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Evaluation of Limb Conformation in Jumping Thoroughbred Horses

Nasser A. Senna, Mohamed B. Mostafa, Ashraf M. Abu-Seida and Yahya M. Elemmawy
Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, P.O. Box 12211, Giza, Egypt

Corresponding Author: Ashraf M. Abu-Seida, Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, P.O. Box 12211, Giza, Egypt

ABSTRACT

Little data are available in the normal range of conformation traits in jumping thoroughbred horses. The aim of this study was to characterize objectively baseline measurements of lengths and angles in fifty-one jumping thoroughbred horses using tape meter and a computer-aided design program (AutoCAD, 2013). An objective photographic method of evaluating conformation was used. All data were analyzed statistically. The results of the present study revealed that the mean lengths of neck, back and breast width were 100.69±5.6, 92.47±5.66 and 51.2±5.6 cm, respectively. The mean lengths of shoulder, arm, forearm and fore cannon were 69±5, 34±2.9, 46±2.4 and 28.67±2.3 cm, respectively. The back length represented 91.8% of neck length and the arm length represented 49.7% of the shoulder length. The fore cannon length represented 62.3% of the forearm length and the forearm length represented 66.6% of the shoulder length. The fore cannon length represented 41% of the shoulder. The mean lengths of pelvis, thigh, gaskin and hind canon were 51.39±5.12, 49.66±5.12, 53.09±4.8 and 37.44±3.67 cm, respectively. The pelvis, thigh and gaskin lengths were nearly equal. The hind cannon length represented nearly 70% of the lengths of pelvis, thigh and gaskin length. The fore cannon was 25% shorter than the hind cannon. In lateral view, the mean shoulder, elbow, carpus and fore fetlock joint angles were 99±3.74°, 138.37±4.7°, 177.7±2.32° and 142.73±6°, respectively. The mean croup, hip, stifle, hock and hind fetlock angles were 144.63±4.8°, 89±8.34°, 114.94±13°, 148.59±5.3° and 149.84±8°, respectively. In dorsal view, the mean right and left shoulder, elbow, carpus and fore fetlock joint angles were 74.31±3°, 168.27±4°, 176.47±2.4° and 173.53±4.8°, respectively. In conclusion, the obtained results provide guidelines for establishing database for selection jumping thoroughbred with better athletic performance.

Key words: Conformation, joints, jumping, limb, thoroughbred horses

INTRODUCTION

Conformation was simply described as "the relationship of form to function" Beeman (1973). It refers to the physical appearance and outline of a horse as dictated primarily by bones, muscles and other tissues (Holmstrom, 2001; Mcilwraith *et al*., 2003). Otherwise, conformation is the indicator of performance and orthopaedic health of athletic horses since 360 BC (Morgan, 2002). It used for selection of the horses with less risk of developing lameness (Hawcroft, 1993). Poor conformation of limbs contributes to certain lameness and produced abnormal strain in particular part of the limb (Adams, 1974; Mostafa *et al*., 2014a, b). Also, it determined the method of progression of the horse (Adams and Stashak, 1987; Wilson *et al*., 2014).

Earlier studies, conformation measurements were performed with tape meter and goniometer and then eventually replaced by photography and computers or video recorded images (Hunt *et al*., 1999). Recently, digital photography was used (Mcilwraith *et al*., 2003).

Evaluation of horse conformation was carried out through subjective methods (Adams and Stashak, 1987) and objective methods (Johnston *et al*., 1996; Barrey, 1999; Anderson and McIlwraith, 2004). Such measurements were carried out on the live horse and/or from photographs with determined of reference points.

There are very little information concerning the objective methods for evaluation of conformation in jumping thoroughbred horses. Therefore the aim of the present study was to use objective methods to establish a set of baseline measurements of conformation in jumping thoroughbred horses.

MATERIALS AND METHODS

This study was carried out on 51 jumping thoroughbred horses belonging to Egyptian Armed Forces Equestrian Club. These horses were of different ages (5-15 years). All horses delivered the same management procedures, same training courses and almost joined the same number of jumping courses per a year.

Subjective methods for conformation evaluation were carried out as described by Adams and Stashak (1987) and objective methods were applied according to Mcilwraith *et al*. (2003) and Anderson *et al*. (2004) as follow.

Subjective conformational trait evaluations

Fore limb evaluation: The horse was standing squarely on flat hard surface bearing its weight equally on all four limbs. The fore limb conformation was taken by an imaginary line dropped from the point of the shoulder joint that should bisect the limb from a lateral view and another line dropped from the tuber spinae of the scapula that should bisect the limb down to the fetlock and end at the heel bulbs. Deviation of the carpus medially, laterally or forward, backward was evaluated. Degree of extension of fetlock joint was evaluated laterally. The hoof-pastern axis of the forefoot and deviation of the toe outward or inward was also evaluated.

Hind limb evaluation: An imaginary line from the point of buttock to the ground that normally was taken to touch the hock and end slightly behind the bulbs of the heels. The length and slope to the pelvis (croup) were measured from the point of the hip to the point of the buttock. From the rear, a line dropped from the point of the buttock to the ground that should essentially bisect the limb was also taken.

In addition, the neck, back and pelvis were also evaluated.

Objective evaluation of conformation: The objective evaluations were carried out as the method described by Mawdsley *et al*. (1996) and Anderson *et al*. (2004). The lengths and angles were measured initially using tape meter and goniometer. Then these measurements were taken from the photographs using AutoCAD 2013 program; a commercial software application for 2D and 3D computer-aided design (Autodesk, Inc., available since 1982, California, USA).

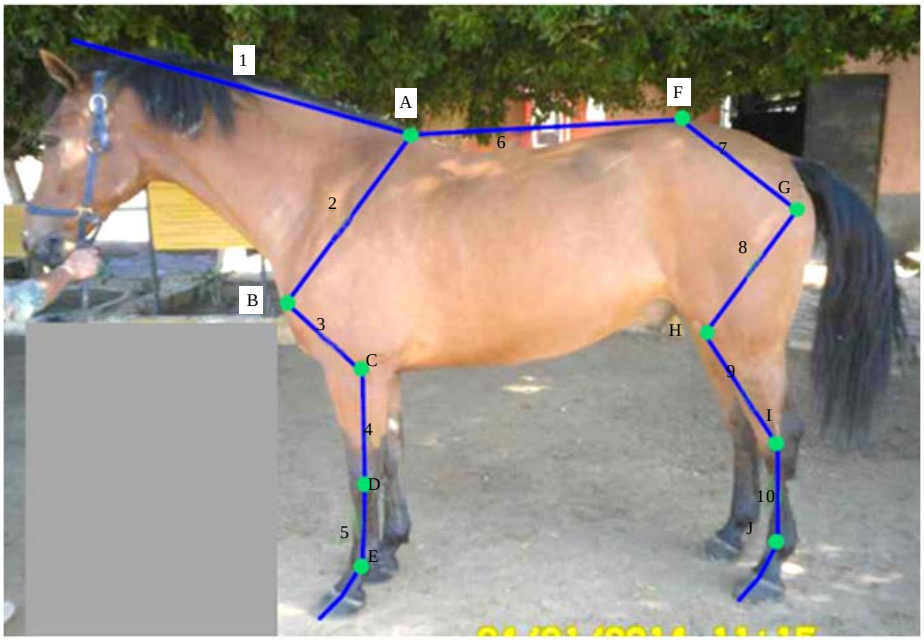

Fig. 1: Reference points and lengths measured in lateral views in thoroughbred horses, 1: Neck length, 2: Shoulder length, 3: Arm length, 4: Forearm length, 5: Fore cannon length, 6: Back length, 7: Pelvis length, 8: Thigh length, 9: Gaskin length, 10: Hind cannon length, A: Point of withers, B: Point of shoulder, C: Point of elbow, D: Point of carpus, E: Point of fore fetlock, F: Point of croup, G: Point of hip, H: Point of stifle, I: Point of hock, J: Point of hind fetlock

Two photographs (lateral and front views) were taken by a Samsung PL80 28 mm digital camera 5X, 12 Megapixel. Then, a computerized method was used to measure the same lengths and angles on these photographs. Labels were stuck to upper reference points and lower limb landmarks were identified directly from photographs. These points were round markers, 1.9 cm in diameter and were glued to the skin over well-defined skeletal structures (Johnston *et al*., 1996; Holmstrom, 2001).

The lengths of neck, back, pelvis, shoulder (lateral and front views), arm (lateral and front views), forearm (lateral and front views), fore cannon (lateral and front views), breast width (front view), thigh (lateral view), gaskin (lateral view) and hind cannon (lateral view) were measured (Fig. 1). Angel between shoulder and back and angels of shoulder joint (lateral view), elbow joint (lateral view), carpus joint (lateral view), fore fetlock joint (lateral view), shoulder joint (front view), elbow joint (front view), carpus joint (front view), fore fetlock joint (front view), croup, hip joint, stifle joint, tarsal joint and hind fetlock joint were also measured (Mcilwraith *et al*., 2003) (Fig. 2 and 3).

Statistical analysis: Descriptive statistical analysis for lengths and angles was done by IBM®SPSS® statistics v 20 program (IBM Corporation, 2009, New York, USA). Mean, median, standard deviation, quartiles and coefficient of variation (C.V) were determined.

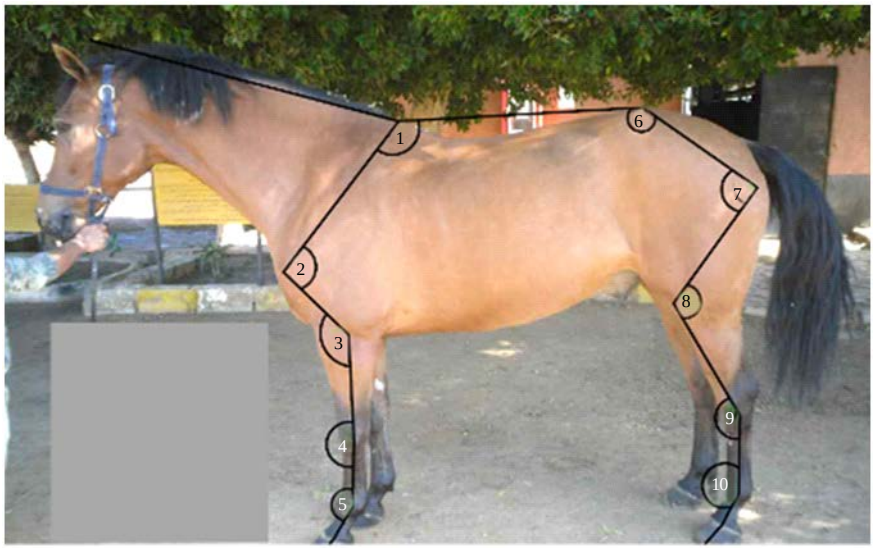

Fig. 2: Angles measured in lateral views in thoroughbred horses.1: Angle between shoulder and back, 2: Shoulder joint angle, 3: Elbow joint angle, 4: Carpus joint angle, 5: Fore fetlock joint angle, 6: Croup angle, 7: Hip joint angle, 8: Stifle joint angle, 9: Tarsal joint angle, 10: Hind fetlock joint angle

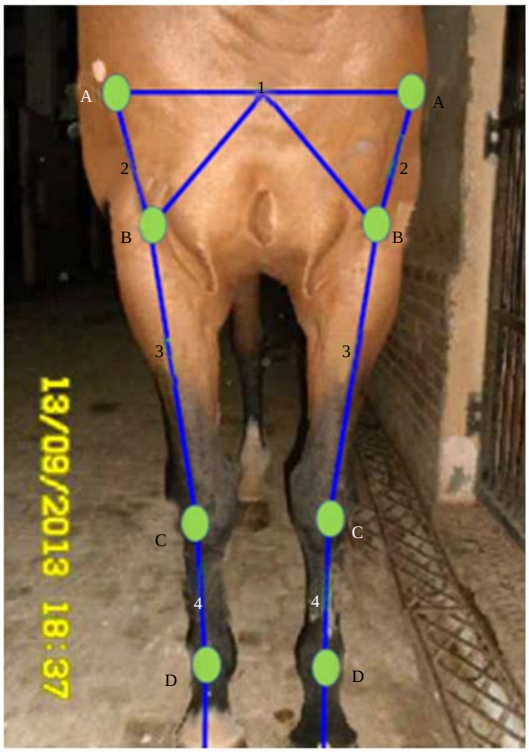

Fig. 3: Reference points, lengths and angles from dorsal view, A: Right and left dorsal shoulder joints, B: Dorsal elbow joint, C: Carpus joint, D: Fore fetlock joint, 1: Breast width, 2: Arm length, 3: Forearm length, 4: Fore cannon length

RESULTS

The mean, maximum, minimum and coefficient of variation in measured lengths among the examined jumping thoroughbred horses were collected in Table 1.

The mean neck length was 100.69±5.6 cm and the coefficient of variations was 40%.

The mean back length was 92.47±5.66 cm and the coefficient of variation was 29%. The mean of breast width was 51.2±5.6 cm and the coefficient of variation was 57%.

The mean lengths of shoulder, arm, forearm and fore cannon were 69±5, 34±2.9, 46±2.4 and 28.67±2.3 cm, respectively. Their coefficient of were 29, 38, 33 and 35%, respectively.

Body conformation measurements in the examined jumping thoroughbred revealed that, back length represented 91.8% of neck length and the arm length represented 49.7% of the shoulder length. The fore cannon length represented 62.3% of the forearm length and the forearm length represented 66.6% of the shoulder length. The fore cannon length represented 41% of the shoulder length.

The measured values of hind limb conformation in the examined jumping thoroughbred horses were collected in Table 2.

The mean pelvic length was 51.39±5.12 cm and the coefficient of variation was 40%. The mean thigh length was 49.66±5.12 cm and the coefficient of variation was 48%. The mean gaskin length was 53.09±4.8 cm and the coefficient of variation in gaskin length measurements was 41%. The mean hind canon length was 37.44±3.67 cm and the coefficient of variation was 39%.

Assessment of hind limb lengths showed that the pelvis, thigh and gaskin lengths were nearly equal. The hind cannon length represented nearly 70% of the lengths of pelvis, thigh and gaskin length in the examined jumping thoroughbred horses. In addition, the fore cannon was shorter 25% than the hind cannon.

In lateral view, the mean shoulder, elbow, carpus and fore fetlock joint angles were 99±3.74°, 138.37±4.7°, 177.7±2.32°and 142.73±6°, respectively (Table 3). The mean croup, buttock, stifle, hock and hind fetlock angles were 144.63±4.8°, 89±8.34°, 114.94±13°, 148.59±5.3° and 149.84±8°, respectively (Table 4).

In dorsal view, the mean right and left shoulder, elbow, carpus and fore fetlock joint angles were 74.31±3°,168.27±4°, 176.47±2.4° and 173.53±4.8°, respectively (Table 3).

Table 1: Mean, standard deviation, median, range, coefficient of variation, minimum, maximum and percentiles values of back, neck and fore limb lengths (cm) in the examined thoroughbred horses

							Percentiles		
Lengths (cm)	Mean±SD	Median	Range	Coefficient of variation (%)	Min.	Max.	25	50	75
Back	92.47±5.66	92.00	27.20	29	82.80	110.00	89.0	92.00	95.00
Neck	100.60±8.45	100.40	40.00	40	85.00	125.00	94.0	100.00	104.00
Shoulder	69.47±5.02	69.24	20.00	29	59.00	79.00	65.2	69.20	73.10
Arm	34.56±2.95	34.54	13.01	38	28.29	41.30	32.2	34.54	37.17
Forearm	46.02±2.42	45.99	15.33	33	37.52	52.85	44.6	45.99	47.49
Fore cannon	28.67±2.31	28.98	9.98	35	23.01	32.99	27.1	28.98	30.41
Front breast width	51.20±5.60	51.61	29.30	57	35.70	65.00	47.9	51.61	55.31

Table 2: Mean, standard deviation, median, range, coefficient of variation, minimum, maximum and percentiles values of hind limb lengths (cm) in the examined thoroughbred horses

							Percentiles		
Lengths (cm)	Mean±SD	Median	Range	Coefficient of variation (%)	Min.	Max.	25	50	75
Pelvis	51.39±5.12	50.46	20.38	40	43.05	63.43	47.3	50.46	54.72
Thigh	49.66±5.22	49.65	23.86	48	38.00	61.86	46.1	49.65	54.21
Gaskin	53.09±4.83	52.25	21.73	41	40.50	62.23	50.8	52.25	55.93
Hind cannon	37.44±3.67	36.47	14.60	39	31.21	45.81	34.9	36.47	40.71

Table 3: Mean, standard deviation, median, minimum, maximum and percentiles values of fore limb angels (cm) in the examined thoroughbred horses

					Percentiles		
Joint angles (°)	Mean±SD	Median	Min.	Max.	25	50	75
Shoulder joint (lateral)	99.08±3.74	99.00	91	105	96	99	102
Shoulder joint (dorsal)	74.31±3.05	75.00	66	80	72	75	77
Elbow joint (lateral)	138.30±4.70	139.00	126	147	136	139	142
Elbow joint (dorsal)	168.20±4.00	168.00	160	179	165	168	171
Carpus joint (lateral)	177.70±2.32	179.00	171	180	177	179	179
Carpus joint (dorsal)	176.40±2.42	177.00	171	180	175	177	178
Fetlock joint (lateral)	142.70±6.07	142.00	127	158	139	142	146
Fore fetlock joint (dorsal)	173.50±4.83	174.00	162	180	169	174	178

Table 4: Mean, standard deviation, median, minimum, maximum and percentiles values of hind limb angels (cm) in the examined thoroughbred horses

					Percentiles		
Joint angles (°)	Mean±SD	Median	Min.	Max.	25	50	75
Croup	144.6±4.8	144.0	133	157	142.00	144.00	149.00
Hip joint	89.0±8.3	88.0	75	114	83.00	88.00	92.00
Hock joint	148.5±5.3	148.0	135	161	146.00	148.00	152.00
Stifle joint	114.9±13	113.0	93	151	106.00	113.00	119.00
Hind fetlock joint	149.8±8	150.0	132	164	143.00	150.00	155.00

There was no significant difference between joint angles measured by AutoCAD program and that obtained by tape meter and goniometer.

DISCUSSION

Performance and soundness are the key factors in an equine athlete regardless of whether the horse is used for work, sport or leisure. Conformation assessment is used as indicator of better soundness and for selection of horses with less risk of developing lameness. In addition, conformation evaluation is used for breeders, trainers and buyers to avoid purchasing horses with limited potential due to serious conformation defects (Hawcroft, 1993).

The criteria for evaluation of conformation are largely undocumented or poorly defined by breed registries. Usually judges were carried out through veterinarians or trainers who are considered experts in their field.

Subjective judging of conformation is based on comparing the live horse to certain standard of perfection. Whereas, objective methods have been used in research work based on measurements on live horse or from photographs with assistance reference markers and imaging programs (Johnston *et al*., 1996; Barrey, 1999; Holmstrom, 2001; Mcilwraith *et al*., 2003). Meanwhile, in the present study, measurements of conformation parameters were carried out on live horses and 2D and 3D computer designing program (AutoCAD, 2013 program) was used. The differences in lengths and angles of live jumping thorough bred horses and the photograph within the programs were non-significant. There was an average error of 2 cm for length measurements in this study.

The results of this study revealed that ratio of back length equaled 91.8% of neck length in jumping thorough bred horses. Long back reduces the flexion forces of the horse during jump flatter with less bascule.

Pelvis length was 51% of neck length and 55.5% of back length in the examined jumping thoroughbred horses. These findings proved that great attention should be taken to the variations in neck and pelvis length during purchasing jumping thorough bred horses.

In contrast to these findings, Holmstrom *et al.* (1990) found that neck length was 71.8 cm in Swedish warmblood breed, 75 cm in elite show jumping horses and 71.9 cm in elite dressage horses.

Furthermore, Weller *et al.* (2006a) recorded that national Hunt race horses had neck length 76 cm, back length was 87 cm and pelvic length was 35 cm. Therefore, jumping thoroughbred horses had longer neck than other breeds of horses to play a role in balance and strength of the body during jumping over the fence. The same findings were mentioned by Holmstrom (2001).

Good show jumper has desirable characteristics of the fore quarters that allowed good lift of the fore legs. Also neck has to be of sufficient length to use as a counter balance.

The arm length represented 66.2% of shoulder length. Arm length was 75% of forearm length. Fore cannon length was 62.3% of forearm length in the examined jumping thoroughbred horses. A long forearm is best for speed, jumping and long distance riding (Rooney, 1998). Koenen *et al.* (1995), reported that a more horizontal scapula is related to higher level of performance. Back *et al.* (1996), added that a more horizontal scapula induces the forelimb to pendulate in a more protracted position so more in front of the body which gives more room to saddle and rider (Holmstrom *et al.*, 1990). In this way dressage horses have a more aesthetic appearance and enable show jumpers to demonstrate and improve forelimb technique.

The difference in measurement techniques made comparison of findings with other authors convoluted. Accordingly, the findings in fore limb measurements conformation in the examined thoroughbred jumping horses displayed different variations in lengths of the arm, forearm and fore cannon. The fore canon showed lowest variation, however, the neck length showed the highest variations.

The fore cannon measurements was 28.67 cm in the examined thoroughbred jumping horses. In this respect, Loving (1997) reported that short cannon bones are frequently desirable for soundness. Rooney (1998), reported that short cannons are desirable for any performance horse as this reduce the weight of the lower leg so less muscular effort is needed to move the limb so maximizing the jumping ability.

The breast width was 51.2 cm in the examined jumping thoroughbred horses. This finding is more or less similar to that of other studies which reported breast width as 46.5 cm in elite show jumpers and 46.2 cm in elite dressage horses (Holmstrom *et al.*, 1990). Breast width plays a significant role in endurance and stamina (Rooney, 1998).

It is interesting to mention that, thigh length was 96.6% of pelvis length and 93.5% of gaskin length. Furthermore, fore cannon length was 76.5% of hind cannon length. Accordingly, fore cannon is shorter in jumping thoroughbred horses than trotters (Weller *et al.*, 2006b).

The insufficient length of pelvis will minimize the length of the muscles needed for powerful and rapid muscular contraction. Thus, it reduces the horse's ability to fully engage the hind quarter needed for collection to pass the fence or even to break in a sliding stop (Robert *et al.,* 2013). Furthermore, the ideal horse has a long tibia (gaskin), short hind cannon and low-set hocks.

The measurements of carpus and fetlock joints angel in the examined horses were similar with other studies (Holmstrom *et al.*, 1990; Weller *et al.*, 2006a). However, the recorded shoulder joint angles either in lateral or dorsal measurements had differences in values. This could be attributed to the methods of measurement. Ross and McIlwraith (2011), reported that the angles of shoulder are important in determining the stride length and balance. Steep shoulder angle shifts the center of gravity forward predisposing to lower limb lameness. Additionally, deviations of the carpus joint angle either medially or laterally significantly predispose the horse to carpus lameness and splints (Barr, 1994).

The examined Jumping thoroughbred horses showed similar values of the hock and hind fetlock angles. The difference in breed under study and the methodology of measurement makes comparison with other studies unclear.

CONCLUSION

In conclusion, the obtained parameters provide guidelines for establishing database for selection jumping thoroughbred horses with better athletic performance and further studies are recommended for evaluation of these parameters for performance and musculoskeletal disorders.

REFERENCES

Adams, O.R., 1974. Lameness in Horses. 3rd Edn., Lea and Febiger, Philadelphia, PA., Page: 32.

Adams, O.R. and T.S. Stashak, 1987. Adam's Lameness in Horses. 4th Edn., Lea and Febiger, Philadelphia, PA., ISBN-13: 9780812109801, Pages: 906.

Anderson, T.M. and C.W. McIlwraith, 2004. Longitudinal development of equine conformation from weanling to age 3 years in the Thoroughbred. Equine Vet. J., 36: 563-570.

Anderson, T.M., C.W. McIlwraith and P. Douay, 2004. The role of conformation in musculoskeletal problems in the racing Thoroughbred. Equine Vet. J., 36: 571-575.

Back, W., H.C. Schamhardt and A. Barneveld, 1996. The influence of conformation on fore and hind limb kinematics of the trotting Dutch warmblood horse. Pferdeheilkunde, 12: 647-650.

Barr, A.R., 1994. Carpal conformation in relation to carpal chip fracture. Vet. Rec., 134: 646-650.

Barrey, E., 1999. Methods, applications and limitations of gait analysis in horses. Vet. J., 157: 7-22.

Beeman, G.M., 1973. Correlation of defects in conformation to pathology in the horse. Proc. Am. Assoc. Equine Pract., 19: 177-198.

Hawcroft, T., 1993. The Complete Book of Horse Care. Howell Book House, Sydney, ISBN-13: 978-0947116774, Pages: 208.

Holmstrom, M., L.E. Magnusson and J. Philipsson, 1990. Variation in conformation of Swedish warmblood horses and conformational characteristics of elite sport horses. Equine Vet. J., 22: 186-193.

Holmstrom, M., 2001. The Effects of Conformation. In: Equine Locomotion, Back, W. and H.M. Clayton (Eds.). WB Saunders, London, UK., pp: 281-295.

Hunt, W.F., V.G. Thomas and W. Stiefel, 1999. Analysis of video-recorded images to determine linear and angular dimensions in the growing horse. Equine Vet. J., 31: 402-410.

Johnston, C., L. Roepstorff, S. Drevemo and P. Kallings, 1996. Kinematics of the distal hindlimb during stance phase in the fast trotting Standardbred. Equine Vet. J., 28: 263-268.

Koenen, E.P.C., A.E. Van veldhuizen and E.W. Brascamp, 1995. Genetic parameters of linear scored conformation traits and their relation to dressage and show-jumping performance in the Dutch warmblood riding horse population. Livestock Prod. Sci., 43: 85-94.

Loving, N.S., 1997. Conformation and Performance. Breakthrough Publications, Ossining, New York, ISBN-13: 9780914327752, Pages: 226.

Mawdsley, A., E.P. Kelly, F.H. Smith and P.O. Brophy, 1996. Linear assessment of the Thoroughbred horse. Equine Vet. J., 28: 461-467.

Mcilwraith, C.W., T.M. Anderson and E.M. Sanschi, 2003. Conformation and musculoskeletal problems in the racehorse. Clin. Tech. Equine Pract., 2: 339-347.

Morgan, M.H., 2002. The Art of Horsemanship. In: Xenophon and the Art of Horsemanship, Morgan, M.H. and J.A. Allen (Eds.). WB Saunders, London, UK., pp: 107-119.

Mostafa, M.B., A.M. Abu-Seida and A.I.A. El-Glil, 2014a. Radiographical, ultrasonographic and arthroscopic findings of osteochondrosis dissecans of the tarsocrural joint in horses. Res. Opin. Anim. Vet. Sci., 4: 318-322.

Mostafa, M.B., A.M. Abu-Seida and A.I.A. El-Glil, 2014b. Septic tarsitis in horses: Clinical, radiological, ultrasonographic, arthroscopic and bacteriological findings. Res. Opin. Anim. Vet. Sci., 4: 30-34.

Robert, C., J. Valette and J.M. Denoix, 2013. Longitudinal development of equine forelimb conformation from birth to weaning in three different horse breeds. Vet. J., 198: 75-80.

Rooney, J.R., 1998. The Lame Horse. The Russel Meerdink Company Ltd., Neenah WI., ISBN-13: 9780929346557, Pages: 261.

Ross, M.W. and C.W. McIlwraith, 2011. Conformation and Lameness. In: Diagnosis and Management of Lameness in the Horse, Ross, M. and S. Dyson (Eds.). WB Saunders, London, UK., pp: 15-30.

Weller, R., T. Pfau, K. Verheyen, S. May and A. Wilson, 2006a. The effect of conformation on orthopaedic health and performance in a cohort of national hunt racehorses: Preliminary results. Equine Vet. J., 38: 622-627.

Weller, R., T. Pfau, S.A. May and A.M. Wilson, 2006b. Variation in conformation in a cohort of national hunt racehorses. Equine Vet. J., 38: 616-621.

Wilson, A., R. Agass, S. Vaux, E. Sherlock, P. Day, T. Pfau and R. Weller, 2014. Foot placement of the equine forelimb: Relationship between foot conformation, foot placement and movement asymmetry. Equine Vet. J. 10.1111/evj.12378