecto de la variacion ponderal sobre la masa osea. *Nutricion Hospitalaria*, 49-54.

****