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## Gross anatomical studies of carpals of blue bull (*Boselaphus tragocamelus*)

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#### Abstract

The present study was conducted on six carcass of Blue bull in Bikaner zoo to study the anatomical and morphological features of the carpals. The study revealed that the carpal bone consist of six short bones arranged in two transverse rows one above the other. The bones of the proximal row from medial to lateral were, radial carpal or Scaphoid, intermediate carpal or Semilunar, ulnar carpal or Cuneiform and accessory carpal or Pisiform. The bones of the distal row were second and third fused carpal or Os magnum and fourth carpal or Unciform. The radial carpal bone was the medial-most of the proximal row. It was somewhat compressed laterally. The ulnar carpal was outermost irregular bone situated lateral to the intermediate carpal. The fourth carpal bone was smaller of the two bones in distal row. It was roughly quadrilateral in outline and decreased in thickness cranio-caudally.

**Keywords:** Blue bull, carpal, proximal row, radial carpal, ulnar carpal

#### Introduction

The Blue bull or Nilgai (*Boselaphus tragocamelus*) is the largest Asian antelope. Blue Bull is a Schedule – III animal of the Wildlife Protection Act (1972), India and is in the “Least concern” category as per the IUCN Red Data List assessed by Mallon (2008) [9]. Blue bull can survive without water for several days, but they live close to waterholes. The deserts earlier limited their range, but the extension of irrigation canals and proliferation of tube-wells in the Thar desert have helped them to colonize in the desert districts of Jodhpur, Barmer, Jaisalmer, Bikaner and Sri Ganganagar.

#### Materials & methods

In this study, six specimens of adult Blue bull (*Boselaphus tragocamelus*) were used which were studied at Bikaner zoo. Out of them three were of male and rest three of female. The sex was confirmed by the history taken from the persons engaged in burying the dead animals in the zoo premises. These osteological specimens were studied to record their gross anatomical and morphological features. Different parameters of carpals were measured and subjected to routine statistical analysis (Snedecor and Cochran, 1994) [16]. The following studies were conducted on the collected specimens.

#### Results and Discussion

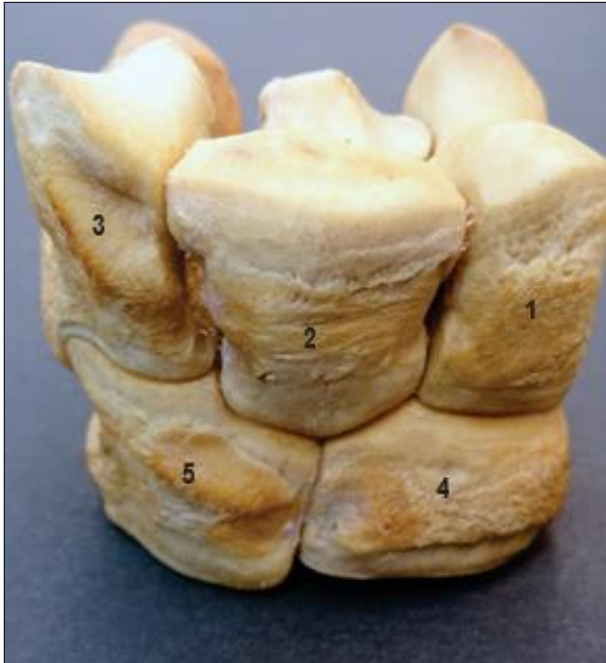
It was observed that carpus of Blue bull consisted of six short bones arranged in two transverse rows one above the other. The bones of the proximal row from medial to lateral were radial, intermediate, ulnar and accessory carpal and of the distal row were second and third fused and fourth carpal. These findings were similar with the observations of Owen (1866) [11], McFadyean (1953), Konig and Liebich (2006) [8], Akers and Denbow (2008) and Frandson *et al* (2009) in ruminants, Chauveau (1905) [2] in ox, sheep and goat, Sisson (1911) [14] and Raghavan (1964) [12] in ox, Getty (1975) [5] in sheep, Ford (1990) in Antelope, Deer, Bighorn sheep and Mountain goats, Budras and Robert (2003) in bovine, Siddiqui *et al* (2008) [13] in Black Bengal goat, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. These findings are inconsistent with the findings of Konig and Liebich (2006) [8] in man and pig, where a typical pattern of eight carpal bones arranged in two rows of four carpals each was found with Miller *et al.* (1964) [10] in dog and Ozkan (2004) in hedgehogs, where upper row missed intermediate carpal and the lower row consisted of first, second, third and fourth carpal with Getty (1975) [5], Konig and Liebich (2006) [8] and Akers and Denbow (2008) in horse where proximal row consisted of radial, intermediate,

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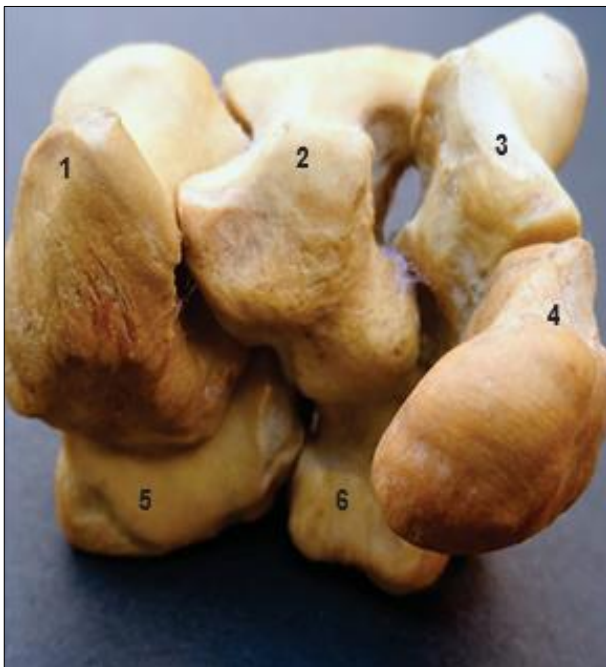
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ulnar and accessory while distal row was comprised of first, second, third and fourth but the first carpal was missing in some individuals with Smuts and Bezuidenhout (1987) [15] in dromedary where distal row missed first carpal from the typical pattern and with Nzalak *et al.* (2010) in the lion which had seven carpal bones that were arranged in two rows; a proximal row of three bones (intermedioradial, ulnar, accessory) and a distal row of four bones (I-IV).



**Fig 1:** Cranio-lateral view of right carpus, 1. Radial carpal, 2. Intermediate carpal, 3. Ulnar carpal, 4. 2+3 fused carpal, 5. 4th carpal



**Fig 2:** Caudal view of Right carpus, 1. Radial carpal, 2. Intermediate carpal, 3. Ulnar carpal, 4. Accessory carpal, 5. 2+3 fused carpal, 6. 4th carpal

In the present study, the radial carpal bone was the medial-most of the proximal row and presented six surfaces. The proximal surface possessed particular area corresponding to

the medial facet on the distal extremity of the radius simulating the findings of Raghavan (1964) [12] in ox, Getty (1975) [5] in horse and Smuts, Bezuidenhout (1987) [15] in dromedary, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. The distal surface possessed articular area corresponding to the medial facet on the proximal surface of the second and third fused carpal bone similar to Raghavan (1964) [12] in ox and Smuts and Bezuidenhout (1987) [15] in dromedary, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital; on the contrary it articulated with all four carpal bones of distal row in dog (Miller *et al.*, 1964) [10]. The lateral surface bore facets for articulation with the medial surface of the intermediate carpal similar to Raghavan (1964) [12] in ox, Getty (1975) [5] in horse, Smuts and Bezuidenhout (1987) [15] in dromedary, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital; in contrast it articulated with ulnar carpal in dog (Miller *et al.*, 1964) [10]. The cranial, medial and caudal surfaces were continuous and rough being non-articular. The cranial surface was thin and convex while the medial surface was larger, slightly depressed and presented few foramina. The caudal surface possessed elongated tubercles on its lower aspect similar to ox (Raghavan, 1964) [12].

The intermediate carpal bone was wedge shaped, being constricted in middle and wide in front which is similar findings in Jangir (2010) [6] in chinkara and Choudhary (2011) in chital, while it was rod-shaped in dromedary (Smuts and Bezuidenhout, 1987) [15]. It was situated between the radial and ulnar carpal bones which was in consonance with the report of Raghavan (1964) [12] in ox, Getty (1975) [5] in horse, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. These observations deviate from the reports of Miller *et al.* (1964) [10] in dog where the intermediate carpal was missing. The proximal surface articulated with the middle facet on the distal extremity of the radius similar to Raghavan (1964) [12] in ox and Getty, (1975) [5] in horse, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. The distal surface was convexo-concave, and was divided by a ridge from before backwards into two unequal halves. The medial of these articulated with the lateral facet on the proximal surface of the second and third fused carpal bone similar to Raghavan (1964) [12] in ox, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. However, in horse this surface articulated with the third and fourth carpal bones (Getty, 1975) [5]. The lateral facet was larger and corresponded with the medial facet on the proximal surface of the fourth carpal similar to ox (Raghavan, 1964) [12]. The lateral surface was larger and possessed facets for articulation with the facets on the medial surface of the ulnar carpal identical to the findings of Raghavan (1964) [12] in ox, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. The anterior surface was narrow rough, while the posterior surface was narrow too and bore a tubercle on its lower part.

The ulnar carpal was outermost irregular bone situated lateral to the intermediate carpal. The proximal surface presented a concave oblique facet, which encroached over the lateral surface similar to the findings of Raghavan (1964) [12] in ox, Jangir (2010) [6] in chinkara and Choudhary (2011) in chital. There was a characteristic sharp medial protrusion on this surface. This surface articulated with the lateral facet on the distal extremity of the radius and the styloid process of the ulna. However, Getty (1975) [5] in horse and Smuts and Bezuidenhout (1987) [15] in dromedary reported it bearing mainly concave area for articulation with radius only. The

distal surface was small, deeply concave, and presented a medio-distally sloped facet, which corresponded to the lateral facet on the proximal surface of the fourth carpal. These findings more or less agreed with the findings of Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital where it was small and concave. Getty (1975)<sup>[5]</sup> in horse, where it was oblique and undulating and Smuts and Bezuidenhout (1987)<sup>[15]</sup> in dromedary, where it was saddle-shaped. The posterior surface was oblique and bore a concave and oval facet for articulation with the accessory carpal similar to horse (Getty, 1975)<sup>[5]</sup>, dog (Miller *et al.*, 1964)<sup>[10]</sup> and ox (Raghavan, 1964)<sup>[12]</sup>, chinkara (Jangir, 2010)<sup>[6]</sup> and chital (Choudhary, 2011). The accessory carpal was a short, medially curved bone. It was placed behind the ulnar carpal similar to the observations of Miller *et al.* (1964)<sup>[10]</sup> in dog and Sisson (1911)<sup>[14]</sup> and Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital. Its anterior surface offered a triangular convex facet for articulation with the facet on the caudal surface of ulnar carpal. In addition to its articulation with the ulnar carpal bone, it articulated with the fused distal part of the ulna in dromedary (Smuts and Bezuidenhout, 1987)<sup>[15]</sup> and lateral facet on the distal extremity of the radius in horse (Getty, 1975)<sup>[5]</sup>.

In the distal row, fused second and third carpal bone was situated medially and was larger than fourth carpal in accordance with the findings of Sisson (1911)<sup>[14]</sup> and Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital. The first carpal bone was missing similar to ox (Raghavan, 1964)<sup>[12]</sup>, dromedary (Smuts and Bezuidenhout, 1987)<sup>[15]</sup> and Black Bengal goat (Siddiqui *et al.*, 2008)<sup>[13]</sup>, chinkara (Jangir, 2010)<sup>[6]</sup> and chital (Choudhary, 2011); however it was present in dog (Miller *et al.*, 1964)<sup>[10]</sup>, in horse (Getty, 1975 and Akers and Denbow, 2008)<sup>[5]</sup>, in hedgehogs (Ozkan, 2004) and in man and pig (Konig and Liebich, 2006)<sup>[8]</sup>.

The proximal surface of fused second and third carpal was wide and concavo-convex articular surface divided by a ridge into two unequal halves. The medial of these was larger and articulated with the distal surface of the radial carpal bone, while the lateral facet was smaller and higher, which articulated with the medial facet on the distal surface of the intermediate carpal bone. These reports are obeying the findings of Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital.

The fourth carpal bone was smaller of the two bones of the distal row. It was roughly quadrilateral in outline and decreased in thickness cranio-caudally, which is in agreement with the findings of Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital and in disagreement with the findings of Miller *et al.* (1964)<sup>[10]</sup> and Smuts and Bezuidenhout (1987)<sup>[15]</sup>, who described in dog and dromedary respectively, that it was the largest one in the distal row. The proximal surface was divided by an antero-posterior oblique ridge into two oblique areas. The medial of these was small and articulated with intermediate carpal, while the lateral facet was way too large and divided into two concave areas; larger cranial and smaller facing outwards, both articulated with the ulnar carpal. These findings were identical to the findings of Raghavan (1964)<sup>[12]</sup> in ox, Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital and more or less similar to the findings of Getty (1975)<sup>[5]</sup> in horse. In dromedary this surface did not articulate with intermediate carpal, but exclusively with the ulnar carpal

(Smuts and Bezuidenhout, 1987)<sup>[15]</sup>. The medial surface presented two facets surrounding a rough and rounded excavated area. These facets articulated to the second and third fused carpal bone which is similar to findings of Jangir (2010)<sup>[6]</sup> in chinkara and Choudhary (2011) in chital, whereas it articulated with third carpal in dog (Miller *et al.*, 1964)<sup>[10]</sup>, in horse (Getty, 1975)<sup>[5]</sup> and in dromedary (Smuts and Bezuidenhout, 1987)<sup>[15]</sup>.

#### 4. Conclusion

Based on the findings of the present study it was concluded that carpus of Blue bull consisted of six short bones arranged in two transverse rows one above the other. The bones of the proximal row from medial to lateral were, radial carpal or Scaphoid, intermediate carpal or Semilunar, ulnar carpal or Cuneiform and accessory carpal or Pisiform. The bones of the distal row were second and third fused carpal or Os magnum and fourth carpal or Unciform. The radial carpal bone was the medial-most of the proximal row. It was somewhat compressed laterally. The intermediate carpal bone was wedge shaped, being constricted in middle and wide in front. It was situated between the radial and ulnar carpal bones. The ulnar carpal was outermost irregular bone situated lateral to the intermediate carpal. The accessory carpal was a short, medially curved bone. It was placed behind the ulnar carpal. Fused second and third carpal bone was the medial one of the distal row of carpals, and was larger than fourth carpal. The fourth carpal bone was smaller of the two bones in distal row. It was roughly quadrilateral in outline and decreased in thickness cranio-caudally.

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