Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 496-499

Received: 04-11-2019
Accepted: 06-12-2019

Anupam Soni
M.V. Sc. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Sharad Mishra
Professor and Head, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

AK Santra
Professor, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

VN Khune
Assistant Professor, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Rupal Pathak
Assistant Professor, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, India

MD Bobade
Ph.D. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Ashutosh Dubey
Ph.D. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Sudheer Bhagat
M.V. Sc. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Subhrajit Das
M.V. Sc. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Corresponding Author:
Anupam Soni
M.V. Sc. Scholar, Department of Livestock Production and Management, College of Veterinary Science & AH, CGKV, Anjora, Durg, Chhattisgarh, India

Position of centre of gravity in different species: A review

Anupam Soni, Sharad Mishra, AK Santra, VN Khune, Rupal Pathak, MD Bobade, Ashutosh Dubey, Sudheer Bhagat and Subhrajit Das

Abstract
The animal movement is depends upon the distribution of body weight in all limbs. The point of centre of gravity to measures the distribution of body weight in all limbs. The location of centre of gravity varied with the age, sex and species of the animals. In cattle, the actual location of centre of gravity is exactly not known. While, in horse the centre of gravity lies below wither and around the heart girth, in cat and dog it lies near the fore limb and in squirrel and bears, the centre of gravity lies towards rear legs. In cattle, the point of centre of gravity play crucial role in their locomotion, any alteration in normal position may be the reason for the lameness in cattle and can have adverse effect on reproductive and productive performance.

Keywords: Centre of gravity, lameness, hind limbs, towards

Introduction

Centre of gravity

Centre of gravity in Bovine and Equine

Phillips (2002) [32] reported that cattle bear more weight in fore limbs in comparision to hind limbs (55– 60% front 40–45% back). Budsberg *et al.* (1987) [4] studied it in other four limbs mammals (60:40%). In horse the bear 58 percent of total weight in forelimbs in respect to hind limbs bear 42 percent of total body weight of Hood *et al.* (2001) [16]. In bovine the distribution ratio on front to hind half of total body weight normal lame cows as well as cows linked with various types of lameness was higher. In cattle, the front legs tried to balance of neck and head region of animal body and position of centre of gravity towards the forelimbs rather than the center position of the four limbs it might be due to head and neck bear more weight and placed anterior (Singh *et al.*, 2012) [37].

Singh *et al*. (2012) [37] reported of higher body weight of cattle shifted to the right hind quarter of the body in respect to left hind quarter during the advanced pregnancy such results might be due the rapidly growing fetus in right flank that is the center of gravity moves towards the right hind quarter. In non-pregnant cows, presence of comparatively heavy stomach present at right side it may be the reason that distribution of higher body weight to left hind quarter as compared to right hindquarter (Singh *et al*., 2012) [37].

Raven (1989) 34] reported that centre of gravity moves from side to side along with each hind foot bear weight and weight bearing varies with the movement.

Jalakas *et al.* (2000) [17] observed that centre of gravity moves towards the posterior suspensory apparatus of udder of Holstein Friesian cattle due to increase size and mass of udder during peak milk production as the udder filled with milk and blood.

Pastell *et al*. (2006) [30] suggested that the cattle face difficulty in kicking by the front legs than rear legs, as the point of centre of gravity lies near to the front leg. Nordenfelt (2006) [29] observed that the cow kept in small stall face difficulty to stand up as there was no proper space for the cow to move its centre of gravity forward enough and able to stand up. As a consequence cow shows frustration such as shake its head, produces noises and abnormal behaviors. Stashak (2006) [38] and Dyce *et al*. (1997) [11] revealed that cattle, the forelimbs bears about 60-65% of live weight of the animal and expansion of forelimbs hooves as compared to the hind limbs. Thus, point of centre of gravity towards the forelimbs. Kubo *et al.* (1992) [19] reported that position change with segment of body changes of Thoroughbred Horses both at rest and locomotion change the centre of gravity from normal position.

Simalenga and Joubert (1997) [36] observed that in cart design, it necessary to maintain the weight of the cart low, to stable point of centre of gravity of donkey and alter downward forces on neck of the donkey.

Sigmund *et al.* (2010) reported that the centre of gravity is normally located near the shoulder region as compared to rear when cattle are in standing condition.

Bradley and Wayne (2007) [2] observed centre of gravity in a standing or quietly walking horse is slightly behind the heart girth and below the wither. Marvin (2008) [26] reported that horse suffers from lameness at fore limbs it is due forelimbs bears 60-65 percent of total body weight thus, the position of centre of gravity in horse towards the fore limbs. Marks (1999) [25] and Buchner *et al.* (2001) [3] identified that shifting of centre of gravity on sound limbs along with weight moved on sound limbs when the horse suffers from induced extension of the vertebral column. Clayton (2005) [5] observed that heavier horses are more stable as compared to light weight horse because the of centre of gravity is lower it might be due more weight shifts close to the ground. The same authors further reported that the Rhinoceros is more stable because it has heavy body mass and short legs then centre of gravity placed at large base of support centrally, while in case of gazelle which has long legs and slender body, it increases maneuverability because centre of gravity placed outside base of support. Coulmance *et al*. (1979) [7]; Gahéry and Nieoullon (1979) [14], reported that when one limb was raised, resulting in weight transfer to the other limbs (diagonal or collateral limbs) to maintain balance. Then, centre of gravity shifts towards diagonal or collateral limbs.

Hood *et al*. (2001) [16] stated that changes in weight distribution in laminitis horses could provide information on how animals are affected by lameness. Adams *et al.* (1986) [1] observed that in horse the center of gravity located behind the elbow when it is standing condition it might be due to weight of the head and neck. Normally horses carry 60-65 percent of total body weight bears by forelimbs because head and neck placed cranially.

The horses have a greater weight distribution when standing square, with more weight exerted on the fore limbs (60%) than on the hind limbs (40%). One way to establish a good canter is to have an elevated forelimb with more weight being carried by the hindquarters. This shifting of the centre of gravity backwards resulting in a greater degree of hind limb engagement (www.yourhorse.uk.co) [42].

Wentink (1978) [41] observed that horse in the swing phase, the limb is shortened by flexion of the joints bringing the centre of gravity of the limb closer to the pivot point at the hip. The initial acceleration and subsequent deceleration of the limb during the swing phase absorb the greater part of the energy spent on locomotion. The closer the centre of gravity of the limb is to the hip, the less will be the energy required to swing the limb forward.

Leach (1991) [20] took up these suggestions and interpreted the typical head and neck movement in both forelimbs and hind limbs lameness as cause for changes in the body centre of gravity movement. He described, for both situations, that the bodies' centre of gravity is shifted away from the lame limb to the sound diagonal limb to reduce the weight bearing responsibility of the lame limb.

According to FEI (2007) [13] that horse when the rider sit on horse the additional weight put on the back of horse it shows arching back its neck and its hocks underneath by shifting of centre of gravity caudally.

Leach (1993) [21] reported that the centre of gravity is the theoretical location where the entire body mass is in balance, and depends on the contribution of forelimb and hind limb load to total load. An increased relative load at the forelimbs implies that the centre of gravity is shifted cranially, whereas a decreased load indicates a shift caudally. Wennerstrand *et al*. (2004) [40] observed that horse suffers from back pain/stiffness have been shown to alter the biomechanics of the spine and shift the centre of gravity.

Gergely *et al*. (2016) [15] revealed that at first, horses take part on conformation evaluation and then during the movement evaluation judges are rating the regularity of walk and trot, the length of stride, the ability of stepping under its centre of gravity.

Dagg (1973) [8] reported that centre of gravity changes less drastically during the trot than it does during the gallop. Large animals, especially those with heavy horns or antlers, would find a gallop particularly tiring, since these would have to be lifted higher during each stride in the gallop as compared to trot.

Ted *et al.* (2011) [39] reported that the horse withers are level or higher than croup, the hindquarter and forehead are balanced then centre of gravity move towards rear.

Centre of gravity in Canine and Feline

Manter (1938) [24] reported that the centre of gravity of the cat lies nearer to the front legs and more weight is normally bear by front legs in standing position. In lion centre of gravity lies between the front and hind feet & vertebral column stretched to the pull in a dorsal direction like a bow & arrow, any weight on hindquarter will cause it to sag down (Eloff, 1969) [12]. According to study done by Di Fabio (1983) [9] lameness of cat has two forms of non postural diagonal adjustment, one where weight transfer occurs only to the contra lateral (i.e. opposite side of the body) limb and the other where weight is shifted to all other limbs. The advantage to the diagonal posture was that there was minimal displacement of the center of gravity (Gahéry and Nieoullon, 1979 [14], Coulmance *et al*., 1979 [7], Dufosse *et al*., 1982) [10] and orientation of the body axis remains unchanged (Dufosse *et al*., 1982) [10]. The weight of the cat is loaded on to the contra lateral and ipsilateral (i.e. same side of the body) limbs.

Leach *et al.* (1977) [22] reported that dog manifested with abnormal gaits, when one or more limbs do not lame then those limb do not bear weight of body, thus, weight shifts towards the sound limbs and increased responsibility of weight-bearing. On this consequences, the weight shift towards the sound limbs it leads to shifting of center of gravity towards sound limbs. The same authors observed that dog suffering from osteochondritis dessicans in which dog was supported for only a short time on the lame leg and this part of the gait looked uncoordinated and awkward. At a fast walk or trot the animal used the lame leg as a strut and appeared to vault over this limb. There was compensation by the hind limbs for this forelimb lameness. The hind limbs was placed in a more advanced position than normal, thus dropping the hindquarters and shifting the center of gravity caudally. Therefore, the hind limbs take more responsibility for support of the animal and reduce the weight directed through the lame leg. The left hind limb was advanced farther than the right. The same authors further reported that dog manifests with hip dysplasia, forelimbs overreached and resulted in a dropping of the anterior part of body. The head was held steady at lower position than normal. Both these

compensations shifted center of gravity forward and reduced the weight being borne by the hind limbs.

Jayes and Alexander (1978) [18] observed that the center of gravity of the lies close to the front legs, probably near the base of the heart. Normal standing condition 60% of total body weight of dog borne by front legs. Riser *et al*. (1969)[35] identified a dog suffers from hind leg lameness then it carry more weight by the front legs further back under the center of mass.

Centre of gravity in Human being

Levangie and Norkin (2011) [23] reported that the position of centre of gravity of the human being lies approximately at anterior to the second sacrum. Other authors also suggested that position of centre of gravity of standing condition in human being is located at the level of approximately 53% to 60% of body height. Mean values are 56.5% for the population of younger males and 55.5% for younger females (Mrozkowiak, 2014) [27].

Centre of gravity in Birds

Corr *et al.* (2003b) [6] observed that the broiler chicken and turkey selected for rapid growth with broad breast muscle, but walk slowly as compared to birds with slower growing rates. The centre of gravity shifted due to heavier breast muscle.

Centre of gravity in Insect

Plateau (1872) [33] observed that the relative location of centre of gravity the following differences Agrion puella, female 1st third of the 3rd abdominal ring, Sanguine female Posterior border of the 2nd abdominal ring Libellula conspurcata posterior border of metathorax, Libellula vulgata ' Groove between thorax and abdomen, Jeschna grandis Middle of 2nd abdominal ring. The centre of gravity does not occupy the same position in the two sexes of one species. It is sometimes less and sometimes more to the rear in the females than as compared to males and its situation depends on the relations existing between the different dimensions of the individuals. It is supposed that the centre of gravity would always be situated further back in female's than in males, as the abdomen of the former is in general more bulky than as compared to males. While standing, centre of gravity is placed at the base of abdomen, or in the posterior parts of the thorax and usually in the centre of the length of the body. When an insect is walking, its centre of gravity undergoes constant displacement about mean point, but the distances of displacement are too small to be measured.

Nickel *et al*. (1986) [28] told that in cattle the muscles are designed for forward movement where the centre of gravity is moved towards the front limb by the propulsive efforts of the hind limb and the front limb is off from ground and repositioned to maintain the animal´s balance.

Conclusion

The centre of gravity is an imaginary point where all the body of animals exactly balanced. The point of centre of gravity shifts according to age, physiological status and movement of animals. The deviation of centre of gravity from its normal position could be the one of the reasons of lameness of animals. It is also concluded that the point of centre of gravity varied with species and also weight shifted towards which organ or point then centre of gravity moves towards the weight shifted.

References

1. Adams, Gary M, Baxter, Ted S, Stashak. History, Visual Exam, Palpation, and Manipulation: Adam's lamenss in horse. First edition, Ames, Iowa: Wiley-Blackwell, 1986, 109-150.
2. Bradley M, Wayne L. Selecting a Saddle. Department of Animal Sciences, University of Missouri–Columbia, 2007.
3. Buchner HH, Obermuller S, Scheidl M. Body centre of mass movement in the lame horse. Equine Veterinary Journal. 2001; 33:122-127.
4. Budsberg SC, Verstraete MC, Soutas-Little RW. Force plate analysis of the walking gait in healthy dogs. American Journal of Veterinary Research. 1987; 48:915-918.
5. Clayton HM. The dynamic horse (Balances basics): A biomechanical guide to horse locomotion and movement. Sport horse publication, 2005.
6. Corr SA, Gentle MJ, Mc Corquodale CC, Bennett D. The effect of morphology on walking ability in the modern broiler: a gait analysis study. Animal Welfare. 2003b; 12:159-171.
7. Coulmance M, Gahery Y, Massion J, Swett JE. The placing reaction in the standing cat: a model for the study of posture and movement. Experimental Brain Research. 1979; 37:265-81.
8. Dagg AI. Gaits in mammals. Mammal Rev.1974; 3:135-154.
9. Di Fabio RP. Postural supporting mechanisms during spontaneous single movement in the cat. Neuroscience Letters. 1983; 40:133-138.
10. Dufosse M, Macpherson J, Massion J. Biomechanical and electro myographical comparison of two supporting mechanisms in the cat. Experimental Brain Research. 1982; 45:38-44.
11. Dyce KM, Sack WO, Wensing CJG. Tratado de anatomia veterinária. 3rd edn. Rio de Janeiro: Guanabara Koogan. 1987, 446-475.
12. Eloff FC. On the predatory habits of lions and hyaenas. University of Pretoria, 1967, 105-112.
13. Fe´de´ration, Equestre Internationale. Dressage handbook guidelines for judging. FEI, Lausanne, Switzerland, 2007.
14. Gahery Y, Nieoullon A. Postural and kinetic coordination following cortical stimuli which induce flexion movements in the cat's limbs. Brain Research. 1979; 149(1):25-37.
15. Gergely Z, Pongrácz L, Szabó F. Conformation evaluation, performance test and estimating of breeding value of the Furioso-North Star and some foreign horse breeds (Review). Acta Agronomica Óváriensis. 2016; 57(1):1-15.
16. Hood DM, Wagner P, Taylor DD, Brumbaugh GW, Chaffin MK. Voluntary limb-load distribution in horse with acute and chronic laminitis. American Journal of Veterinary Research. 2001; 62:1393-1398.
17. Jalakas M, Saks P, Klaassen M. Suspensory Apparatus of the Bovine Udder in the Estonian Black and White Holstein Breed: Increased Milk Production (Udder Mass) Induced Changes in the Pelvic Structure. Anatomia Histologia Embryologia. 2000; 29(1):51-61.
18. Jayes AS, Alexander R. Mechanics of locomotion of dogs (Canisfamiliaris) and sheep (Ovisaries). Journal of Zoology.1978; 185:289.
19. Kubo K, Sakai T, Sakuraoka H, Ishii K. Segmental body

weight, volume and mass centre in Thoroughbred horses. Japanse Journal of Equine Science.1992; 3(2):149-155.
20. Leach DH. Objective studies of gait compensations for equine lameness. In: Proceedings of the 18th Annual Meeting of the American College of Veterinary Surgeons, 1991, 326-328.
21. Leach DH. Recommended terminology for researchers in locomotion and biomechanics of quadrupedal animals. Acta Anatomica.1993; 146:130-6.
22. Leach D, Sumner-Smith G, Dagg AI. Diagnosis of lameness in dogs: A preliminary study. Canandian Veterinary Journal. 1977; 18:58.
23. Levangie PK, Norkin CC. Joint structure & function: A comprehensive analysis. FA. Davis Company; 5th revised edition, 2011 (online).
24. Manter JT. The dynamics of quadruped walking. University of South Dakota, 1938, 522-540.
25. Marks D. Back problems. Medical management of back pain. Veterinary Clinics North America Equine Practice. 1999; 15:179-194.
26. Marvin BG. Conformation of the Horse: Relationship of Form to Function. AAEP proceedings. 2008; 54:1-5.
27. Mrozkowiak M, Dorota D, Ambroży D. Control and correction of horse rider's body posture. Central European Journal of Sport Sciences and Medicine. 2014; 6(2):21-33.
28. Nickel R, Schummer A, Seiferle E, Frewein, J, Wilkens H, Wille KH *et al*. The Locomotors System of the Domestic Mammals. Verlag Paul Parey. Berlin, Germany, 1986, 448-457.
29. Nordenfelt L. Animal and Human Health and Welfare: A Comparative Philosophical Analysis. 1st edn, CABI Publishing, 2006, 118-119.
30. Pastell M, Takko H, Grohn H, Hautala M, Poikalainen V, Praks J *et al*. Assessing cow's welfare: weighing the cow in a milking robot. Bio system Engineering. 2006; 93(1):81-87.
31. Patel GP, Topiwala JJ. Measuring a centre of gravity of an object using 4 load transducer method. International Journal of engineering research and technology. 2017; 6:210-213.
32. Phillips C. The welfare of dairy cows. In: cattle behaviour and welfare. 2nd edn, Blackwell Science Ltd. 2002, 19-20.
33. Plateau F. Un mot surle mode d'adherence des m A. les de Dytiscides aUX femelles pendant I'acte de I'accouplement. Annales, Societe Entomologique de Belgique. 1872; 15:205-242.
34. Raven ET. Cattle Footcare and Claw Trimming Third impression (with amendments), Farming Press, Ipswich, U.K, 1989.
35. Riser WH, Parkes LJ, Rhodes WH. Genu valgum: A stifle deformity of giant dogs. Journal of Animal & Veterinary Sciences. 1969; 10:28.
36. Simalenga TE, Joubert ABD. Animal traction in South Africa: today & tomorrow. Proceeding of Sanat workshop. 1997, 82.
37. Singh M, Lathwal SS, Singh Y, Kumar A, Gupta AK, Mohanty TK *et al*. Association of lameness with per cent body weight distribution and shifting to individual limbs of static Karan Fries crossbred cows. Indian Journal of Animal Sciences. 2012; 82(9):962-970.
38. Stashak TS. Claudicação em equinos segundo Adams. 5. edn, São Paulo: Roca. 2006, 1093.
39. Ted S, Stashak, Hill C. Conformation and movement: Adams and Stashak's lameness in horses. Sixth edition, Ames, Iowa: Wiley-Blackwell, 2011, 73-111.
40. Wennerstrand J, Johnston C, Roethlisberger-Holm K, Erichsen C, Eksell P, Drevemo S. Kinematic evaluation of the back in the sport horse with back pain. Equine Veterinary Journal. 2004; 36:707-711.
41. Wentink GH. Biokinetical analysis of the movements of the pelvic limb of the horse and the role of the muscles in the walk and the trot. Anatomy Embryology (Berlin). 1978; 152:261-272.
42. www.yourhorse.uk.co.