

## RESEARCH ARTICLE

# Epidemiological Aspects of Osteosarcoma, Giant Cell Tumor and Chondrosarcoma Musculoskeletal Tumors - Experience of the National Rehabilitation Institute, Mexico City

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## Abstract

**Background:** Primary bone neoplasms are rare, contributing only 0.2% of the global burden of all human malignancies. Osteosarcoma (OS) and chondrosarcoma (CS) are the most common malignancies of bone. The giant cell tumor of bone (GCTb) is a benign tumor with behavior characterized by osteolytic bone destruction. The OS, CS and GCTb affect both sexes, all races and generally have incidence peaks regarding the age of the patient which vary according to the tumor type. We analyzed the incidences of OS, CS and GCTb and their relations with gender and age in patients treated in the National Rehabilitation Institute (INR, for its acronym in Spanish) over a period of nine years. **Materials and Methods:** In the study period, clinic pathological data for 384 patients were obtained with clinical, radiological and histopathological diagnosis for OS, GCTb and CS. Data analysis was performed using the chi-square and Fisher's exact tests. **Results:** From 2006 to 2014 were recorded 384 cases of bone malignancies in the database of INR. The GCTb had the highest incidence (53.1%), followed by OS (31.3%) and finally the CS (15.6%). The overall average age was 33.6±15.8 years and the overall frequency of gender had a ratio of 1/1.03 male/female. The states with the highest incidence were Distrito Federal and Estado de Mexico with 29.2% and 25.3% respectively. Malignant neoplasms of bone assessed in the course of nine years show three significant increases in 2008, 2011 and 2014 (p=0.14). We found association between sex and tumor type (p=0.03), GCTb and CS predominated in females (54.9% and 56.6% respectively), while for the OS males were most affected (59.1%). Age was different in relation with tumor type (p=0.0001), average age was 24.3±11.2 years for OS, 34.5±13 years for GCTb and 49.2±18.5 years for CS. Furthermore, associations of tumor type with topographic location of the primary tumor (P=0.0001) were found. **Conclusions:** In this study we can see that incidence of musculoskeletal tumor in our population is continuously increasing and in nine years an approximately 200% increase of musculoskeletal tumor cases was observed.

**Keywords:** Osteosarcoma - chondrosarcoma - giant cell tumor of bone - Mexico

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## Introduction

The Osteosarcoma is highly malignant and its origin from mesenchyme is characterized by the formation of immature or osteoid bone, it has reported an incidence of 35% between all primary bone malignancies. The first peak of incidence in OS was observed in adolescence (10-19 years old) it's more common in women than in men, is variable in adults (20-59 years) and decreases in the elderly (>60 years) (Mirabello et al., 2009; Wiromrat et al., 2012; Ward et al., 2014). The OS mainly affects the long

bones of the limbs, especially near to metaphyseal growth plates (80%), non-appendicular sites were lesser-affected 4-8%. (Mirabello et al., 2009), also the main target for this metastatic sarcoma is the lung 45.7% (Choeypasert et al., 2014). Cartilage tissue is the origin of CS and ranks second in incidence of all primary malignant bone tumors, with reporting about 25% incidence (Geest et al., 2002) regarding age, CS it is more common in adults between 40-80 years old, and is slightly more common in men. In women the appendicular CS are more common than the axial CS while in men appendicular and axial CS show

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similar incidence ratio (Giuffrida et al., 2009; Yang et al., 2012.). The main site of CS metastasis is the lung (Giuffrida et al., 2009). In the case of GCTb, it has been reported incidence varies from 5% to 20% of tumors of primary bone in adults (Turcotte, 2006), GCTb is characterized by an intramedullary bone tumor composed of mononuclear cells and multinucleated giant cells to cause osteoclasts the osteolytic bone destruction, their behavior is aggressive, mainly affects the metaphyseal region of long bones, especially in the knee joint. Presents frequent local recurrence (>50%) with rare lung metastases (Sung et al., 1982; Niu et al., 2012). In Mexico, it was reported that over a period of five years (2000-2005), the incidence of OS was 46.6% and CS of 14% compared to malignant tumors and 14.6% for GCTb respect to benign tumors (Baena et al., 2009); in another study, mentioned that the OS was the predominant bone malignancy, this was an increase of 166% in five years, the GCTb showed no change and the CS had an increase of 185.7%. In the same study it mentioned that the male sex was the most affected in the three tumor types (Rizo-Rios et al., 2007).

Materials and Methods

Procedures

384 biopsies from patients treated at the National Rehabilitation Institute with clinical and radiological diagnosis of OS, GCTb and CS in the period from 2006 to 2014. The clinical and pathological data were collected from medical records and reviewed taking into account ethical standards. An expert pathologist in bone tumors performed the analysis of the biopsies, with attachment on the criteria established by the World Health Organization. Both primary and secondary tumors were included.

Statistical analysis

Measures of central tendency and dispersion, frequencies and percentages were determined. The Kolmogorov-Smirnov test, Chi square test, Fisher's Exact test were applied. Data analysis was performed using SPSS program v19. A confidence interval of 95% was considered.



Figure 1. Global Incidence of Bone Tumors (OS, GCTb and CS) by State for the 2006 to 2014 Period (P = 0.0001)

Results

Of the total of 384 cases of malignant neoplasms of bone (OS, GCTb and CS), the GCTb was the highest incidence with 53.1% (204 cases) followed by OS 31.1% (120 cases) and finally the CS 15.6% (60 cases). The overall incidence of primary malignant tumors studied according to their residence was higher in Distrito Federal, followed by Estado de Mexico, with 29.2% (112 cases) and 25.3% (97 cases) respectively, and Veracruz 5.7 % (22 cases), the other states had less than 20 cases with the exception of San Luis Potosi, Chihuahua and Colima, where no cases reported (Figure 1) were found. The incidence of malignant neoplasms of bone (OS, GCTb and CS) during the nine years covered by this study, showed an increase of 214% (beginning-end). The annual global report on the INR for these malignancies of bone were in 2006, 5.5% (21 cases); in 2007, 6.3% (24 cases); 2008, 12.2% (47 cases); 2009, 12.5% (48 cases); 2010, 11.7% (45 cases); 2011, 14.1% (54 cases); 2012, 13% (50 cases); 2013, 7.6% (29 cases) and 2014, 17.2% (66 cases). The highest incidence for the OS was in 2008 with 21 cases; for GCTb and CS in 2014 with 36 and 14 cases respectively. The lower incidence for the OS was in 2013 with 6 cases and the GCTb and CS 2006 with 8 cases and 1 case respectively (Figure 2). The relationship between gender/tumor type showed significant (p=0.03), these results are shown in Figure 3. In the OS, male sex was the most affected with 59.2% (71 cases) than female 40.8% (49 cases), with male/female ratio 1.44: 1 cases. It wasn't found association between frequency per year and sex (p=0.66), however, in the years 2006, 2008, 2009, 2011, 2012 and 2013 the incidence was higher for men, but not in 2007 and 2010 here was slightly higher in women. In 2014 were reported the same number of diagnosed cases for both sexes in the database in INR. In the case of GCTb, female sex was most affected with 54.9% (112 cases) compared to males 45.1% (92 cases), with a male/female ratio of 1: 1.22 cases (p=0.10). In 2008 and 2012 the rate was higher for men, while in 2007, 2009-2011, 2013 and 2014 was higher in women and in 2006 found reported the same number of diagnosed cases for both sexes. In the case of CS, females were most affected with 56.7% (34 cases) than male 43.3% (26 cases), with male/

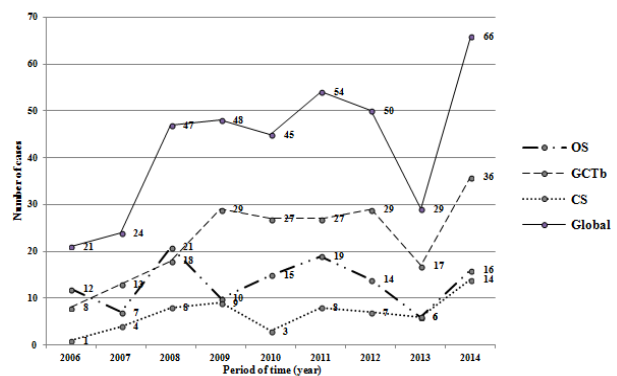
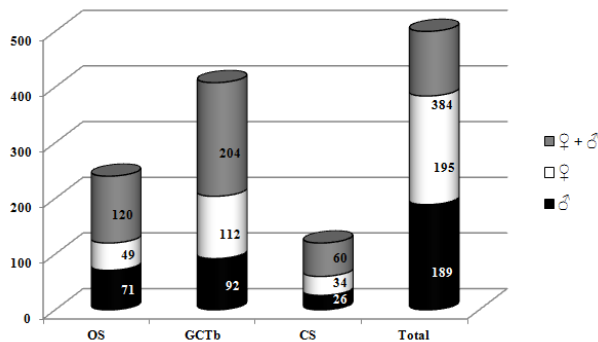


Figure 2. Incidence of Bone Tumors (OS, GCTb and CS) in the 2006-2014 Period (p=0.14)

**Table 1. Year and Age of Incidence of Primary Bone Tumors (OS, GCTb and CS)**

Year	Osteosarcoma			Giant Cell Tumor of bone			Condrosarcoma		
	Minimum Age	Middle Ages	Maximum Age	Minimum Age	Middle Ages	Maximum Age	Minimum Age	Middle Ages	Maximum Age
2006	14	23.0±6.56	37	14	33.2±511.84	56	81	81.0±0	81
2007	14	25.14± 11.93	49	23	39.92±20.51	54	24	57.25±24.94	84
2008	13	25.48±11.85	52	12	34.44±14.05	81	27	52±18.43	88
2009	18	31.5±14.05	67	23	36.38±12.57	69	11	48.89±24.58	87
2010	12	21.07±6.51	36	20	34.04±13.92	81	40	47.67±10.01	59
2011	14	26.05±12.96	64	16	33.67±15.54	74	42	59.38±12.10	85
2012	8	24.64±14.51	67	18	33.72±11.93	56	6	35.86±24.94	70
2013	9	20.67±12.48	43	19	34.94±12.30	57	31	39.33±9.52	58
2014	11	20.88±7.75	35	17	32.42±13.31	80	35	48.71±11.20	74
Total	8	24.30±11.23	67	12	34.45±13.08	81	6	49.22±18.47	88



**Figure 3. Distribution of primary malignant bone tumors (OS, GCTb and CS) by gender and diagnosis (P=0.03). Gender: Male ♂, Female ♀, Total ♂ + ♀**

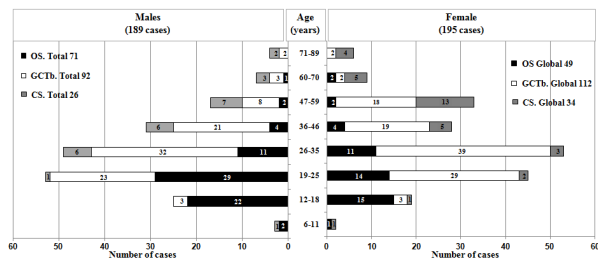
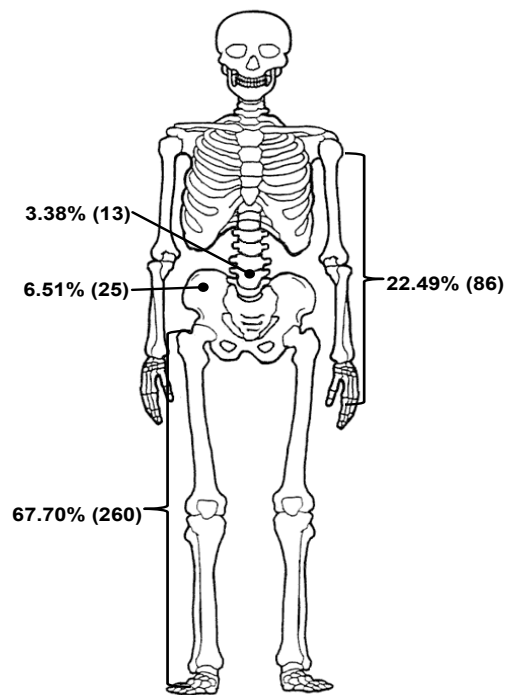


Figure 4. Relationship of age range by sex and diagnosis (P = 0.0001).

**Figure 4. Relationship of Age Range by Gender and Diagnosis (P = 0.0001) of Primary Malignant Tumors of Bone (OS, GCTb and CS)**



**Figure 5. Incidence topographical of primary malignant tumors of bone.**

**Figure 5. Topographical Incidence of Primary Malignant Tumors of Bone**

female ratio 1: 1.30 cases (p=0.24). In the years 2006, 2007, 2009 and 2013 the rate was slightly higher for men, while 2010, 2012 and 2014 were higher in women and in 2008 and 2011 the same number of diagnosed cases for both sexes were found. Figure 4. The average age of primary malignant bone tumors (OS, GCTb and CS) together was 33.58±15.75 years in the period that included this study. The minimum age at diagnosis was 6 years and maximum 88 years. Significant differences in the average age in relation to tumor type (p=0.0001) were found. The average age for OS was 24.3±11.23 years (minimum eight years and maximum 67 years) for GCTb was 34.45±13.08 years (minimum 12 and maximum 81 years) and the CS 49.22±18.47 (Minimum 6 years and maximum 88 years). The average minimum/maximum and

average age ranged from the year of diagnosis as shown in Table 1. In addition, association of tumor type and the topographic location of the primary tumor (P=0.0001) were found. Of the three bone tumors (OS, GCTb and CS), the lower limbs were the most affected 67.7% (260 cases); the second place was taken by the upper limbs 22.49% (86 cases) and the third and fourth hip and column with 6.51% (25 cases) and 3.38% (13 cases) respectively (see Figure 5). Involvement with a primary tumor in the upper extremity and lower extremity prevailed in GCTb (64%, 52.7% respectively) column was the OS (38.5%) and hip CS (40%). Of the total cases, 23.43% (90 cases) were found with metastases, 14.06% (54 cases) were to lung, 4.42% (17 cases) to another bone and 4.94% (19 cases) to other body sites. For three tumor types, the most

common lung metastases were: 72.7% by OS, the 51.85% in the GCTb and 42.2% in the CS.

## **Discussion**

Bone tumors are a health problem with difficult treatment and high mortality in the most histological types (Rizo-Rios et al., 2007). In this study from 2006 to 2014 was observed that, with respect to OS, GCTb and CS, 42.6 cases were filed per year; this represents an overall increase of 73.17% compared to that observed in the period from 2000 to 2005 in Mexico, where 24.6 cases reported per year (Baena-Ocampo et al., 2009). Regarding the OS, a relative incidence of 12.3 cases per year were identified in GCTb was 22.6 cases per year and the CS was 6.6 cases per year; compared with those reported by Baena-Ocampo, our results suggest an increase in the relative incidence of OS 6.4%, GCTb 130.61% and CS 186.95%. (Baena-Ocampo et al., 2009). The CS may increase due to increased age in Mexican population. The highest incidence occurred in the central area of this country (Distrito Federal and Estado de Mexico), this may be a result of the location of institute, despite that INR is a national reference center for care of bone tumors, this institute receives most patients with adjacent residence. However, it is required to do a study where the frequencies of these tumors in relation to the various delegations and municipalities in the metropolitan area is organized to be assessed; This will clarify whether the geographical and medium-environmental factor influencing the etiology of bone tumors. In the analysis of the initial frequency (2006) vs end (2014) of our study, we observed an overall increase of 214.28%; the largest increase was recorded in the CS 1400%, followed by GCTb with 350% and finally, 33.3% for the OS. In 2007, Rizo et al., reported an increase in the overall incidence of 166%, unchanged for the GCTb and CS 185.7% for a period of five years, for the Mexican population. The incidence peaks are found in 2008, 2011 and 2014 with 123%, 14.8% and 22% increase over the starting year (2006). As for sex, from the global point of view (OS, GCTb and CS), we found no significant difference, however, women had a higher percentage in relation to men. These results differ with those reported by Rizo-Rios (2007), and by Baena-Ocampo (2009), which mentions that the frequency of these three tumor types was higher in men for Mexican population; however, we found no association between sex and tumor type. For the OS, we found that males were more affected; this coincides with that published by WHO Classification of Bone Tumours, (Fletcher et al., 2002) and reported by Muscolo et al. (2009) for Argentine population. In the case of GCTb and CS, we see the most cases in females; GCTb regarding our results agree with the study by De la Garza et al. (1999) and Sanchez-Torres et al. (2012) in the Mexican population and by Niu in Chinese population, they mentions that GCTb predominates in Caucasian women and It differs in the mongoloid race, where man is the most affected (Niu et al., 2012). For CS, in the United States, were reported slight predominance in males (Giuffrida et al., 2009), with a male/female ratio 1.22/1, in contrast to our findings reason. The average age for the OS

in our cohort of patients was 24 years with a range of 59 years, this is slightly different to that reported previously (Muscolo, et al., 2009), where it is mentioned that this type of tumor is more common in adolescents and young adults between 15 and 19 years and with those reported by Kim and Park in 2014, where they observe two peaks of incidence, the first of 15-19 years and the second in older adults. This variation can be explained because the majority of tumors in children are referred to health institutions where conditions are met only in children. To GCTb the average age was 34.45 years observed with a range of 69, this coincides with that reported in Chinese population, where the average age was 31.4 years with a range of 60 (Niu et al., 2012). For CS, the average age was 49.2 years with a range of 82 years, this is similar to that reported by Giuffrida et al. (2009) Which it mentions that the average age is 51, with an age range 101 years. The anatomical incidence for the three primary tumors we tested was higher in the lower extremity followed by upper extremity, similar to that reported for Thai population (Choeprasert et al., 2014), for US population (Giuffrida et al., 2009; Mirabello et al., 2009) and for the Chinese population (Jiang et al., 2013). For the OS, the anatomical site most frequently affected were the long bones of the lower extremity, coinciding with those reported by Mirabello et al. (2009) Palomo-Colli et al. (2012) and Choeprasert et al. (2014), in all stages of life. For CS appendicular skeletal location was the most frequent in this study, followed by the axial; this coincides with what was reported by Giuffrida et al. (2009) but differs from reported by Pring et al. (2001) with higher frequency in pelvis. The frequency of metastases at diagnosis of cancer disease OS, GCTb and CS was 23.43% in this research; individually the OS provided 36% of metastases, with 16% higher than reported by Gomez-Martinez (2012), which was mentioned that 20% of metastases at diagnosis. Compared our results with those reported in Thailand, we found a 9.7% lower than reported by Choeprasert et al. (2014) in pediatric patients. In relation to GCTb, observed 6.8% lung metastases at diagnosis time, twice that reported by Niu et al. (2012). Chondrosarcoma show 31.6% of metastases, 21.6% higher than that reported in the literature (Hasan, et al., 2001). In conclusion, bone tumors in our country, continue to have a high mortality rate due to late diagnosis. Approximately 25% of patients have metastases when the primary tumor is detected, reducing the survival of patients despite receiving invasive treatments. The observed increase of the three tumor types studied (OS, GCTb and CS), comparing the frequency in 2006 vs 2014 is alarming, especially in the case of chondrosarcoma (1400%) and GCTb (350%); it should be noted that similar to happens in other cancers types, intervals age at diagnosis of tumors evaluated, are expanding, observing higher incidence in population, by age, was not considered at risk. This demonstrates the need for future research to clarify the causes of these neoplasms.

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