International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2024; SP-9(1): 37-40

www.veterinarypaper.com
Received: 28-10-2023
Accepted: 30-11-2023

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Gross and morphometrical examination of scapula bone of Bluebull (*Boselaphus tragocamelus*)

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Abstract
The gross morphometrical examination was conducted on the scapula of six adult Blue bulls. The shape of scapula was flat and triangular. Scapula contains two surfaces, three angles and three borders. In this study, no significant difference in between scapulae of right and left side from same animal. The lateral surface was separated by the scapular spine into two parts i.e. supra-spinous fossa which is small and elongated and infra-spinous fossa which is much larger and triangular. The outline of spine was sharp and wavy. The sub-scapular fossa was marked deep, acromian process was sharp and tuber spine was unable to distinguish. The tuber-scapulae of scapula was small and the coracoids process was not well evolved. There was shallow, oval shaped glenoid cavity. Above glenoid cavity a small glenoid notch was present.

Keywords: Bluebull, morphometrical, scapular spine, scapula

Introduction
The Blue bull or Nilgai (*Boselaphus tragocamelus*) is the biggest Asian antelope. Blue Bull comes under Schedule – III of the Wildlife Protection Act (1972), India and is in the "Least concern" category as per the IUCN Red Data List evaluated by Mallon (2008) [14]. The focus of this research is to examine scapula of Blue bull, in the vetero-legal cases because some time it is quit hard to recognize the bones of this animal from those of some other small ruminants. This research will be helpful for not only field veterinarians but also for zoo veterinarians.

Materials and Methods
Six specimens of adult Blue bulls (*Boselaphus tragocamelus*) were used in this investigation which were examined at Bikaner zoo.
In these specimens three were male and three of female. The sex of these Blue bull was confirmed by the history taken from the persons involved in buying the dead animals in the zoo site. Gross morphological features were recorded by examining osteological specimens. Diverse parameters of scapula were calculated and subjected to routine statistical analysis (Snedecor and Cochran, 1994) [12]. The following studies were carried out on the collected specimens. Scapular index (SI) was measured as the average ratio between the length and breadth of scapula.

SI = Maximum length / Maximum breadth*100 (Miller *et al*., 1964) [7].

Results and Discussion
The scapula was a flat and triangular in shape. It is comparatively wider bone at the dorsal end and narrower at the ventral end, which is comparable to the findings of Miller *et al.* (1964) [7] in dog, Choudhary and Singh (2016a) [13] in Blackbuck, Raghavan (1964) [9] in ox, Getty (1975) [4] in horse, Nzalak *et al.* (2010) [8] in Lion, Choudhary *et al.* (2013) [2] in Chital, Jangir (2010) [6] in Chinkara, Gupta and Deshmukh (2014) [5] in dromendary camel.
The surface of lateral side (fig.1) was separated by the scapular spine into a smaller supra-spinous fossa and a much larger, infra-spinous fossa which was in harmony with Raghavan (1964) [9] in ox, Jangir (2010) [6] in Chinkara, Getty (1975) [4] in horse, Nzalak *et al.* (2010) [8]

in Lion, Gupta and Deshmukh (2014) [5] in dromendary camel, Choudhary *et al.* (2013) [2] in Chital, and Choudhary and Singh (2016a) [13] in Blackbuck but was in dissimilarity with Miller *et al.* (1964) [7] in dog.

The average proportion of the maximum lengths of infra-spinous fossa to supra-spinous fossa was 3.03: 1(fig.1), while ratio of area was 4:1 for ox (Raghavan, 1964) [9] 4.23:1 for Chinkara (Jangir, 2010) [6], 4.15:1 for Chital (Choudhary *et al*., 2013) [2], 3.21:1 for Blackbuck (Choudhary and Singh, 2016a) [13].

The scapular spine goes up to the level of neck as acromian process (fig.1) analogous to the results of Raghavan (1964) [9] in ox, Jangir (2010) [6] in Chinkara, Choudhary *et al* (2013) [2] in Chital, Choudhary and Singh (2016a) [13] in Blackbuck and Gupta and Deshmukh (2014) [5] in dromendary camel. Though, on the contrary, it was declared by Getty (1975) [4] that the scapula spine subsides at the neck of the bone in horse. In addition, the acromian process was prominent and plate like as met-acromian process according to Nzalak *et al.* (2010) [8] and Miller *et al.* (1964) [7] in Lion.

The tuber spine was indiscriminate which was in harmony with the results of Miller *et al.* (1964) [7] in dog, Rhagwan (1964) in ox, Jangir (2010) [6] in Chinkara, Choudhary and Singh (2016a) [13] in Blackbuck, Choudhary *et al.* (2013) [2] in Chital, though it was prominent in horse (Getty, 1975) [4].

The sub-scapular fossa on medial surface (fig.2), was deep which was simulated the result of Getty (1975) [4] in horse, while it was disagreed with the results of Jangir (2010) [6] in Chinkara, Raghavan (1964) [9] in ox, Nzalak *et al.* (2010) [8] in lion, Choudhary *et al.* (2013) [2] in Chital, Gupta and Desmukh (2014) [5] in dromendary camel and Choudhary and Singh (2016a) [13] in Blackbuck,

The facies serrate contained of a comparatively large triangular cranial area and less wide caudal linear area of Bluebull (fig.2) similar to the conclusion of Jangir (2010) [6] in Chinkara, Raghavan (1964) [9] in ox. This result was in dissimilarity with Getty (1975) [4] in horse where both the caudal and cranial areas were triangular.

Wavyness was found in vertebral border of Blue bull which is in accordance to the results of Choudhary *et al.* (2013) [2] in Chital, Jangir (2010) [6] in Chinkara and Singh (2016a) [13] in Blackbuck, while it was noticeably convex at the middle in Sambar deer and concave in Bakarwali goat (Sarma *et al*., 2004). The caudal border was thickest of all three borders, which is similar to dog (Miller *et al*., 1964) [7].

In the scapula of Blue bull, nutrient foramen was present at the distal third of the caudal border which confirmed with the results of Jangir (2010) [6] in Chinkara, Getty (1975) [4] in horse, Choudhary *et al.* (2013) [2] in Chital and Choudhary and Singh (2016a) [13] in Blackbuck, but it was in dissimilarity with Miller *et al.* (1964) [7], who renowned it to be situated on the junction of ventral border of spine and scapula properly in dog.

In the present investigation, the glenoid cavity was shallow and oval or heart-shaped in Blue bull which is comparable to the results in Chital (Choudhary *et al.* 2013) [2], Chinkara (Jangir, 2010) [6], in dromedary camel (Gupta and Desmukh, 2014) [5] and in blackbuck (Choudhary and Singh, 2016a) [13]; while it was commonly circular and deep in Black Bengal goat (Siddiqui *et al*, 2008), shallow and circular in outline in ox (Raghavan, 1964) [9], very shallow in the dog (Miller *et al*, 1964) [7] and oval in outline in horse (Getty, 1975) [4].

A small glenoid notch was there over the rim of glenoid cavity in Blue bull, which is analogous to Getty (1975) [4] in horse.

In Blue bull, tuber scapulae was small which simulates the results in Chital (Choudhary *et al.* 2013) [2], in blackbuck (Choudhary and Singh, 2016a) [13]; it not match with the results in dog (Miller *et al*., 1964) [7], in horse (Getty, 1975) [4], and in dromedary camel (Gupta and Desmukh, 2014) [5] where it was prominent one.

The coracoid process was less-developed in the current investigation, which is more or less similar to the result of Getty (1975) [4] in horse, Jangir 2010) [6] Chinkara, Siddiqui *et al.* (2008) in Black Bengal goat, Choudhary *et al.* (2013) [2] in chital and Choudhary and Singh (2016a) [13] in blackbuck; while not match with the observations of Gupta and Desmukh (2014) [5] in dromedary camel where it was well developed.

The average maximum length and breadth of scapula in Blue bull was 31.40±0.616 cm and 15.62±0.29 cm respectively, which was 13.94±0.30 cm and 6.62±0.11 cm in Black Bengal goat (Siddiqui *et al*.2008); 14.07±0.019 cm and 8.59±0.016 cm in blackbuck (Choudhary and Singh, 2016a) [13], 20.46±0.03 cm and 11.94±0.03cm, in chital (Choudhary *et al*., 2013) [2] and 12.35±0.12cm and 6.94±0.06 cm in chinkara (Jangir, 2010) [6].

The scapular index in the current investigation was 49:74 for Blue bull which was 72.82 for leopard, 67.34 for Sambar, 65.83 for sheep, 62.43 for buffalo, 55.74 for pig, 52.59 for ox, 45.86 for horse and as per calculations of Dalvi *et al* (1997), 57.78 for Chinkara (Jangir, 2010) [6], 58.35 for Chital (Choudhary *et al*, 2013) [2] and 61.05 for blackbuck (Choudhary and Singh, 2016a) [13].

The average maximum length of breadth of necks of scapulae, spines and breadth of glenoid cavities were 6.833±0.148 cm, 26.67±0.33 cm and 3.9±0.217 cm, respectively.

Fig 1: Lateral view of Right scapula –1.Cranial angle 2. Caudal angle 3.Ventral angle 4.Supra-spinatous fossa 5.Infra-spinatous fossa 6.Cranial Border 7.Vertebral Border 8.Caudal Border 9. Scapular spine 10. Acromian process 11. Glenoid cavity

Fig 2: Medial view of Right Scapula- 1.Cranial part for facies serrate 2.Caudal part for facies serrate 3. Sub-scapular fossa 4.Neck 5.Tuber scapulae 6.Glenoid cavity

Table 1: Different measurements of Scapula

S. No.	Descripition		Maximum height (Hm)	Maximum breadth (Bm)	Maximum length of spine (Ls)	Maximum breadth of Neck(Bn)	Maximum breadth of glenoid cavity(Dg)	Maximum breadth of supra-spinatus fossa(Bs)	Maximum breadth of infra-spinatus fossa(Bi)
1.	Female -1	Left	29.40	14.80	25.62	6.30	4.50	3.25	11.70
		Right	29.45	14.75	25.65	6.20	6.20	3.20	11.75
2.	Female -2	Left	29.00	14.45	25.60	6.15	6.15	3.30	11.35
		Right	29.10	14.50	25.62	6.20	6.20	3.25	11.40
3.	Female -3	Left	29.60	14.80	25.50	6.80	6.80	3.15	11.15
		Right	29.65	14.70	25.52	6.75	6.75	3.10	11.10
4.	Male - 1	Left	33.25	16.75	27.75	7.50	7.50	4.45	12.20
		Right	33.28	16.80	27.72	7.45	7.45	4.90	12.25
5.	Male - 1	Left	33.38	16.55	27.70	7.10	7.10	4.85	12.35
		Right	33.45	16.50	27.78	7.00	7.00	4.80	12.40
6.	Male - 1	Left	33.60	16.35	27.80	7.25	7.25	4.25	12.10
		Right	33.65	16.45	27.82	7.30	7.30	4.30	12.15
Mean			31.40	15.62	26.67	6.83	6.68	3.9	11.83
SD			2.14	1.01	1.14	0.51	0.84	0.75	0.48
SE			0.62	0.29	0.33	0.15	0.24	0.22	0.14

Conclusion

It is concluded that scapula of Blue bull is flat and triangular bone and it's lateral surface divided into supra-spinous and infra-spinous fossa and it's ratio vary from other species.

Acknowledgement

I am very thankful to Forest Ministry, Rajasthan Govt., Deputy Conservator of Forest (WL), Bikaner, Additional Principal Chief Conservator of Forest (APCCF), Jaipur (Rajasthan) who helped during the course of my thesis work.

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