Original Research

Gross Anatomical Observations on the Sacrum of Guinea Pig (*Cavia porcellus*)

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Abstract

Sacrum of guinea pig was triangular in shape. Sacrum was formed by fusion of four and three sacral vertebrae in male and female guinea pigs respectively. Adorsal sacral and two lateral sacral crests were present on the dorsal surface of sacrum. Wings presented an articular area in the lower part of its lateral aspect for the ilium. Anterior articular processes were present and faced upwards. Slender transverse processes were two at the caudal part of sacrum and projected backwards. Sacral spinal canal had a cranial triangular opening whereas posteriorly resembled an aperture. The number of dorsal and ventral sacral foramina differed in both the sexes. The morphometric measurements namely, length and width of sacrum were measured.

Key words: Gross Anatomy, Guinea Pig, Sacrum

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Introduction

Guinea pigs (*Cavia porcellus*) are small laboratory animals, which constitute a small suborder (Hystricomorphic) from the order rodentia. This type of rodent is probably first introduced into Europe from South America some 400 years ago (Wagner and Manning, 1976). Only five strains of guinea pigs are often used in research. The most common, the short haired American or English guinea pig is also the most popular laboratory and pet variety. Other typically used laboratory variety includes the Duncan Hartley, Hartley, strain 2 and strain 13 (Clemons and Seeman, 2011). The experimental animals like guinea pigs, mouse, rats, pigs and monkeys play an important role for solving many human problems in human medicine since the anatomical structure of the organs of experimental animals is similar to anatomical structure of the organs of human beings (Al-Sharoot, 2014). However, literature on detailed study of gross morphological features of skeleton of guinea pig including sacrum was very much limited. Hence, the

present study was conducted with an aim to explore the gross anatomical features including the sexual dimorphism of the sacrum in guinea pig.

Materials and Methods

Six adult guinea pigs (three males and three females) from Duncan Hartley strain were obtained for research purpose from Laboratory animal medicine, Madhavaram milk colony, TANUVAS, Chennai-600051. Entire skeleton of those animals were obtained by natural maceration and further, sacrum of those animals were taken for this study. The length of sacrum was measured from cranial to caudal ends. The width of sacrum was measured at base middle and apex parts. After gross morphometric observations, sacrum of guinea pigs was subjected to gross morphological observations.

Results and Discussion

The sacrum of male and female guinea pigs was found to be triangular in shape as reported in domestic animals (Dyce *et al.*, 2006) and in blue bull (Sathapathy *et al.*, 2017). The average length of sacrum of male guinea pig was 2.9 cm whereas that of female guinea pig was 2.2cm.However, the length of sacrum of African giant rat was reported as 3.8 -4 cm (Olude *et al.*, 2013). The average width at base(lateral surface of wing) of sacrum was 1.85cm and 1.9 cm in male and female guinea pigs respectively. The average width at middle of sacrum was 0.85cm and 0.8 cm whereas in apex was 0.45cm and 0.7 cm in male and female guinea pigs respectively. Apex of sacrum of female guinea pig was wider than that of male. The sacrum of guinea pig of both the sexes had a body, two wings, a base and an apex as in domestic animals (Dyce *et al.*, 2006) whereas Kamal *et al.* (2016) stated that sacrum of white New Zealand rabbit had a body, two neural arches, two transverse processes and two articular processes.

The sacrum of male guinea pig was formed by fusion of four sacral vertebrae as in pig (McCrackin and Michael swindle,2016) and African giant rat (Olude *et al.*, 2013) whereas Romer and Parson (1978) stated that mammalian sacrals were generally comprised of three to five sacral vertebrae. In female guinea pig, the sacrum was formed by the fusion of three sacral vertebrae. Sexual dimorphism with regard to the number of sacral vertebrae in the present finding was in concurrence of report of Noonan (1994) in guinea pig whereas Clemons and Seeman (2011) reported that in guinea pig, the sacrum was made up of two to three fused sacral vertebrae. White house and Grove (1958) stated that in rabbit, first three vertebrae of sacrum were fused while the fourth one was variably fused which was not observed in the present study. Further, Christian (2008) stated that adult rats and rabbit had four fused sacral vertebrae.

However, in hamster, sacrum was comprised of four sacral vertebrae whereas Chinchilla had only two sacral vertebrae (Suckow *et al.*, 2012). Further, Getty (2012) and Prasanth Babu *et al.* (2017) stated that, the sacrum was made up of three fused sacral vertebrae in dog and in Indian Mangoose respectively. The presence of three sacral vertebrae were in the sacrum was also reported by Powers and Brown (2012) in

Ferret, Erkin *et al.* (2013) in rabbit and Kamal *et al.* (2016) in white New Zealand rabbit. In anteater, the sacrum was made up of four or five fused sacral vertebrae as reported by Borges *et al.* (2017). Fusion of sacrum with last lumbar vertebra as well as with first coccygeal vertebra was not observed in guinea pig. But, Jerome and Hoch (2012) reported that it is not uncommon to observe fusion of last lumbar with sacrum in rodents. Borges *et al.* (2017) stated that first coccygeal vertebra was fused to sacrum and ischium in anteater.

In guinea pig, long axis of body was flat whereas it was reported as curved in ox by Getty (2012). It had dorsal and ventral surfaces. Dorsal surface was found to be wide cranially and narrow behind. Dorsal surface was traversed by a dorsal median crest (Fig. 1) since dorsal spinous processes were fused in guinea pig as in tiger (Pandit, 1994), in ox (Dyce *et al.*, 2006), in Afrian gaint rat (Olude *et al.*, 2013) and in Giant Ant eater (Borges *et al.*, 2017). Fused dorsal spinous processes appeared as a bony plate like structure in the sacrum of guinea pig of both the sexes. Height of spinous process was decreased from cranial to caudal ends. In guinea pig, lateral sacral crests were thin and observed as one on either side of the median crest of sacrum of guinea pig (Fig. 1) as in ox (Dyce *et al.*, 2006). Further, three and two dorsal sacral foramina were observed on either side of base of dorsal median crest in male and female guinea pig respectively (Fig.1).

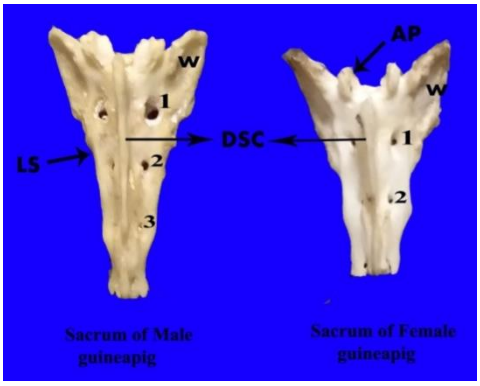

Fig.1: Photograph showing dorsal aspect of the sacrum of male and female guinea pigs. (AP-Anterior articular process, W-wing, LS- Lateral sacral crest, DSC-Dorsal sacral crest, 1,2,3-Dorsal sacral foramens)

The ventral surface of sacrum of both male and female guinea pigs appeared as a flat surface with transverse lines. In male guinea pigs, three transverse lines were observed as an indication of fusion of four sacral vertebrae (Fig. 2) as opined by Dyce *et al.* (2006) in domestic animals. In female guinea pig, the number of transverse lines were two since the number of sacral vertebrae were three (Fig. 2). The bodies of sacral vertebrae of both the sexes of guinea pigs were observed as long segments. Similar to dorsal surface, ventral surface of sacrum also possessed three and two ventral sacral foramina in male and female guinea pigs respectively (Fig. 2). These foramina were said to allow the exit the dorsal and ventral sacral spinal nerves

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(Maynard and Downes, 2019). The number of intervertebral foramina were correspond to the number of sacral vertebra in Giant ant eater (Borger *et al.*, 2017).

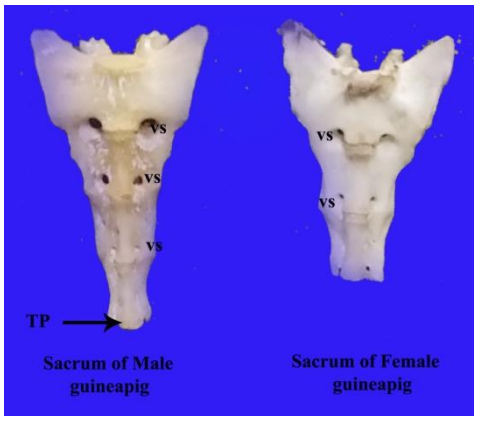

Fig. 2: Photograph showing ventral aspect of the sacrum of male and female guinea pigs. (TP-Transverse process, VS-Ventral sacral foramens)

The present observation with regard to relation of number of intervertebral foramens to the number of sacral vertebrae was not in agreement with the statement of aforesaid authors since they were located at intercentral fusion of sacral vertebrae. The ventral sacral groove for middle sacral artery was not distinct in the sacrum of guinea pig of both the sexes.

Promontory was distinct at the base of body of the first sacral vertebra (Fig. 3) as in dog (Miller *et al.*, 1964) and in Indian Mangoose (Prasanth Babu *et al.*, 2017) and in blue bull (Sathapathy *et al.*, 2017). Wings were two and prismatic and had an articular facet on its lower part of lateral aspect for ilium (Fig. 1) as in ox (Dyce *et al.*, 2006). In the present study, medial aspect of wings or alae of sacrum showed a narrow articular like surface.

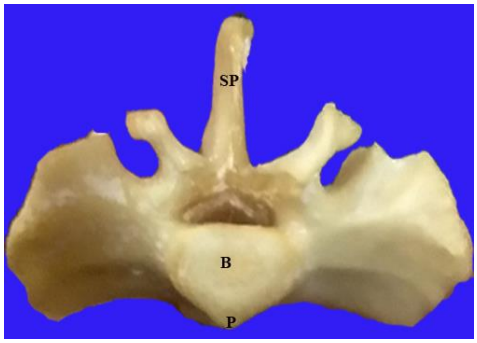

Fig. 3: Photograph showing anterior aspect of the sacrum of male guinea pig. (SP-Spinous process, B-body of the first sacral vertebrae, P-Promontary)

Cranial and caudal neural arches were observed in the sacrum of guinea pig. Anterior articular processes were distinct and two in number which is in concurrence with the observations of Olude *et al.* (2013) in

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African giant rat. These articular process faced upwards for articulation with the posterior articular processes of last lumbar vertebra as in domestic animals (Dyce *et al.*, 2006). Transverse processes were two in number and were seen as very small slender projections which was directed caudally from the body of last sacral vertebra (Fig. 2) as in dog (Miller *et al.,* 1964). In African giant rat, transverse process somewhat fused with what probably by ossification due to aging and most were still separable only by connective tissue and ligament (Olude *et al.*, 2013). Fusion of transverse processes as a plate like structure was not noticed in the sacrum of guinea pig whereas Prasanth Babu *et al*. (2017) stated that in Indian Mangoose, transverse process of second and third sacral vertebrae were fused plate like and directed downward and backward. However, Olude *et al*. (2013) reported that transverse processes were visible and fused transverse processes of first and second sacral vertebrae articulate with ilium while the remaining two were never involved in articulation in African giant rat.

Maynard and Downes (2019) reported that transverse process of sacral vertebrae were linked together and formed a series of link plates in mole rats and transverse process were further fused with sacral spinous process to form pars lateralis as in mole rats. These observations were not noticed in sacrum of guinea pig. Cranial opening of sacral spinal canal was triangular in shape whereas the caudal opening was very minimal in size resembling an aperture.

Conclusion

Sacrum of guinea pig was triangular in shape and formed due to the fusion of sacral vertebrae. It had a body, two wings, a base and an apex. A dorsal median sacral crest and two lateral crests were present in the dorsum of sacrum of guinea pig. Two transverse process were present in the caudal aspect of sacrum. Promontary was distinct. Certain gross anatomical observations on the sacrum of guinea pig showed sexual dimorphism. In male guinea pig, four sacral vertebrae were fused to form the sacrum whereas in female, sacrum was made up of three sacral vertebrae. Similarly, the number of intervertebral foramen (both dorsal and ventral sacral foramen) differed among both the sexes. The apex of sacrum of female guinea pigs appeared wider than that of male guinea pigs.

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