

## **Radiographic Assessment of Bone Cortex to Bone Diameter Ratio of Manus and Pes in Camel**

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### **Abstract**

**Objective-** To measure statistically bone cortex to diameter (C/D) ratio in metacarpo/metatarsal and proximal phalanges in camel. This ratio may be used in diagnosing possible metabolic and nutritional diseases in camel.

**Design-** Experimental study.

**Animals-** Twelve camel limbs (6 fore limbs & 6 hind limbs)

**Procedures-** This study was conducted on dorsopalmar/dorsoplantar radiographs of twelve fore and hind limbs of camel. Cortical thickness, bone diameter and C/D ratio of mid metacarpo/metatarsal regions, C/D ratio of metacarpo/metatarsal regions just proximal to its bifurcation and C/D ratio of proximal phalanges were measured on all radiographs. Available data were analyzed statistically and the average, P-values, and standard deviations are given. Important characteristic of measurements are discussed.

**Results-** C/D ratios of mid metacarpal region and just proximal to its bifurcation were 0.18 and 0.13 respectively. C/D ratios of mid metatarsal region and just proximal to its bifurcation were 0.21 and 0.14 respectively. C/D ratios of mid lateral and medial proximal phalanx of forelimb were 0.21 and 0.22 respectively. C/D ratios of mid lateral and medial proximal phalanx of hind limb were 0.22 and 0.24 respectively.

**Conclusion and Clinical Relevance-** This study showed that there were significant differences between C/D ratios of manus and pes measured in all locations except between metacarpal to metatarsal region just proximal to its bifurcation. No acceptable reason was found for this result so it can be attributed to measurement inaccuracy in this site.

**Key words:** Radiography, Bone Cortex to Diameter Ratio, Camel

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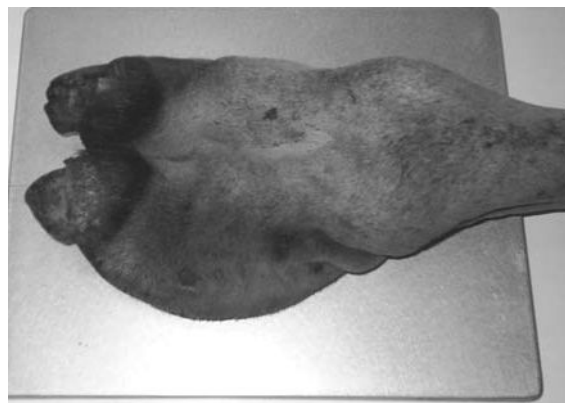
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## Introduction

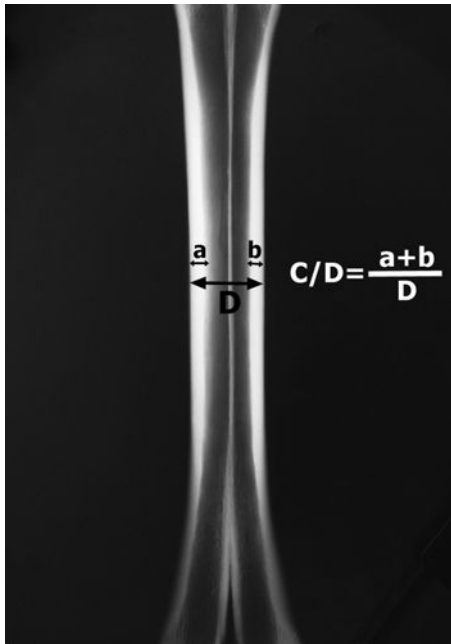
Cortical thinning and subsequent pathologic fractures due to metabolic, nutritional, malignancy, aging and disusing can occur most often in human and animals. Bone densitometry is most accurate and sensitive assessment of bone health especially in human. Bone densitometry can detect the changes in bone volume as little as one percent. Although bone densitometry is used in veterinary research and practice but it has not become routine in veterinary medicine due to the price of unit and variety in the size of animals. Plain radiography can detect decrease in density when at least 30% of the normal bone density is decreased. Although radiographic diagnosis is very accurate in advanced cases but it is very subjective in early cases. C/D ratios are a radiographic and computed tomography parameter that is used in human to assess the amount of bone health. These ratios are very easy to obtain on the radiographs<sup>1,2</sup>. These ratios are not routinely used for assessing bone health in animals like dog and cat as well as in camel. This study was conducted to have some normal values of C/D ratios in fore and hind limb in camel.

## Materials and Methods

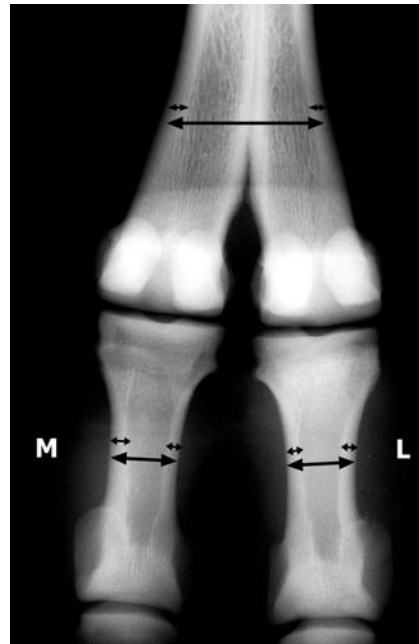
Twelve fore and hind limbs of slaughtered one humped camel (Dormdrain dromedaries) were radiographed in dorsopalmar/dorsoplantar view using 60 kVp and 5 mAs with FFD of 80 cm (Fig1). C/D ratio of mid metacarpo/metatarsal region (Fig 2), and C/D ratio of metacarpo/metatarsal region were measured on the dorsopalmar region just proximal to its bifurcation (Fig 2) , middle of lateral phalanges and middle of medial phalanges of fore and hind limb (Fig 3). An independent student's t-test and paired sample t-test were used to detect significant differences between data collected from fore and hind limbs. A nonparametric Mann-Whitney U test was used where data did not follow a normal distribution. The significance level was set at  $P < 0.05$ .



**Fig 1-** Dorsopalmar radiography



**Fig. 2:** C/D ratio measurement in D-Pl view



**Fig. 3:** C/D ratio measurement in D-Pa view

## Results

The mean  $\pm$  SE of C/D ratios of mid metacarpal region and metacarpal region just proximal to its bifurcation were  $0.18 \pm 0.006$  and  $0.13 \pm 0.005$  respectively. The mean  $\pm$  SE of C/D ratios of mid metatarsal region and metatarsal region just proximal to its bifurcation were  $0.21 \pm 0.004$  and  $0.14 \pm 0.004$  respectively. The mean  $\pm$  SE of C/D ratios of mid lateral and medial proximal phalanges of forelimb were  $0.21 \pm 0.003$  and  $0.22 \pm 0.006$  respectively. The mean  $\pm$  SE of C/D ratios of mid lateral and medial proximal phalanx of hind limb were  $0.22 \pm 0.006$  and  $0.24 \pm 0.006$  respectively.

There was significant difference between mean value of C/D ratios of mid metacarpal region to metacarpal region just proximal to its bifurcation ( $P < 0.05$ ) and also between mid metatarsal region and metatarsal region just proximal to its bifurcation. There was no significant difference between mean value of C/D ratios of middle of lateral and medial proximal phalanges of fore limb ( $P = 0.25$ ). Unlike forelimb, there was significant difference between mean value of C/D ratios of middle of lateral and medial proximal phalanges of hind limb ( $P\text{-value} = 0.017$ ). There was significant difference between C/D ratio of mid metacarpal and mid metatarsal region ( $P\text{-value} = 0.017$ ) but there was no significant difference between metacarpal and metatarsal region just proximal to its bifurcation ( $P = 0.50$ ). There was significant difference between lateral proximal phalanges of fore and hind limb ( $P\text{-value} = 0.037$ ) and between medial proximal phalanges of fore and hind limb ( $P\text{-value} = 0.045$ ). (Table 1 & 2)

**Table 1: Mean of cortex, bone diameter and C/D index of metacarpal/metatarsal region**

Anatomical region	Mid metacarpal/metatarsal region			Metacarpal/metatarsal region just to its bifurcation		
	Mean±SE of CT (mm)	Mean±SE of BD (mm)	Mean±SE of C/D index	Mean±SE of CT (mm)	Mean±SE of BD (mm)	Mean±SE of C/D index
Manus	8.08±0.41	44.50±1.43 <sup>a</sup>	0.18±0.006 <sup>b</sup>	8.80±0.45	63.01±2.39 <sup>c</sup>	0.13±0.005
Pes	7.07±0.37	36.60±1.30 <sup>a</sup>	0.21±0.004 <sup>b</sup>	7.70±0.15	54.30±0.59 <sup>c</sup>	0.14±0.004

\* CT = Cortical thickness \*\* BD = Bone diameter

Means with the same superscripts are significantly differed at P<0.05

**Table 2: Mean of cortex, bone diameter and C/D index of lateral and Medial proximal phalanx**

Anatomical region	Mid medial proximal phalanx		
	Mean±SE of CT (mm)	Mean±SE of BD (mm)	Mean±SE of C/D index
Manus	5.40±0.19	24.5±0.27 <sup>c</sup>	0.22±0.006 <sup>d</sup>
Pes	5.30±0.19	21.9±0.52 <sup>c</sup>	0.24±0.006 <sup>d</sup>

Anatomical region	Mid lateral proximal phalanx		
	Mean±SE of CT (mm)	Mean±SE of BD (mm)	Mean±SE of C/D index
Manus	5.40±0.10	25.10±0.35 <sup>a</sup>	0.21±0.003 <sup>b</sup>
Pes	4.90±0.10	21.60±0.26 <sup>a</sup>	0.22±0.006 <sup>b</sup>

\* CT = Cortical thickness \*\* BD = Bone diameter

Means with the same superscripts are significantly differed at P<0.05

## Discussion

Bone densitometry is one of the main pillars in assessment of osteoporosis in human<sup>1</sup>. The most important modalities are dual x-ray absorptiometry (DXA), quantitative computed tomography (QCT), and quantitative ultrasound (QUS)<sup>1</sup>. Although the DXA or QUS are more accurate measurement in assessment of osteoporosis but these techniques are not practically available in assessment of osteoporosis/osteopenia in animals generally and specially in camel. C/D ratios are very important and practical index that can be used to assess bone health<sup>1</sup>. C/D ratio has been used in human to assess bone changes<sup>1,2</sup>. Bone diseases causing decrease in bone density can be detected in early stages by knowing normal C/D ratios of bones in different animals<sup>3</sup>. C/D ratio has got merit to cortical thickness measurement alone because this index exclude related factors such as age, sex, weight, height and breed. This study showed that, there is significant differences between C/D ratios of manus and pes measured in all sites mentioned in Table 1 and 2 except between metacarpal to metatarsal region just proximal to its bifurcation. No explanation was found for this result so it can be attributed to measurement inaccuracy in this site. This study showed that, there was no significant difference between C/D ratio of lateral and medial proximal phalanges of fore

limb, whereas the C/D ratio of lateral and medial proximal phalanges of hind limb was different significantly.

Although cortical thickness in manus is greater than pes in all areas, which have been measured but the C/D ratio in pes is higher than manus. This is due to the smaller bone diameter in all areas measured in pes. In this study the C/D index was obtained on the basis of the cortical thickness measurement only, because this index is not affected by disturbing factors such as age, sex, weight, height and breed.

## References

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## ارزیابی رادیوگرافی نسبت کورتکس به قطر استخوانهای دست و پا در شتر

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**هدف:** محاسبه نسبت ضخامت کورتکس به قطر استخوان (C/D) در استخوانهای قلم و بند اول انگشتان دست و پا در شتر به منظور استفاده در تشخیص بیماریهای احتمالی تغذیه ای و متابولیکی.

**حیوانات:** دوازده اندام حرکتی شتر (۶ اندام قدامی و ۶ اندام خلفی)

**روش کار:** این مطالعه بر روی رادیوگرافهای تهیه شده از تعداد ۱۲ اندام قدامی و خلفی شتر در دو حالت گماری پستی- کف دستی و پستی- کف پای انجام شد. از روی رادیوگرافها، ضخامت کورتکس و قطر استخوان و نسبت C/D در نواحی میانی و ناحیه ای بلافاصله قبل از محل دو شاخه شدن استخوانهای قلم و بند اول انگشتان در دست و پا اندازه گیری و محاسبه شدند. یافته های به دست آمده مورد تجزیه و تحلیل آماری قرار گرفته و میانگین، انحراف معیار و سطح معنی داری اختلافهای موجود به دست آمد. خصوصیات مهم اندازه گیری ها مورد بحث قرار گرفت.

**نتایج:** نسبت C/D در ناحیه میانی و ناحیه بلافاصله قبل از محل دو شاخه شدن استخوان قلم دست به ترتیب ۰/۱۸ و ۰/۱۳ و نسبت C/D در ناحیه میانی و ناحیه بلافاصله قبل از محل دو شاخه شدن استخوان قلم پا به ترتیب ۰/۲۱ و ۰/۱۴ محاسبه گردیدند. همچنین نسبت C/D ناحیه میانی بند اول انگشتان جانبی و میانی در دست به ترتیب ۰/۲۱ و ۰/۲۲ و نسبت C/D ناحیه میانی بند اول انگشتان جانبی و میانی در پا به ترتیب ۰/۲۲ و ۰/۲۴ به دست آمد.

**نتیجه گیری:** این مطالعه نشان داد که اختلاف معنی داری بین نسبت C/D استخوانهای تمام نواحی دست به جز ناحیه بلافاصله قبل از محل دو شاخه شدن استخوان قلم با استخوانهای مشابه در پا وجود دارد. هیچ دلیل قابل توجهی برای این عدم وجود اختلاف معنی دار بین نسبت C/D در ناحیه بلافاصله قبل از محل دو شاخه شدن استخوانهای قلم دست با پا به دست نیامد و لذا ممکن است این مورد به دقت نبودن اندازه گیری در این محل مربوط باشد.

**کلید واژگان:** رادیوگرافی، استخوان، کورتکس، شتر