Introduction

As equestrian sports grow in international popularity, the demand for high quality equine athletes continues to rise. The sport horse industry is growing worldwide. The sport horse is an athlete and its value depends mainly on performance in competitions. Performance is the result of a complex combination of conformational, physiological and behavioral traits.

Conformational traits include body measures and angles, leg stance and hoof quality. The traits can be divided into scored (subjective) and measured (objective) traits **(Koenen, van Veldhuizen and Brascamp, 1995)**. Subjective evaluation of conformation is the traditional and still primary used method of evaluating equine conformation and varies greatly between judges **(Magnusson and Thafvelin, 1985b)**.

Evaluation of horse conformation was carried out through subjective methods (**Stashak, 1987)** and objective methods **(Johnston, Roepstorff, Drevemo and Kallings, 1996; Barrey, 1999; Clayton and Schamhardt, 2001; McIlwraith, Anderson and Sanschi, 2003 and Anderson, McIlwraith and Douay, 2004).** Such measurements are carried out on the live horse and or from photographs with determined of reference points **(Langlois, Froideveaux, Lamarche, Legault, Tassencourt and Théret, 1978 and Langlois, 1979).**

Earlier studies, conformation measurements were performed with tape meter and goniometer and then eventually replaced by photography and computers **(Magnusson and Thafvelin, 1985a)** or video recorded images **(Hunt, Thomas and Stiefel, 1999).** Recently, digital photography and advances in computer technology have become common in objective measurements in conformation research **(McIlwraith et al., 2003).**

The conformation is used as indicator for better soundness and for selection of the horses with less risk of developing lameness **(Hawcroft, 1993 and Ross, 2003)**. Poor conformation of limbs contributes to certain lameness and produced abnormal strain in particular part of the limb **(Adams, 1974).**

Horse trainers, veterinarian and owners all have an interest in understanding ideal equine conformation. Scientific investigations into relationships between conformation and gait, performance and orthopedic health have confirmed important connections between these traits **(Back, Schamhardt and Barneveld, 1996 and Barrey, Desliens, Poirel, Biau, Lemaire, Rivero, and Langlois, 2002).**

Many conformation faults have been positively correlated with injury occurrence among Warmbloods and racing breeds **(Magnusson and Thafvelin, 1985c; Hölmstrom and Philipsson, 1993; Anderson et al., 2004 and van Weeren and Cervier Denoix, 2006).**

The importance of conformation makes it an important criterion when selecting potential top equine athletes. Early selection of top animals for further training can avoid economic losses through training of incapable prospects **(Hölmstrom, 2001).** The relationship between conformation and performance in competition in show jumping were linked to the conformation data and competition results **(Pretorius, 2003)**.

Thoroughbred jumping horses dominate the top levels of jumping in Egypt. Although much have been written about conformation of horses and its relationship to performance and musculoskeletal problems, little subjective and objective data are available about the thoroughbred jumping horses. Therefore, the aims of this study were to;

1- Determine the distribution of conformation parameters in a sample of jumping thoroughbred horses to establish set of baseline measurements of conformational (morphological) traits.

2- Investigate the role of conformation and its relationship to musculoskeletal problems in jumping thoroughbred horses' sample. The hypothesis was that certain conformations could significantly contribute to certain musculoskeletal problems.

3- Evaluate the relationship between the measured conformational traits and the jumping competitions' results of the sample.

Review of literature

Definition of conformation:

Conformation referred as the physical appearance and outline of a horse as determined primarily by bones, muscles and other tissues (comprise the segment length, joint angles and deviations of the segments from the vertical) **(Marks, 2000; Hölmstrom, 2001; Morgan, 2002 and McIlwraith et al., 2003**).

Other authors were defined conformation simply as "the relationship of form to function" **(McIlwraith et al., 2003). Beeman (1973), Rooney (1998) and Thomas (2005)** explained that as horse with poor form for a challenging show jumper could have excellent conformation for to be a champion draft or cutting horse. Furthermore, conformation is often a subjective assessment based on what a particular breed may consider to be "ideal" **(Baxter, Stashak and Hill, 2011).**

Disagreement about ideal conformation:

Oliver and Langrish (1991), Marks (2000) and **Stashak and Hill (2002)** found that it is easier for a well conformed horse to stay sound and many horses with conformation defects are able to perform well.

Hawcroft (1993) reported that ideal conformation is the form which does not exert excess strain on any single structure of the limb**. Nikolic (2009)** said that correct alignment of the skeleton is important in that it provides a solid supportive base for the attachment of muscles and other tissues.

They added that desirable conformation included moderate length and slope of bones with straight alignment when viewed both from front, side and back, large and un-swollen joints, high quality and appropriate size of hooves, adequate dimensions of the heel and a concave sole were observed.

On the other hand, **Baxter et al. (2011**) recommended that it is impractical to set a single standard of perfection or to specifically define ideal or normal conformation. **Marks and Prax (2013)** said that it might be surprised to know that there is no ideal formula. The best jumpers possess a combination of great strength and coordination**.**

History:

Bourgelat (1750) and **Magne (1866)** were early written in importance of conformation in performance of the horses. They stressed on the importance of the hindquarter conformation. Horses with hind limbs placed well underneath themselves were found suitable for dressage work, whereas those with hind limbs camped out behind were to show good speed.

Another early author, **Hörman (1837)** wrote that a long and forwardly sloping femur facilitates lifting of the hindlimb and the horse's ability to step under itself. **Morgan (2002)** reported that conformation was thought to be an important indicator of future musculoskeletal health since 360 BC.

Role of conformation:

Salib (1949) stated that mathematical study of conformation in relation to speed help us to assign to a horse his future success or failure as a racing animal and added that the highest success in this connection will be attained by the judicious blending of practice with science

Adams (1974) stated that "poor conformation of limbs contributes to certain lameness and may actually be the cause of lameness in some cases". **Rooney (1968)** reported that the laws of biomechanics make it very plausible that horses with particular relationships between different parts of their musculoskeletal system are more likely to put excessive strain on specific parts of their anatomy.

Clayton (1986) and Stashak (1995) mentioned that conformation of a horse is the key to method of progression. The condition of limbs and feet were noticed. The proportion of the body conformation, as compared with the limb conformation, and conformation is considered a major factor in soundness of the limbs, it often determined the useful lifetime of a horse.

McIlwraith (1986), McIlwraith, Yovich and Martin (1987), Mohammed, Hill and Love (1991), Dolvik and Klemetsdal (1994, 1996 and 1999) and Anderson et al. (2004) explained that the causes of race injuries in the horse is considered to be multifactorial, with genetics, race surface, number of starts, age of the horse, pre-existing pathology, biomechanics (conformation) and trauma being implicated as potential etiological factors.

Oliver and Langrish (1991) and Globe (1992) reported that conformation is often used to predict the anatomical predilection site for injuries. At pre-purchase examination, veterinary surgeons will often comment on defective conformation with regard to future soundness of horses**.**

Hölmstrom (2001) added that conformation and movement must have the basic qualities that create the necessary conditions for successful training of the horse that gives the ability to collect and work in balance necessary for a jumping horse. He suggested that resistance from the horse is often interpreted as poor temperament but might just as well be due to pain or lack of ability to carry weight on the hindlimbs caused by inappropriate conformation and/or movement.

Saastamoinen and Barrey (2002) said that conformation has been thought of an indicator of performance and orthopaedic health of horses**. Baxter et al. (2011**) added that inheritable conformation predisposing to navicular disease, bone spavin, carpal bone fracture, curb, and upward fixation of the patella is prevalent and should be considered undesirable either when purchasing a horse or when considering a stallion or mare for mating.

Variability of methods of conformation evaluation:

Subjective method:

Adams (1969) stated that subjective evaluation of conformation is the traditional and still the primary used method of evaluating equine conformation but it found varies greatly between judges as it based on experience or opinion and very little is based on research **(Magnusson and Thafvelin, 1985b).**

In this method, assessment of the curvature and proportions of the topline, assessing the balance of the forehand to the hindquarter, straightness and symmetry of limbs, hooves quality, assessment of the depth and length of the muscles in the forearm and chest were performed from the left side and the right (off) side of the horse **(Adams, 1969).**

Stashak (1987) reported that it is critical to evaluate limb conformation with the horse standing squarely on a firm, flat surface and with an experienced handler who can make the horse cooperate. If the clinician observes a fault that may result from how the horse is standing, he or she should reevaluate the horse after repositioning. Horses often stand camped out, both behind and in front, simply as the result of improper positioning**.**

Butler (1985) and Seidlitz, Willeke and Von Butler-Wemken (1991) mentioned that subjective evaluation of equine conformation is usually based on experience or opinion. **Hölmstrom (2001)** mentioned that almost every country has its own protocol, moreover, each breed has its specific standard and so its regulations for judgment.

Semi-objective method:

Mawdesley, Kelly, Smith and Brophy (1996) developed semi objective method for linear assessment trait evaluation system to allow quantitative description of the static conformation of the thoroughbred horse. Measurements were made on 27 selected traits. They scheduled the various abnormal conformations in one chart for easily guidance in judgment. . In the Netherlands this is done for the Warm blood (KWPN) as well as the Friesian (KFPS) horses at studbook admission **(Pretorius, 2003).**

Objective (quantitative) method

This method was described by **Schmaltz (1906), Schottler (1910)** and **Rosio (1927)** for measurement of conformation on the live animals.

Specific characters of the objective method of conformation evaluation:

Standard Height Stick**:** The measuring stick on a level was an accurate, practical and satisfactory method for scaling of the lengths measured **(Hickman and Colles, 1984)**.

Photographic Measurements: **Magnusson (1985) and Holmstrom and Philipsson (1993)** developed and utilized a method of marking horses and measuring linear and angular conformation from still photographs with the assistance of reference points according to **Kronacher and Ogrizek (1932) and Langlois (1979).**

Magnusson's Method: Twenty-five anatomical points were chosen for paper marker placement on the live animal. Points were chosen to be easily palpable and not heavily influenced by muscle, fat or hair. They reasonably represented the end of bones and the center of joints, and the lines between these points coincided with lines and axis used in subjective horse evaluation. Horses stood in a standardized, square position, and a measuring stick was included in each photo for scaling. Film was then developed to slides, and linear and angular measurements were taken from projected images **(Magnusson, 1985).**

Flexible measuring tape**:** Morphometric measurements taken with a flexible measuring tape **(Mawdsley et al., 1996).**

Distortion Error: Translating the 3-dimensional (3D) animal to a 2-dimensional (2D) image and planar differences between markers create measurement error. Increasing the lens's focal length from 40mm to 200mm significantly reduces this distortion **(Magnusson, 1985).** When compared to measurements taken from a 3D system, 2D measurement error averaged 2 cm with a maximum error of 5 cm for the scapula length **(Weller, Pfau, Verheyen, May and Wilson, 2006a).**

Corrections for **"fish-eye"** distortion caused by video and camera lens attributes ranged from 0 cm at the center of the screen to 2 cm at image edges **(Hunt et al., 1999).** A fisheye lens is an ultra-wide angle lens that produces strong visual distortion intended to create a wide panoramic or hemispherical image. Full-frame fisheye lenses enlarged the image circle to cover the entire rectangular frame. The picture angle produced by these lenses only measures 180 degrees when measured from corner to corner **(Kingslake, 1989).**

Hölmstrom et al. (1990) advised when measurement was taken from live animals, a uniform stance for photographs is important for accuracy and repeatability. Changes in limb placement and weight distribution can significantly influence angular conformation measurements.

Reference points: **Holmstrom (2001)** mentioned that the bony prominences used for that purpose were: the cranial end of the wing of the atlas, the proximal end of the spine of the scapula, the posterior part of the greater tubercle of the humerus, the transition between the proximal and middle thirds of the lateral collateral ligament of the elbow joint, the lateral tuberosity of the distal end of the radius, the space between the fourth carpal and the third and fourth metacarpal bones, the proximal attachment of the lateral collateral ligament of the fetlock joint to the distal end of the third metacarpal bone, the proximal attachment of the lateral collateral ligament of the pastern joint to the distal end of the first phalanx, the proximal end of the lateral angle of the ilium, the center of the anterior part of the greater trochanter of the femur, the proximal attachment of the lateral collateral ligament of the stifle joint to the femur, the attachment of the long lateral ligament of the hock joint to the plantar border of the calcaneus bone, the space between the fourth tarsal and the third and fourth metatarsal bones, the proximal attachment of the lateral collateral ligament of the fetlock joint to the distal end of the third metatarsal bone and the proximal attachment of the lateral collateral ligament of the pastern joint to the distal end of the first phalanx.

Camera Placement: Camera placement is an important concern when utilizing photographs to measure conformation. The camera should be placed at a height as close to that of the center of horse's thorax as possible (behind the apex of the heart) **(McIlwraith et al., 2003)**. Overly high camera placement causes significant overestimation of horizontal and vertical linear measurements taken from the upper half of the frame **(Hunt et al., 1999).**

Weller et al. (2006a) reported that utilizing a single practiced individual to mark all animals in a study is often done to control error associated with differences between applicators. From measurements taken after multiple marker applications by a single individual, mean differences greater than 2 cm were reported for neck, trunk length, croup length and tibia. Length measurements distal to the carpus and tarsus averaged less than 1cm difference between marker applications. Angular absolute value differences between markers average 3.2° **(McIlwraith et al., 2003).** It is worth to mention that each of objective conformation evaluation's authors **(Magnusson, 1985; Holmstrom, Magnusson and Philipsson, 1990; Johnston et al., 1996; McIlwraith et al., 2003 and Robert, Valette and Denoix, 2013)** used different reference points from each other.

Animal Stance: As with measurement taken from live animals, a uniform stance for photographs is important for accuracy and repeatability. Changes in limb placement and weight distribution can significantly influence angular conformation measurements **(Weller et al., 2006).**

Live Animal Measurements: The most straight-forward methods for quantifying linear conformation is to take measurements on the live animal. These methods have been used extensively in equine growth research as accepted methods of quantifying linear conformation **(Denham, 2007).**

History of the objective method of conformation evaluation:

Van Vleck and Albrectsen (1965), Grundler (1980) and Magnusson (1985) reported that a problem with traditional evaluation is that subjective evaluations of conformation vary greatly between judges, although some morphological characteristics are assessed more consistently than others**.** Even though objective methods for conformation evaluation will probably play a more important role in the future, traditional subjective evaluation will always be important.

Fedorski and Pikula (1988) mentioned that limited number of objective conformation studies based on height, girth and cannon bone circumference have been carried out, usually in the context of heritability. Such measurements are carried out on the live horse and/or from photographs with the assistance of reference points.

Saastamoinen (1990) reported that a quantitative approach to conformation traits was undertaken in the 18th century by **Bourgelat (1750).** In the 19th and early 20th century, others developed hippometric methods and took into account the joint angles and inclinations of the limb segments

Hölmstrom et al. (1990) and Mawdsley et al. (1996) said that early researchers in this field often noticed the importance of utilizing a standardized animal stance when evaluating equine conformation through photographs or human observation. However, little published research is available quantifying the effects of stance on angular conformation. Therefore, using a standard position helps to reduce errors due to stance variations.

Hölmstrom and Philipsson (1993) mentioned that quantitative conformational analysis, act as a complement to the traditional evaluation has been proven to increase the accuracy in the prediction of performance potential in young horses.

Most reported conformation correlations:

Bourgelat (1750), Ehrengranat (1818) and Magne (1866) mentioned that horses with well camped under hind legs were found suitable for dressage work, whereas those with hindlegs camped behind are likely be fast**.** They added that a sloping shoulder, long radius, short fore cannon and a flat croup are desirable for good movement.

Kronacher and Ogrizek (1931) reported that the lengths of humerus, femur and pelvis were positively correlated with the stride length in the walk of Brandenburg horses, while **Henninges (1933)** found this positive correlation with the angle of slope of the shoulder.

Neisser (1976) and **Müller and Schwark (1979 a and b)** studied the positive correlations between body measurements and jumping ability. They found that 391 show jumpers had a larger height at the withers compared to 175 dressage horses.

Thafvelin (1978) and **Thafvelin, Philipsson and Darenius (1980)** found that highly significant correlations were reported between conformation and movement as well as between conformation and orthopedics health.

Langlois et al. (1978) and **Hölmstrom (2001)** reported that a long neck is thought to be an advantage for jumping horses, possibly because this feature makes it easier for the horse to maintain balance over the fence and when the horse is viewed from behind, width through the hips and shoulders is desirable.

Traditional evaluation of conformation had put much emphasis on the correctness of the limb **(Wrangel, 1981).** The reason is logic as the deviations from straight or normal angles are thought to put excessive strain on the joints **(Denoix, 1999). Magnusson (2006)** reported that in the forelimbs the main focus is on deviations that are detected from the front with focusing on the angles and spaces between the forelimbs.

Another objective radiological method for limb conformation evaluation:

Barr (1994) used an objective radiological method of assessing the degree to which horses is 'back at the knee' (hyperextended). This method considered unique as this method provides the advantage of allowing an assessment of skeletal without complication of variations in the shape or bulk of soft tissue. He suggested that if this angle was greater than 180° it represented carpal flexion (over at the knee) precisely and if it was less than 180° it represented hyperextension (back at the knee).

Faulty conformations:

Adams (1974) and **Ross and McIlwraith (2011)** said that faulty conformation is not unsoundness, but it is a warning sign. That poor conformation does not necessarily condemn a horse to lameness and on the other hand, good conformation is not synonymous with success. The following examples were the common conformation faults with illustrations of method of its evaluation:

Steep shoulder: in which the scapular angle with the horizontal line and the scapula-humeral joint were wider as possible that scapula appear upright **(Ross and McIlwraith, 2011)**.

Backward deviation of the carpus (calf knee): in which the carpal joint is directed backward from lateral view (Figure 1-A)**.**

Forward deviation of the carpus (buck knee): in which the carpal joint is directed forward from lateral view (Figure 1-C).

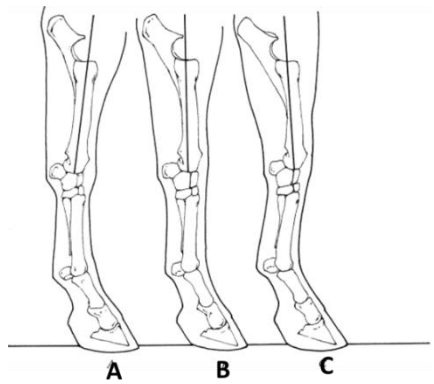


Fig. (1): Calf knee (A), Normal (B), Buck knee (C) **(after Baxter, Stashak and Hill, 2011).**

Lateral deviation of the carpus (bowleg) (carpus varus): in which the carpal joint is directed laterally from the front (Figure 2-A).

Medial deviation of the carpus (knock knee) (carpus valgus): in which the carpal joint is directed medially from the front (Figure 2-B).

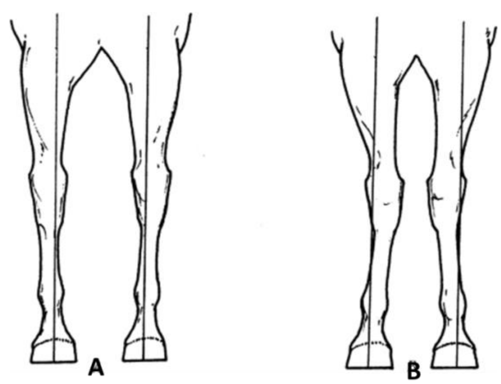


Fig. (2): Carpus varus (A), Carpus valgus (B) **(after Baxter, Stashak and Hill, 2011)**.

Bench knee (Offset knee): in which the cannon bone is offset to the lateral side and does not follow a straight line down from the radius (displaced laterally) when viewed from the front (Figure 3).

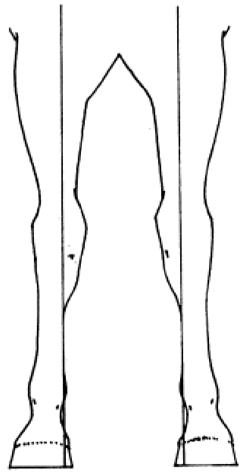


Fig. (3): Offset knee (Bench knee) **(after Baxter, Stashak and Hill, 2011)**.

Standing under in front: in which the entire forelimb (from the elbow down) is placed too far under the body when the horse is viewed from the side (Figure 4).

Fig. (4): Standing under in front **(after Baxter, Stashak and Hill, 2011)**.

Upright pastern: in which the fetlock joint and the pastern were in less extended position (more vertical), usually associated with short pastern and straight (steep) shoulders (Figure 5).

Fig. (5): Upright pastern **(after Baxter, Stashak and Hill, 2011).**

Standing under behind: in which the entire limb is placed too far forward when viewed from the side. The perpendicular line drawn from the point of the buttock (tuber ischii) would strike the ground slightly far behind the limb (Figure 6).

Fig. (6): Standing under behind **(after Baxter, Stashak and Hill, 2011).**

Sickle hocks (small hock angle): Hock angles less than 150°to 153°are considered sickle **(HÖlmstrom and Philipsson, 1993; Marks, 2000; HÖlmstrom, 2001 and Pretorius, 2003)** (Figure 7).

Fig. (7): Sickle hocks **(after Pretorius, 2003)**.

Straight hocks (Post legged): in which there is very little angle between the tibia and femur, and the hock is excessively straight (large hock joint angle of more than 165°to 170°) when viewed from the side **(Marks, 2000; Pretorius, 2003 and Gnagey et al., 2006)** (Figure 8).

Fig. (8): Straight hocks **(after Pretorius, 2003).**

Standing out behind: in which the entire limb is placed too far caudally when viewed from the side. A perpendicular line dropped from the point of the buttock would hit the toe, or halfway between the toe and heel. Upright pasterns often accompany this condition (Figure 9).

Fig. (9): Standing out behind **(after Baxter, Stashak and Hill, 2011).**

Medial deviation of the hock (Cow hocks) (Tarsal valgus): in which the limbs are base-narrow down to the hock and then base-wide from the hock to the feet. The hocks are too close together and point toward one another, and the feet are widely separated (Figure 10).

Fig. (10): Cow hocks (accompanied with base wide) **(after Baxter, Stashak and Hill, 2011).**

Lateral deviation of the hock (bow hocks) (Tarsus varus): in which the limbs are base-wide down to the hock and then base-narrow from the hock to the feet. The hocks are too far (Figure 11).

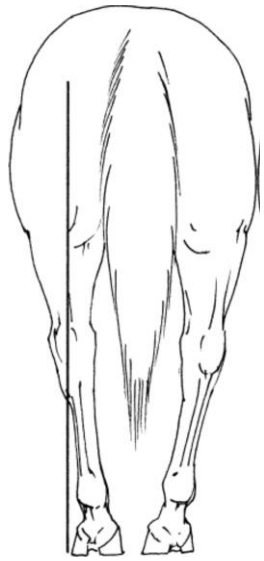


Fig. (11): Bow hind limbs (accompanied with base narrow behind) **(after Baxter, Stashak and Hill, 2011).**

Role of conformation faults in musculoskeletal problem predisposition and performance evaluation:

Rooney (1963), Oliver and Langrish (1991) and Globe (1992) reported that many conformational faults were thought to play a great role in musculoskeletal problems predisposition.

Gill (1987) stated that camped under in front is unusual and usually also results from temporary mal-positioning of the horse. If a horse prefers to stand camped under and is otherwise sound, however, this trait may be a sign of "extreme speed". **Mero and Pool (2002)** noticed horses with normal initial hind limb conformation may become straight behind if they develop severe suspensory desmitis and lose support of the fetlock joint.

HÖlmstrom et al. (1990) and Magnusson and Thafvelin (1985b) reported that toed-out conformation is common and if mild may be considered normal or inconsequential. They added that toed-out conformation resulted in abnormal wear on the inside aspect of the foot. Exostoses (splints) on the second metacarpal bone (McII) or (McIII) may develop. In STB pacers, interference injury occurs as high as the distal aspect of the radius.

Hölmstrom et al. (1990) mentioned that the conformational trait that has been linked most consistently to successful jumping performance is the shoulder that is preferably to be sloping. The fore pastern has been shown to be significantly larger in elite jumping horses compared to other riding horses.

Magnusson and Thafvelin (1985b) reported that mostly examined hind limb conformations is hock conformation. **Hölmstrom et al. (1990)** mentioned that sickle-hocked conformation was nearly absent in elite horses, and it was hypothesized that sickle-hocked conformation either predisposed a horse to lameness or impaired a horse's ability to achieve upper levels of competition.

Additionally, **Magnusson and Thafvelin (1985b), and Gangey, Clayton and Lanovaz (2006)** considered hock angle of 155.5º -165.5º optimal for vertical impulse of upward and forward movements in elite Standardbred trotters while smaller hock angles was associated with significantly more effusions in the stifle and hock joints.

But, **Hölmstrom et al. (1990) and Ross and McIlwraith (2011)** believed that horses with excessively large hock angles (straight behind) are substantially prone to suspensory desmitis. In addition, it leads to rigid and incorrect hind leg actions as well as an increased strain on the hind leg joints

Gnagey et al. (2006) said that sickle-hocked conformation concentrates load in the distal, plantar aspect of the hock, predisposing to curb and to distal hock joint pain. In a recent study evaluating tarsal angles and joint kinematics and kinetics, horses with large hock angles (straighter behind) had less absorbed concussion during impact, smaller vertical impulse, and less extensor movement, characteristics thought to predispose these horses to OA.

Hölmstrom and Philipsson (1993) noticed that the length of the pelvis has a positive correlation with jumping ability and a forward sloping femur also correlates to good jumping performance. The latter feature has the strongest correlation to overall gait quality of all conformational variables.

Johnston, Roethlisberger-Holm, Erichsen, Eksell and Drevemo, (2004) showed that show jumpers have shorter backs than dressage horses, possibly related to the suppleness required in the dressage horse.

McIlwraith et al. (2003) and Anderson et al. (2004) found that good shoulder length appears to be important and desirable, but recent objective data from TB and QH racehorses suggest that horses with long limbs may be at increased risk for lower limb lameness. Both reported that horses that are base wide stand with the forelimbs lateral to the plumb line and generally are narrow in the chest, resulting in overload of the medial aspect of the lower limb, predisposing to lameness.

Anderson et al. (2004) suggested that a certain degree of carpal valgus is protective for synovitis and capsulitis, as well as chip fractures in the carpus predisposed to carpal lameness and splints with carpal valgus conformation probably applies only to horses with severe abnormalities. **Thomas (2005)** said that horses with severe calf-kneed conformation may develop other problems and not advance enough in training to develop carpal chip fractures.

Upright pasterns appear to be prone to foot lameness and perhaps superficial digital flexor tendonitis. Those with long, sloping pasterns may be at risk to develop OA of the fetlock joint and proximal phalangeal fractures. Horses with short, upright pasterns are at risk for developing foot lameness **(Anderson et al., 2004).**

Marks and Prax (2013) reported that good jumpers do not have low-set, short necks. The best ones have more upright scapulas (shoulder blades) with an angle ranging between 67 and 70 degrees relative to the ground. All elite jumpers have very well developed triceps muscles in the front legs. Moreover, a top jumper’s humerus typically measured about 66 percent of the length of his shoulder blade. The angle of the shoulder joint where the scapula connects to the humerus should be no less than about 45 degrees.

<u>Most common musculoskeletal problems of jumpers:</u>

Baxter et al. (2011) reported that the jumpers are susceptible to navicular syndrome, fore-limb and hind-limb proximal suspensory desmitis, fetlock synovitis/OA, SDFT tendinitis, distal tarsitis or bone spavin, back problems and sacroiliac problems.

Principles of selection of an athlete horse:

Huizinga and van der Meij (1989) and **Huizinga, Boukamp and Smolders (1990)** reported that most important trait of interest in selecting a horse and designing its breeding program is the result of the ability of that horse in combination with the years of intensive training. In addition, they mentioned that the majority of the horses are kept in small studs of one or a few horses and there is a large variation in rearing and training among studs. The owner decides, depending upon his ambition and professionalism, what level of management and training a horse will receive during its rearing.

Ducro (2011) mentioned that a successful sport career does not only concern top level performance, also the duration of the sport career. Early retirement from sport will not only reduce returns on the investments but it often has also emotional consequences**.**

Ross and McIlwraith (2011) and Hölmostrom and Back (2013) reported that searching for talented young sport horses involves evaluation of many different qualities. Temperament, movement, conformation and jumping ability are of course the most important in riding horses recognizing desirable conformational traits in horses suited for a particular sporting activity and learning when to overlook a minor fault that has little clinical relevance is important**.**

The specific character of the jumper conformation:

Marks and Prax (2013) stated that unique conformation of the jumper was that he needs all of the levers in his body (the bones) to be constructed and connected in such a way that he can most effectively convert his forward momentum and muscle shortening into upward momentum**.**

Competition results in show jumping as indicator of performance:

Langlois et al. (1978) investigated the relationship between conformation and jumping ability by comparing good and poor show jumpers and found the good show jumpers were characterized by wider breast and pelvis, a greater chest girth, longer pelvis and smaller angle of the femur with respect to the horizontal plane.

Pretorius (2003) stated that competition results of performance in show jumping were linked to the conformation data to estimate the genetic relationship between conformation and performance in competition. The length of neck, length and position of the shoulders, shape and length of croup and muscularity of the haunches had a significant genetic correlation with show jumping.

Jumping mechanism:

Stinner (2014) reported that understanding the jumping mechanics can help rider and trainer to keep their horse sound so can be considered a useful tool for diagnosing and preventing soundness problems**.**

Sheila (2014) added that the most important difficulty facing any jumper and not present in other equine activities is the overcoming of the force of gravity and its body weight during take-off and landing**.** Mechanism by which a horse used his body to generate the force required to propel it up and over a fence should be well known.

Sheila (2014) and Marks and Prax (2013) broke the jumping process down into 5 phases: the approach, the take-off, flight, landing, and recovery.

They explained the horse approach phase during jumping, the horse prepared himself to obtain the required maximum amount of push of the hind quarters for the upcoming obstacle. He rounds his back to bring his hind legs farther underneath his body with each stride using an extremely collected gait with a four-beat rhythm. In the last approach stride, the horse lowers his withers and rotates his scapula (shoulder bone) backward under the flap of the saddle, extending his front legs in front of his body, preparing to plant them on the ground the way the pole-vaulter plants the pole in the box (Figure 12).

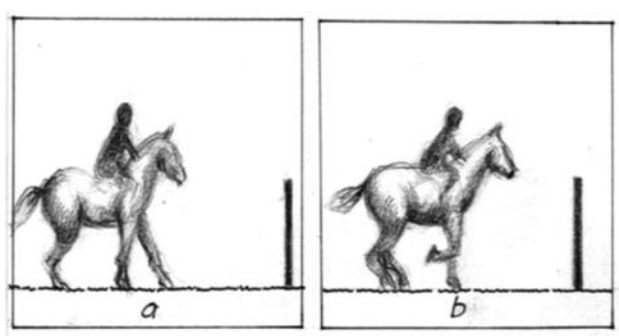


Fig. (12): The approach phase **(after Stinner, 2014).**

They added that during take – off phase the horse raises the head, shorten the neck, and lift the shoulders. As the weight moves backward, the hind legs compressed or coiled to create the energy needed to propel the horse over the fence. All joints of the hind legs should be flexed equally so that no one joint is pressured more than the others. The hind legs are in full extension right before they leave the ground. The abdominal muscles of the horse will really start to come into play at this point as the horse begins to lift the top line to clear the fence. During this phase, the back and shoulders extend, but the neck remains relatively short. The horse's shoulders rotate up and forward helping to pull the hind legs off the ground (Figure 13).

Sheila (2014) mentioned that the gluteal (croup) muscles and hamstring group (biceps femoris, semitendinosus and semimembranosus) are the power houses creating this propulsion. The shape of the horse's trajectory through the air is the accurate translation of the word "bascule." (Curve their backs and necks around the fence.

Fig. (13): The take-off phase **(after https://www.flickr.com/photos/44121651@N02/4238782378/in/photostream).**

Stinner (2014) clarified that during flight phase, the neck begins to extend further forward to assist the body in the forward movement necessary to reach over the fence and obtain the scope necessary. The knees lift and bend to curl the legs up under the forehand, the tighter the better so the chance of hitting the fence by the front legs is reduced making the horse more streamlined.

The horse bends his elbows and uses the long brachiocephalicus muscle, and the trapezius muscle to pull his forearms up and forward. Then, he tightly folds his lower forelegs (Fig.14).

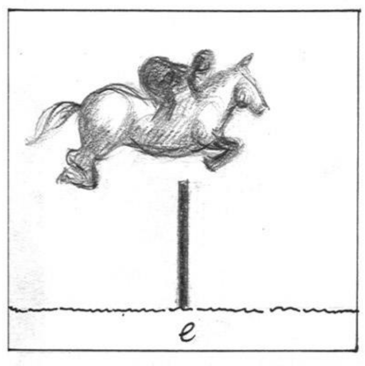


Fig. (14): Flight phase **(after Stinner, 2014).**

During the landing phase, the horse will swing the neck and head up as the forelegs reach toward the ground. The hindquarters rotate underneath the trunk, and reach toward the ground as the fore hand moves forward and out of the way of the hindquarters (Fig.15).

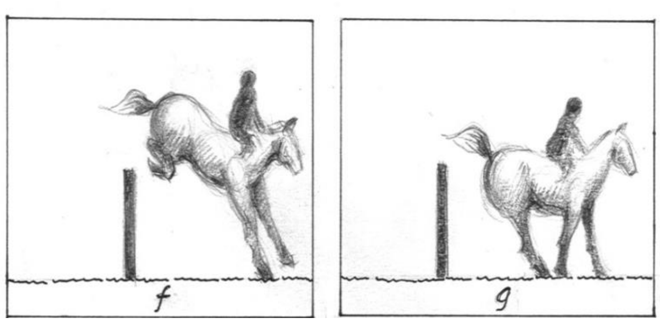


Fig. (15): Landing phase **(after Stinner, 2014).**

Materials and methods

This study was carried out on 51 jumping thoroughbred horses (geldings and females) bred in armed forces equestrian club. Their ages ranged from 5-15 years old and weighed 450-600 kg. All horses delivered the same management procedures, same training courses, and almost joined the same number of jumping courses /a year. The whole body conformation trait, musculoskeletal problems and performance during jumping competitions and ranking were evaluated.

Subjective evaluations of body conformations were carried out as described by **(Stashak, 1987)** and Objective methods of evaluations were designed as the methods described by **(Mawdsely et al., 1996** and **Anderson et al., 2004).** Conformation measurements were obtained from photographs of horses with markers at specific reference points and digitally analyzed using computer aided image analysis (**AutoCAD 2013 v19 program**).

<u>Subjective conformational trait evaluations (Stashak, 1987):</u>

A general systematic assessment of the horse's four functional sections is made (head and neck, forelimbs, trunk, and hindlimbs).

The evaluation begins by viewing the horse from the near (left) side in profile then from the off side (right) and assessing balance by comparing the forehand (head, neck, and forelimbs) to the hindquarters (hindlimbs and croup). Attention paid to the curvature and proportions of the top line, and observations made from poll to tail and down to the gaskin. The horses should be proportional regardless of their size. From the front of the horse, the limbs and hooves are evaluated for straightness and symmetry.

From directly behind the tail, the hindquarters; the straightness and symmetry of the back, croup, point of the hip, and buttock; and the limbs are evaluated. The observer should then make another entire circle around the horse, this time stopping at each quadrant to look diagonally across the center of the horse. From the rear of the horse, the observer should look from the left hindlimb toward the right forelimb, and from the right hindlimb toward the left forelimb. This angle will often reveal abnormalities in the limbs and hooves that were missed during the side, front, and rear examinations. The horse is then viewed from the front in a similar diagonal approach.

The neck acts as a lever to help regulate the horse’s balance while moving; therefore, it should be long and flexible with a slight convex curve to its top line. The hindlimbs are the source of power for propulsion and stopping. The hindlimb muscling should be assessed in relation to the type, breed, and use of the horse. The symmetry of the croup and points of the hip and buttock should be assessed, and the straightness and soundness of the limbs should be assessed.

The ratio of the top line’s components, curvature of the top line, strength of loin (longissimus dorsi muscles in the lumbar region), sharpness of withers, slope to the croup, and length of the underline in relation to the length of back all affect a horse’s movement. The neck is measured from the poll to the highest point of the withers. The back measurement is taken from the withers to the caudal extent of the loin located in front of the pelvis. The hip length is measured from the caudal loin to the point of the buttock. A general rule of thumb is that the neck length should be greater than or equal to the back length, and that the hip should be at least two-thirds the length of the back.

The dorsal (upper) neck length (poll to withers) to the ventral (lower) neck length (throat latch to chest) should be assessed. This is dictated to a large degree by the slope of the shoulder. The withers should be assessed if blending gradually into the back, ending ideally at about the midpoint of the back also assessed or present a prominent dip in the muscles in front of or behind the withers.

The back muscles aid to counteract the gravitational pull from the weight of the horse’s internal organs and to support the rider’s weight, therefore it should be assessed. The loin is located along the lumbar vertebrae from the last thoracic vertebrae to the lumbosacral junction. The loin length and muscling should be evaluated. (The coupling is the area behind the ribs and in front of a vertical line dropped from the point of the hip).

The croup is measured from the lumbosacral junction to the tail head. The croup should be fairly long, because this is associated with a good length to the hip and a desirable forward-placement of the lumbosacral articulation. The top line (the back) should be short in relation to the underline. Such a combination indicates strength plus desirable length of stride.

The length and slope to the shoulder, arm, forearm, croup, hip, stifle, and pasterns should be assessed together. There should be a straight alignment of bones when viewed from the front and rear, large clean joints, high-quality hoof horn, adequate height and width of heel, concave sole, and adequate hoof size.

Both forelimbs should be of equal length and size and should appear to bear equal weight when the horse is standing squarely. A line dropped from the point of the shoulder (middle of the scapula humeral joint) to the ground should bisect the limb. The manner in which the shoulder blade and arm (humerus) are conformed and attach to the chest often dictates the alignment of the lower limb (Fig. 16)

The medial-lateral slope of the humerus is evaluated by finding the point of the shoulder and a spot in front of the point of the elbow on each side. The four points are then connected visually. If the resulting box is square, the humerus lies in an ideal position for straight lower limbs. If the bottom of the box is wider, the horse may toe-in and travel with loose elbows and paddle. If the bottom of the box is narrower, the horse will probably toe-out, have tight elbows, and wing in.

The length of the humerus (from the point of the shoulder to the point of the elbow) also affects stride length. The angle formed by the humerus and radius and ulna at the elbow joint should be between 120° and 150°, therefore it should be assessed for straightness or sloppiness.

The muscles of the forearm (antebrachium) should extend to the knee, tapering gradually rather than ending abruptly a few inches above the knee. The pectoral muscles should also extend far down onto the limb. The pectoral and the forearm muscles help a horse to move its limbs laterally and medially, and to elevate the forelimb.

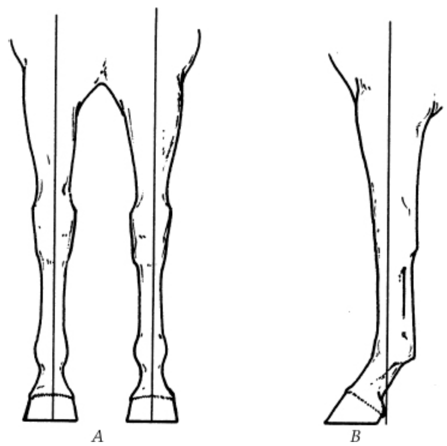


Fig. (16): Cranial and lateral views of normal forelimbs. A. A line dropped from the point of the shoulder joint should bisect the limb. B. A line dropped from the tuber spinae of the scapula should bisect the limb down to the fetlock and end at the heel bulbs **(after Baxter et al. 2011)**.

The carpal joints should be balanced and should not deviate toward, or away from, one another. The cannon bone should be centered under the carpus and not to the lateral side (bench knees). Deviations from a straight limb may cause strain on the collateral support structures and asymmetrical loading (compression) of the hinge joints in the forelimb.

When viewed from the side, limbs should exhibit a composite of moderate angles so that shock absorption is efficient. The shoulder angle is measured along the spine of the scapula, from the point of the shoulder to the point of the withers. The angle of the scapula and shoulder tend to increase (become more upright) as horses mature from foals to adults. Also important is the angle the shoulder makes with the arm, which should be at least 90°.

Fetlock joint size and angle should be assessed. Short, upright pasterns or a broken forward hoof-pastern axis are evaluated as this is thought to cause greater concussive stresses to the fetlock, phalangeal joints, and foot.

The hindlimbs constitute the “engine” of the horse regardless of its intended use. Endurance horses are characterized by longer, flatter muscles, stock horses are characterized by shorter, thicker muscles, and all-around horses have moderate muscling.

Lack of hindlimb musculature or a disparity between the amount of forelimb vs. hindlimb muscle development may suggest chronic hindlimb lameness problems.

LATERAL VIEW

When viewed from the side, the hindlimbs should exhibit a composite of moderate angles so that shock absorption will be efficient. A line from the point of buttock to the ground should touch the hock and end slightly behind the bulbs of the heels. A hindlimb in front of this line is often standing under or sickle-hocked; a hindlimb behind this line is often post-legged or camped out. The hindquarter should be symmetric and well connected to the barrel and the lower limb. The gluteal muscles should tie well forward into the back and the hamstrings should extend down low into the Achilles tendon of the hock (Fig. 17).

Fig. (17): Normal hindlimb conformation as viewed from the side. A line dropped from the point of the buttock (tuber ischii) should follow the cannon bone (**after Baxter et al., 2011)**.

The relationship of the length of the bones, the angles of the joints, and the overall height of the hindlimb often dictate the type of action and amount of power produced. The length and slope to the pelvis (croup) are measured from the point of the hip to the point of the buttock.

From the rear, both hindlimbs should be symmetrical, the same length, and bear equal weight. A left-to-right symmetry should be evident between the peaks of the croup (tuber sacrale), the points of the hip, the points of the buttock, and the midline position of the tail.

A line dropped from the point of the buttock to the ground should essentially bisect the limb; however, the hindlimbs are not designed to point absolutely straight forward. It is also normal for the stifles to point slightly outward, which in turn causes the points of the hocks to face slightly inward and the toes to point slightly outward. The rounder the belly and/or the shorter the loin and coupling, the more the stifles must point outward and the points of the hocks appear to point inward. When the cannon bone faces outward, the horse is considered to be cow-hocked; when the cannon bones face inward, the horse is bowlegged (Fig. 18)

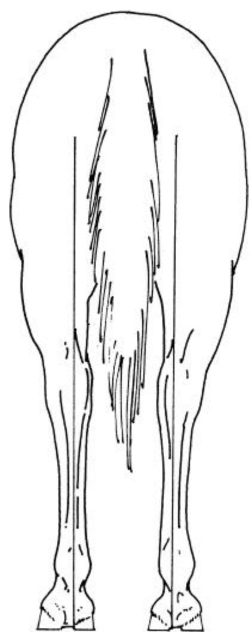


Fig. (18): Normal hindlimbs as viewed from the rear. A line dropped from the point of the buttock (tuber ischii) should bisect the limb (**after Baxter et al., 2011)**.

Objective evaluation of conformation:

Firstly, the lengths and angles were measured initially using tape meter and goniometer. Then, a photographic computer method of measuring conformation was used. Two photographs were taken of each horse; lateral (from the left side), front using Samsung PL80 28-mm digital camera 5X, 12 Megapixel. Labels were affixed precisely to the recorded reference points (markers) that identified directly from photographs (**Johnston et al., 1996)**. Table (1) showed these points that are round markers, 1.9 cm in diameter, were glued to the skin over well-defined skeletal structures (Figure 19 and 20). These points used for length measurements (Table 2).

Table (1): Reference points (markers) and their anatomic location.

Reference points	Anatomic location
Poll	The cranial end of the wing of atlas.
Withers	Highest point of horse body.
Point of shoulder (lateral)	Posterior part of the greater tubercle of humerus.
Point of shoulder (front)	Center point of shoulder joint dorsally.
Point of Elbow (lateral)	Caudal edge of lateral collateral ligament of elbow joint
Point of Elbow (front)	Center point at attachment of breast and forelimb dorsally.
Point of Carpus (lateral)	Just below the styloid process of ulna.
Point of Carpus (front)	Center point of carpus dorsally.
Point of Fore-fetlock (lateral)	The center point of fetlock joint laterally.
Point of Fore-fetlock (front)	The center point of fetlock joint laterally.
Point of Croup (lateral)	Highest point of croup (lumbosacral joint).
Point of Hip (lateral)	The groove between semitendinous and biceps muscle just caudal to hip joint.
Point of Stifle (lateral)	Distal end of the patella (over palpable tibial tuberosity).
Point of Tarsal (lateral)	Midpoint of lateral aspect of tarsal joint.
Point of Hind fetlock	Midpoint of lateral aspect hind fetlock joint.

Then, these measurements were taken from the images using AutoCAD 2013 v19 program; a commercial software application for 2D and 3D computer-aided design, developed by Autodesk, Inc., available since 1982, California, USA.

Animal Stance:

The horse walked 3-4 strides on a flat level surface till reaching a repeatable complete stride. Then it should be given a chance to stand squarely in a relaxed position (not extended), looking forward exactly. The neck should be settled raised on back and shoulder.

The left side of the horse that will be photographed should be squared; the left fore and left hind limbs set as vertical as possible with the ground. The horse head haltered freely by an assistant present in front and laterally.

<u>Method of taking a correct photo of the horse:</u>

The horse should be present in center of the frame. Image photographer should be exactly parallel to the horizontal axis of the horse. Camera present just behind center of gravity at midpoint of lateral thoracic wall not higher, lower, forward or backward. Background of the photo must in opposite color of the horse for the reference points easily distinguished on the horse in the photo.

Finally, lengths and angles measured for each horse using measuring tape and goniometer used for calibration and scaling the measurements taken on the photos by AutoCAD 2013 v19 program.

Table (2): Measuring the lengths of body conformation in jumping thoroughbred horses.

Lengths	Description
Neck (NL(l))	From point of withers to poll.
Back (BL(l))	From point of withers to point of croup.
Pelvis (PL(l))	From point of croup to point of hip.
Shoulder (SL(l))	From withers to point of shoulder laterally.
Arm (lateral) (AL(l))	From point of shoulder to point of elbow laterally.
Arm (front) (AL(f))	From point of shoulder to point of elbow dorsally.
Fore-arm (lateral) (FAL(l))	From point of elbow to point of carpus laterally.
Fore-arm (front) (FAL(f))	From point of elbow to point of carpus dorsally.
Fore cannon (lateral) (FCL(l))	From point of carpus to point of fetlock joint laterally
Fore cannon (front) (FCL(f))	From point of carpus to point of fetlock joint dorsally.
Breast Width (BW (f))	From right to left front points of shoulder joints.
Thigh (lateral) (TL(l))	From point of hip to point of the stifle laterally.
Gaskin (lateral) (GL(l))	From point of the stifle to point of tarsal joint laterally.
Hind cannon (lateral) (HCL (l))	From point of tarsal joint to point of hind fetlock joint laterally.

Measurements of fore and hind limb angles:

Shoulder joint angle (lateral view): Between shoulder length (lateral) and arm length (lateral). Elbow joint angle (lateral view): Between arm length (lateral) and fore-arm length (lateral). Carpus joint angle (lateral view): Between fore-arm length (lateral) and fore cannon length (lateral). Fore fetlock joint angle (lateral view): Between fore cannon length (lateral) and pastern length. Shoulder joint angle (front view): Between breast width (front) and arm length (front). Elbow joint angle (front view): Between arm length (front) and fore arm length (front). Carpus joint angle (front view): Between fore arm length (front) and fore cannon length (front). Fore fetlock joint angle (front view): Between fore cannon length (front) and pastern length (front). Croup angle: Between back length (lateral) and pelvis length (lateral). Hip joint angle: Between pelvis length and thigh length (lateral). Stifle joint angle: Between thigh length and gaskin length (lateral). Tarsal joint angle: Between gaskin length and hind cannon length (lateral). Hind fetlock joint angle (lateral): Between hind cannon length (lateral) and hind pastern.

Fig. (19): Correct stance and reference points glued of the horses for accurate objective conformation evaluation from lateral side.

Fig. (20): Correct stance and reference points of the horses for accurate objective conformation evaluation of fore limb from front view.

Procedure of working on AutoCAD 2013 program (Figures 21a-21h)**:**

After launching the program, import the picture from its storage place in the computer into the window of the program. The reference points on the horse are identified on the picture (Fig. 21a and 21b).

From the menu bar click DRAW and select LINE to draw each segment length between its corresponding reference points (Fig.21c and 21d).

Click DIMENSION and select ALIGNED to measure the length of each segment by clicking on the first reference point of the segment then drag the other point and click on it, the length will appeared above the segment (Fig. 21e).

Click DIMENSION and select ANGULAR to measure the angles between the lengths as described. These steps were done on the pictures of the lateral view and that of the front view of the forelimb (Fig. 21f).

Make a scale to the whole picture by dividing the value appeared on the value measured by the tape meter of that segment, then click MODIFY and select SCALE then mark the whole picture and click ENTER. Here any length measured will be nearly equal that measured by tape meter was appeared (Fig. 21g).

Save the model as JPG picture or PDF picture, click Ctrl+P in the keyboard and choose in the PRINTER/PLOTTER the form of saving wanted then in the PLOT AREA in the DISPLAY box choose WINDOW then OK (Fig. 21h).

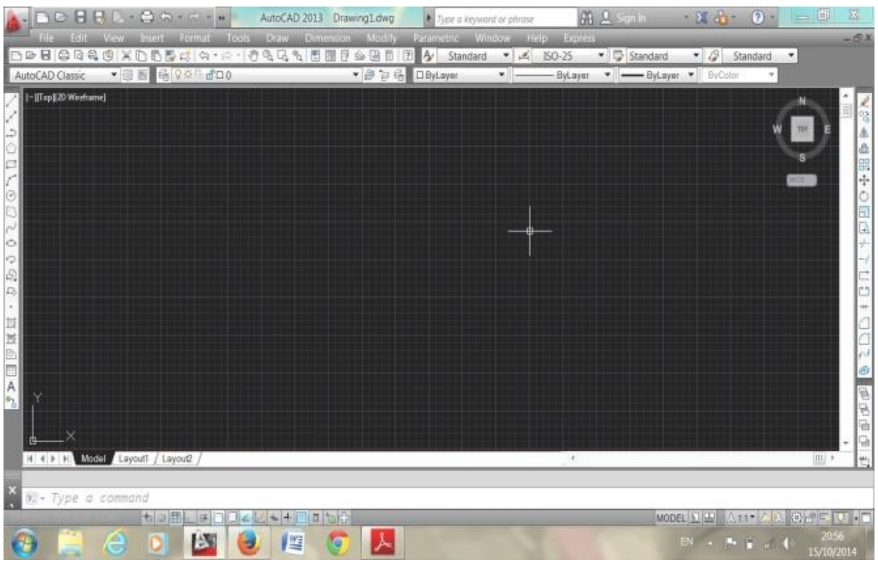


Fig. (21a): Processing of measurements in AutoCAD 2013 v19 program (Window of the program)

Fig. (21b): Processing of measurements in AutoCAD 2013 v19 program (Importing of the photograph of the horse into the program).

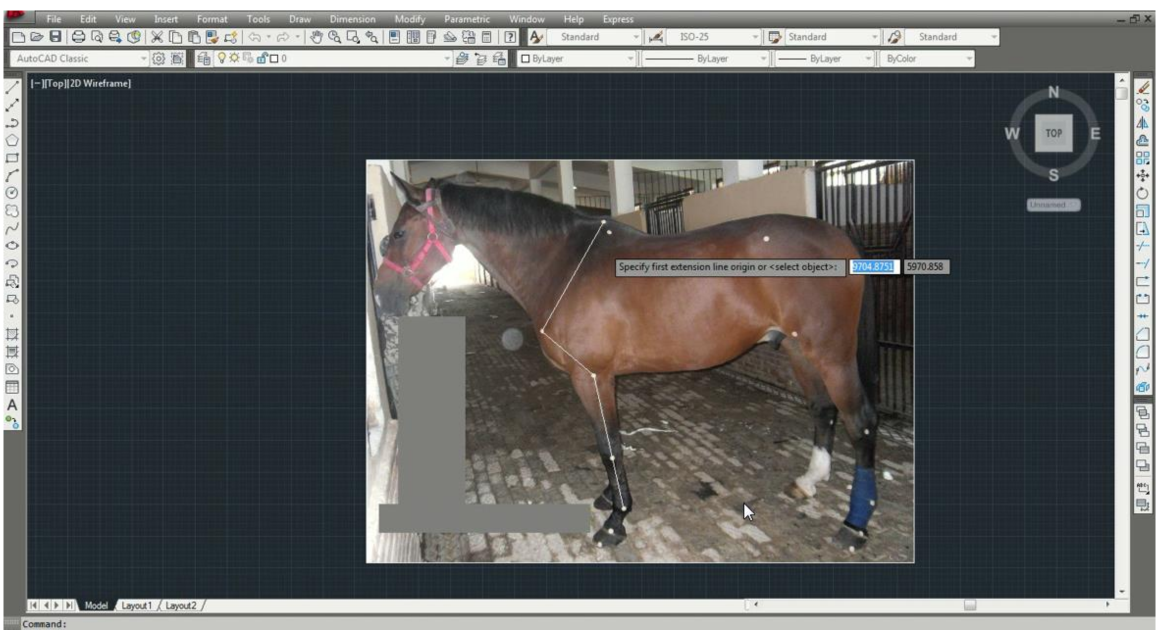


Fig. (21c): Lengths drawing on AutoCAD 2013 v19 program.

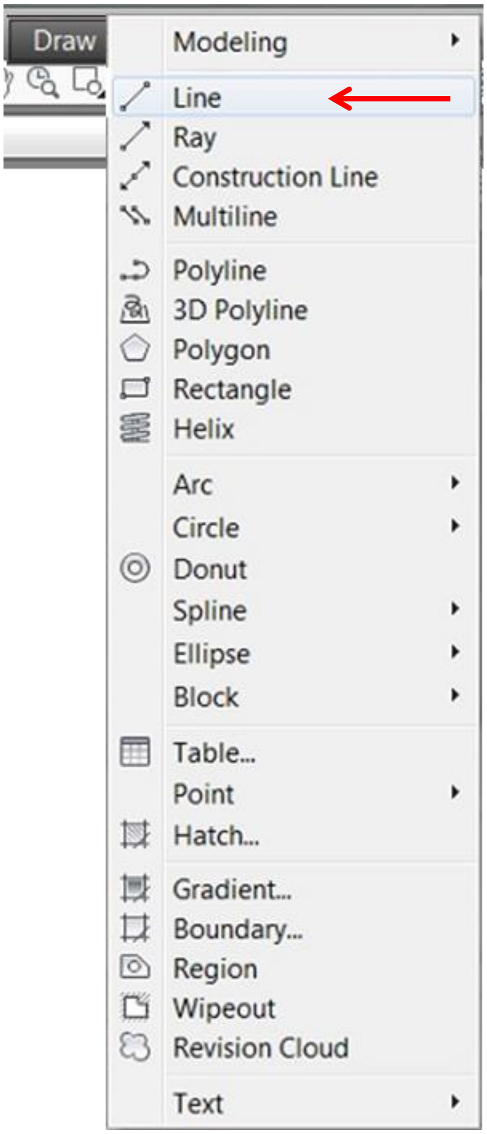


Fig. (21d): Processing of measurements in AutoCAD 2013 v19 program (Lengths identification).

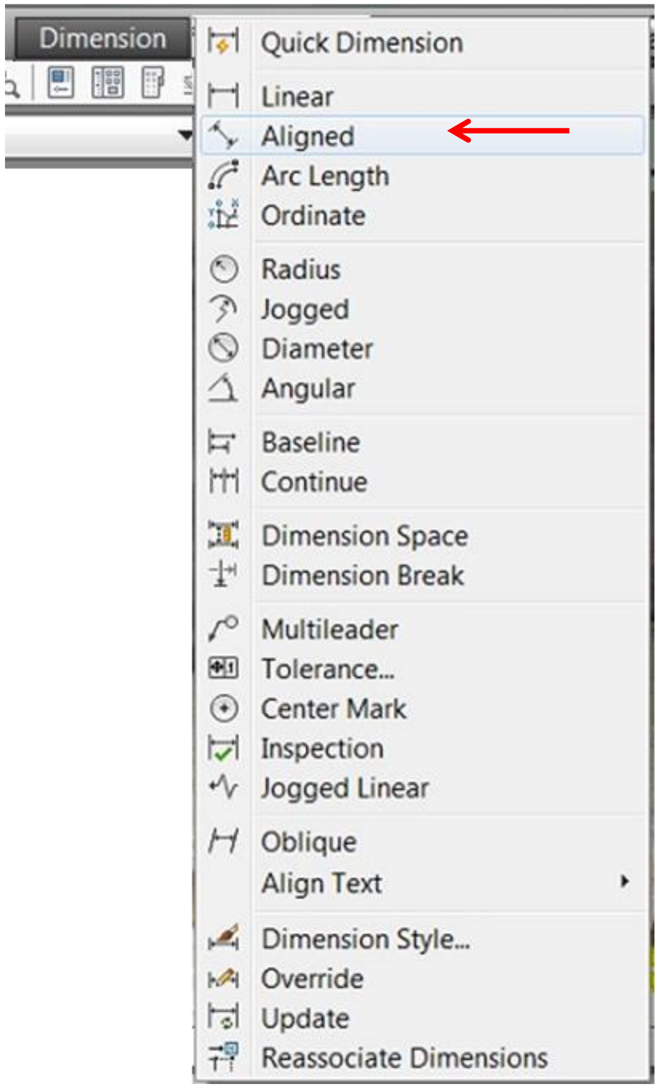


Fig. (21e): Processing of measurements in AutoCAD 2013 v19 program (Lengths measurements).

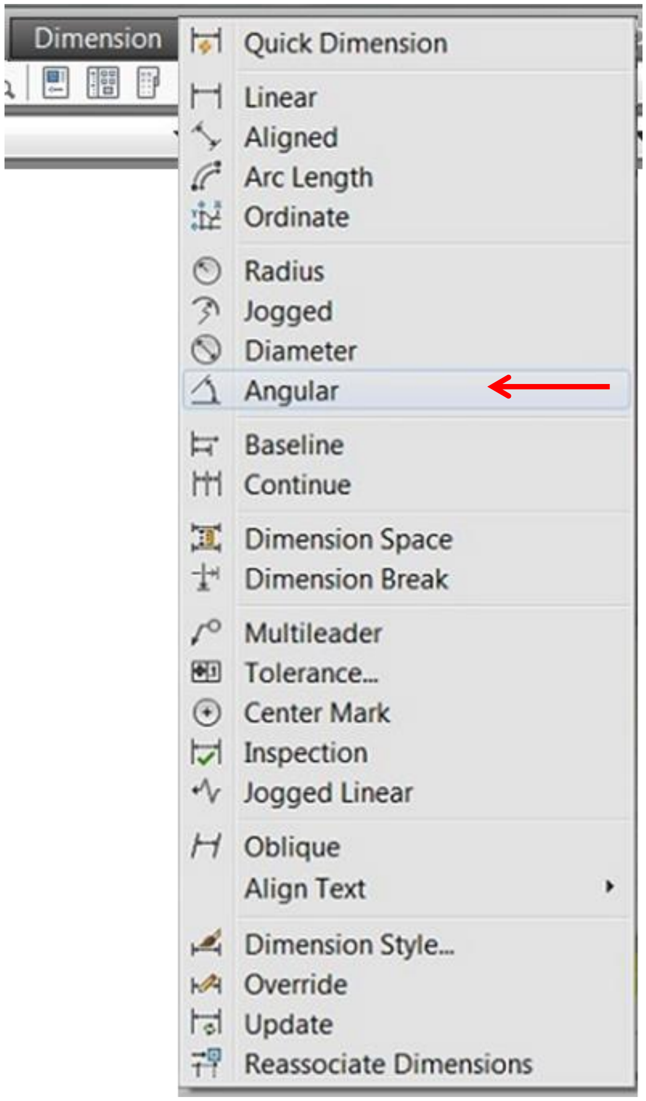


Fig. (21f): Processing of measurements in AutoCAD 2013 v19 program (Angles measurements).

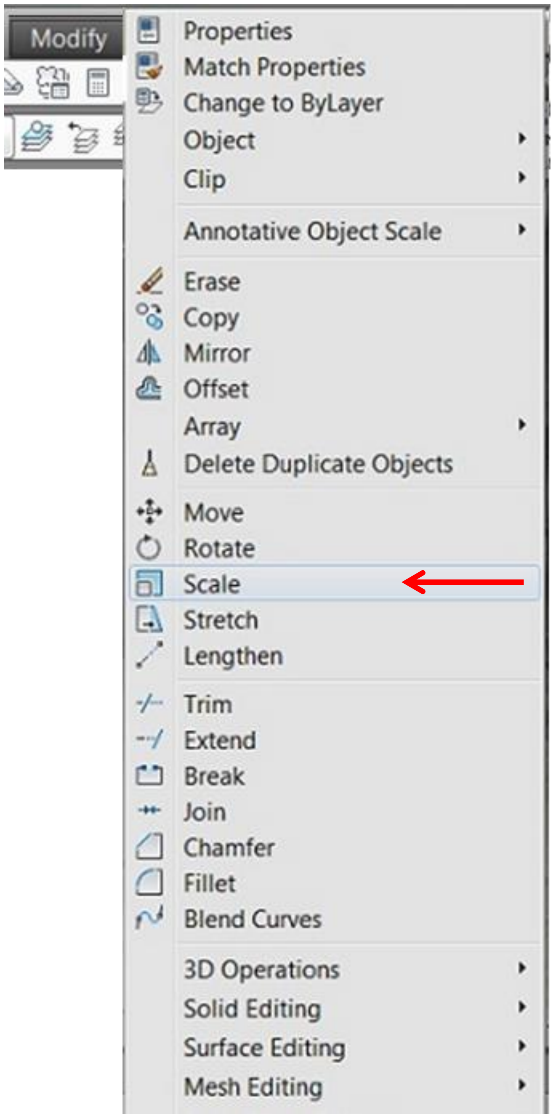


Fig. (21g): Processing of measurements in AutoCAD 2013 v19 program (Scaling).

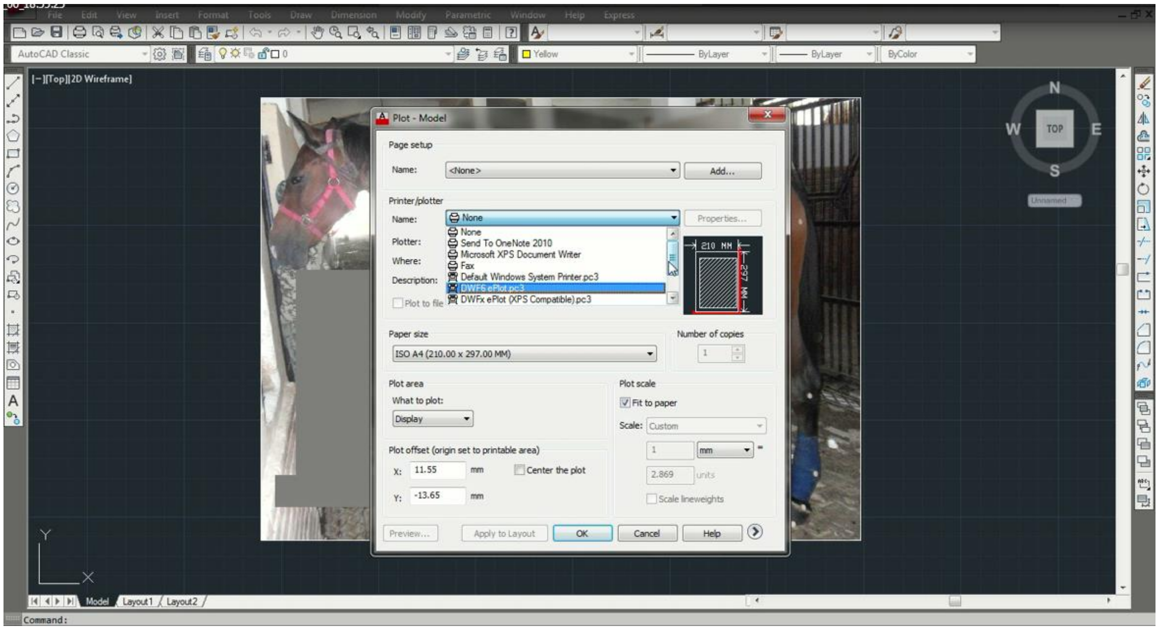


Fig. (21h): Processing of measurements in AutoCAD 2013 v19 program (Saving) (Ctrl+P).

Calculation of angles of joints on X-ray images by software AutoCAD 2013:

Import the image into the desktop of the program. Click DRAW and choose CIRCLE then 2POINTS. Make 3 or 4 circles between the lateral and medial cortices of the superior bone of the joint and the inferior one then attach all center point of each circle in each bone separate to form the center axis of each bone. Click DIMENSION and choose ANGULAR to measure the formed angle between the center axes (Figure 22).

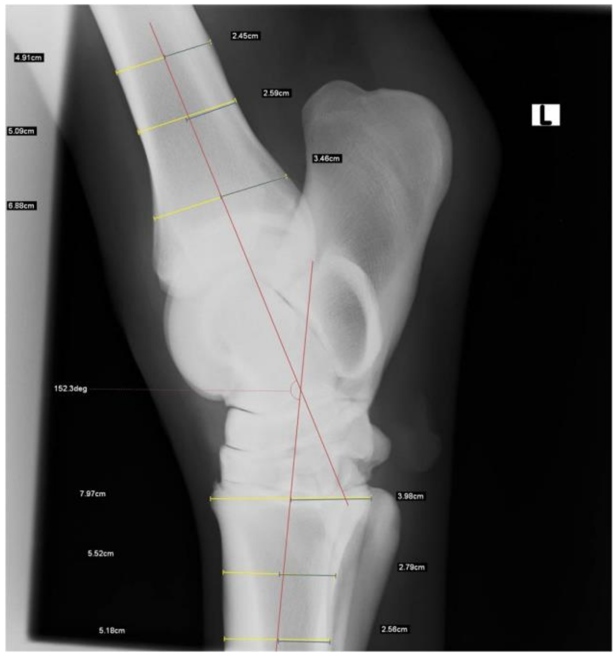


Fig. (22): Measurement of tarsal joint angle by Computed Radiography.

Lameness examination:

After subjective and objective conformation evaluations were completed, the horses subjected to the routine or traditional lameness examination. This examination included taking complete history about the management procedures, the training courses, the jumping competitions attended by the horse and if the horse was lamed or not.

Visual exam of the horse at rest and in motion (usually at a straight walk and trot/lope followed by circling) was done. Palpation of the musculoskeletal system including hoof tester examination of the feet was the next step. Manipulative tests such as flexion test and diagnostic anesthesia (if necessary) then carried out. Diagnostic imaging was the final step according to **Anderson et al. (2004) and Baxter and Stashak (2011).**

Computed radiographic examination of three joints; carpus, fetlock and tarsal joints in each horse was done in order to examine these joints for radiographic changes and also measure the lateral angle of these joints and the frontal angle of carpus and fetlock joints using the options available in this apparatus.

Views taken for musculoskeletal evaluation were medio-lateral, anterio-posterior, cranio-palmar, cranio-planter views using computed radiography unit that consisted of: image reader (FUJIFILM FCR CAPSULA X Image Reader (Model: CR-IR 357), Tokyo, Japan), image plate cassette (FUJIFILM), and specified attached printer.

Performance assessment in jumping thoroughbred:

Performance in jumping competitions from 2012-2013 were recorded according to Egyptian Equestrian Federation Rules for jumping, 2012/2013. Accordingly these jumping horses were classified into five categories according to Egyptian Federation rules for jumping (Table 3).

Table (3): Egyptian Equestrian Federation Rules for jumping (2012/2013).

Rules / Classes	Obstacle height	No. of obstacles	Compound obstacles	Speed
First class (A1 & A2)	135-155 cm	10-12 obstacles (13-16 jumps)	Triple and paired obstacles or two paired obstacles	350 m/min.
Second class	130-135 cm	10-12 obstacles (13-16 jumps)	Triple and paired obstacles or two paired obstacles	350 m/min.
Third class	120-125 cm	10-12 obstacles (13-15 jumps)	Triple and paired obstacles	350 m/min.
Fourth class	110-115 cm	10-12 obstacles (13-15 jumps)	Triple and paired obstacles	350 m/min.
Fifth class	105 cm	Up to 10 obstacles (11 jumps)	Paired obstacles	325 m/min.
Sixth class	100 cm	Up to 10 obstacles (11 jumps)	Paired obstacles	300 m/min.

Statistical analysis:

The collected data were subjected to descriptive and analytical statistics. Mean, median, standard deviation, coefficient of variation, quartiles and one way ANOVA test using **IBM SPSS Statistics (2013) v20 program.** According to **Petrie and Watson (2006),** the coefficient of variation (CV) defined as a standardized measure of dispersion of a probability distribution or frequency distribution. In addition, it is defined as the ratio of the standard deviation (σ) to the mean (μ).The absolute value of the CV is sometimes known as relative standard deviation (RSD), which is expressed as a percentage (**Petrie and Watson, 2006 and Weller et al., 2006)**.

Results

I-1) Length measurements (Lateral view) (Fig. 23 and 26):

Neck lengths were measured from point of poll to point of withers. Mean of neck lengths were 100.69 cm (SD ± 8.45 cm). Twenty five percent (25%) of horses had neck length lower than 94 cm till 85 cm. Twenty five percent horses had neck length higher than 104 cm till 125 cm. Amount of variation of neck length within the population of the study was 40% (Table 4).

Back length were measured from point of wither to point of croup. Mean back lengths were 92.47 cm (SD ± 5.66 cm). Twenty five percent of horses had back length lower than 89 cm till 82 cm. Twenty five percent of horses had back length higher than 95 cm till 110 cm. Amount of variation of back length was 29%.

I-1-A) ***The forelimb lengths (Table 4):***

Shoulder lengths were measured from point of withers to point of shoulder (lateral view (Fig. 21). Mean shoulder lengths were 69.47 cm (SD ± 5 cm). Twenty five percent of horses had shoulder length lower than 65.25 cm till 59 cm. Twenty five percent had shoulder length higher than 73 cm till 79 cm. Amount of variation of shoulder length in the study was 29% (Table 4). Arm lengths were measured from point of shoulder to point of elbow (lateral view). Mean arm lengths were 34.56 cm (SD ± 2.95 cm). Twenty five (25%) of horses had arm length lower than 32.2 cm till 28.29 cm and 25% of horses had arm length higher than 37.17 cm till 41.3 cm. Amount of variation of arm length was 38%.

Forearm lengths were measured from point of elbow to point of carpus (lateral view). Mean forearm lengths were 46 cm (SD ± 2.4 cm). Twenty five percent of horses had forearm length lower than 44.63 cm till 37.52 cm and 25% of horses had forearm length higher than 47.49 cm till 52.85 cm. Amount of variation of forearm length in the study was 33%. Fore cannon lengths were measured from point of carpus to point of fetlock (lateral view). Mean fore cannon lengths were 28.67 cm (SD ± 2.3 cm). Twenty five percent of horses had fore cannon length lower than 27.14 cm till 23 cm and 25% of horses had fore cannon length higher than 30.4 cm till 32.99 cm. Amount of variation of fore cannon length was 35%.

I-1-B) ***The hind limb lengths (Table 5):***

Pelvis lengths were measured from point of croup to point of hip (lateral view), Mean pelvis lengths were 51.39 cm (SD ± 5.12 cm). Twenty five percent of horses had pelvis length lower than 47.38 cm till 43 cm. Twenty five percent had pelvis length higher than 54.72 cm till 63.43 cm. Amount of variation of pelvis length was 40%.

Thigh lengths were measured from Point of hip to point of stifle (lateral view). Mean thigh lengths were measured from 49.66 cm (SD ± 5.12 cm). Twenty five percent of horses had thigh length lower than 46.19 cm till 38 cm. Twenty five percent had thigh length higher than 54.21 cm till 61.86 cm. Amount of variation of thigh length in the study was 48%. Gaskin lengths were measured from point of stifle to point of tarsus. Means of gaskin lengths were 53.09 cm (SD ± 4.8 cm). Twenty five percent of horses had gaskin length lower than 50.8 cm till 40.5 cm. Twenty five percent of horses had gaskin length 55.9 cm till 62.23 cm. Amount of variation of gaskin length was 41%.

Hind cannon lengths were measured from Point of tarsus to point hind fetlock. Means of hind cannon lengths were 37.44 cm (SD ± 3.67 cm). Twenty five percent of horses had hind cannon length lower than 34.9 cm till 31.21 cm. Twenty five percent of horses had hind cannon length higher than 40.71 cm till 45.81 cm. Amount of variation in hind cannon length was 39%.

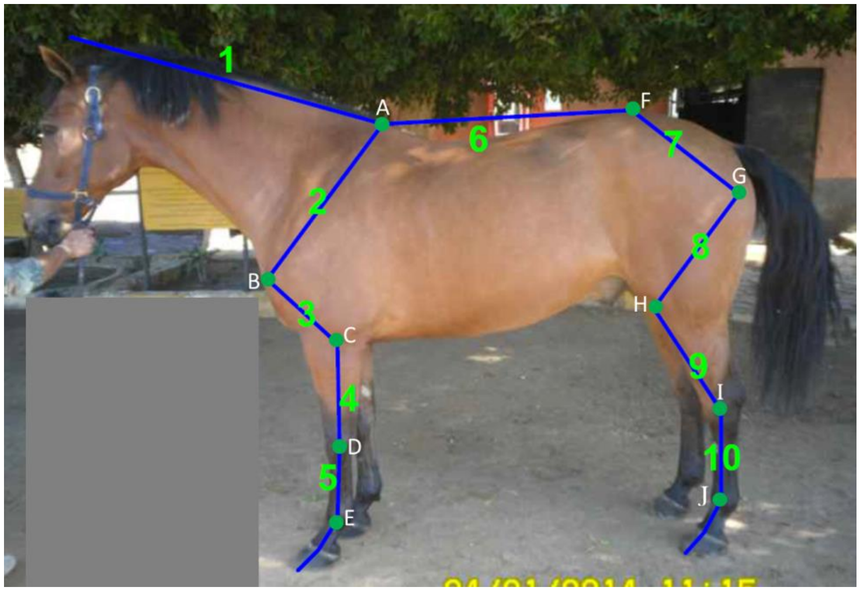


Fig. (23): Reference points and Lengths measured in lateral views in thoroughbred horses. (1: neck length, 2: shoulder length, 3: Arm length, 4: fore - arm length, 5: fore cannon length, 6: back length, 7: pelvis length, 8: thigh length, 9: gaskin length, 10: hind cannon length, A: point of wither, B: 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 (after Anderson et al., 2004)).

I-2- Length Measurements (front view):

Breast width was measured from point of right shoulder to point of left shoulder. Means of front breast width were 51.2 cm (SD ± 5.6 cm). Twenty five percent of horses had front breast width lower than 47.9 cm till 35.7 cm. Twenty five percent of horses had front breast width higher than 55.3 cm till 65 cm. Amount of variation of front breast width was 57%.

Arm front lengths were measured from point of shoulder joint front to point of elbow joint. Mean arm front lengths were 32.45 cm. Twenty five percent of horses had front arm length lower than 30 cm till 20.43 cm. Twenty five percent of horses had arm front length higher than 34.48 cm till 42.81 cm. Amount of variation of arm front length was 69%.

Fore arm front lengths were measured from point of elbow joint front to point of carpus joint front. Mean fore arm front lengths were 48.98 cm. Twenty five percent of horses had arm front length lower than 47.47 cm till 40.98 cm. Twenty five percent of horses had arm front length higher than 50.26 cm till 55.37 cm. Amount of variation of arm front length was 29%.

Fore cannon front lengths were measured from point of carpus joint front to point of fetlock joint front. Mean fore cannon front lengths were 28.19 cm (SD± 2.3 cm). Twenty five percent of horses had fore cannon front length lower than 27.59 cm till 22.36 cm and 25% of horses had fore cannon front length higher than 29.19 cm till 33.77 cm. Amount of variation of fore cannon front length was 40% (Table 4, Fig. 25).

Table (4): Descriptive statistics of fore limb lengths in 51 jumping thoroughbred horses.

Lengths	Mean± SD	Median	Range	Coefficient of variation	Minimum	Maximum	Percentiles		
							25	50	75
Back	92.47± 5.6	92.00	27.20	29	82.80	110.0	89.00	92.00	95.00
Neck	100.6± 8.4	100.4	40.00	40	85.00	125.0	94.00	100.4	104.0
Shoulder lateral	69.47± 5.01	69.24	20.00	29	59.00	79.00	65.25	69.24	73.10
Arm lateral	34.56± 2.9	34.54	13.01	38	28.29	41.30	32.28	34.54	37.17
Forearm lateral	46.02± 2.4	45.99	15.33	33	37.52	52.85	44.63	45.99	47.49
Fore cannon lateral	28.67± 2.3	28.98	9.98	35	23.01	32.99	27.14	28.98	30.41
Breast width	51.20± 5.6	51.610	29.30	57	35.70	65.00	47.930	51.610	55.31
Arm front	32.45± 5.09	32.40	22.38	69	20.43	42.81	30.11	32.40	34.48
Forearm front	48.98± 2.7	49.49	14.39	29	40.98	55.37	47.47	49.49	50.26
Fore cannon front	28.19± 2.3	28.55	11.41	40	22.36	33.77	27.59	28.55	29.19

Table (5): Descriptive statistics of the hind limb lengths in 51 jumping thoroughbred horses.

Lengths (lateral)	Mean± SD	Median	Range	Coefficient of variation	Minimum	Maximum	Percentiles		
							25	50	75
Pelvis	51.39±5.1	50.46	20.38	40	43.05	63.43	47.38	50.46	54.72
Thigh	49.66±5.2	49.65	23.86	48	38.00	61.86	46.19	49.65	54.21
Gaskin	53.09±4.8	52.25	21.73	41	40.50	62.23	50.80	52.25	55.93
Hind cannon	37.44±3.6	36.47	14.60	39	31.21	45.81	34.94	36.47	40.71

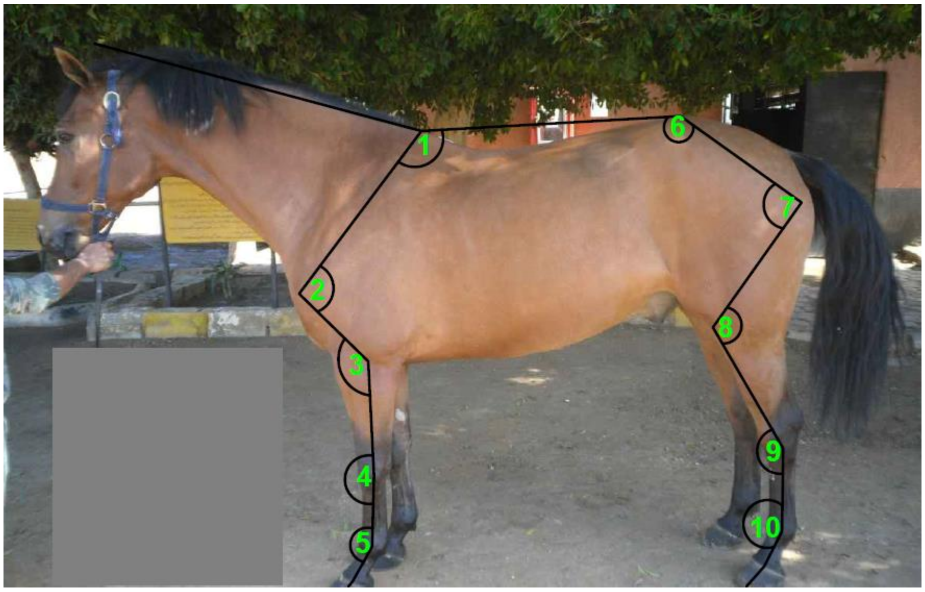


Fig. (24): Angles measured in lateral views in thoroughbred horses. (1: angle between shoulder and back, 2: shoulder joint angle, 3: elbow joint angle, 4: carpus joint angle, 5: fore fetlock joint angle, 6: croup angle, 7: hip joint angle, 8: stifle joint angle, 9: tarsal joint angle, 10: hind fetlock joint angle (after Hölmstrom, 2001)).

II- Joint angles measurements **(Fig. 24, 25 and 27):**

II-1- Measurement of joint angles (Lateral view) (Table 6 and 7):

Shoulder joint lateral angles were measured between shoulder length and arm length. Mean shoulder joint angles were 99° (SD ± 3.74°). Twenty five percent of horses had angles lower than 96° till 91° and 25% of horses higher than 102° till 105° .

Elbow joint angle were measured between arm length and fore arm length. Mean elbow joint angles were 138.37 (SD ± 4.7°). Twenty five percent of horses had angles lower than 136 ° till 126° and 25% of horses higher than 142 ° till 147 °. Carpus joint angle measured between fore arm length and fore cannon length. Mean carpus joint angles were 138.37(SD ± 2.32°). Twenty five percent of horses had angles lower than 177° till 171° and 25% of horses higher than 179° till 180° . Fetlock joint angle measured between fore cannon length and pastern length. Mean fetlock joint angles were 142.73° (SD ± 6°). Twenty five percent of horses had angles lower than 139 ° till 127° and 25% of horses higher than 146 ° till 158 ° (Table 6).

Table (7) showed croup angles were measured between back length and pelvis length. Mean croup angles were 144.63° (SD ± 4.8°). Twenty five percent of horses had angles lower than 142° till 133° and 25% of horses higher than 149° till 157°. The hip joint angles were measured between pelvis length and thigh length. Mean hip angles were 89° (SD ± 8.34°). Twenty five percent of horses had angles lower than 83° till 75° and 25% of horses higher than 92° till 114°.

Stifle joint angles were measured between thigh length and gaskin length. Mean stifle joint angles were 114.94° (SD ± 13°). Twenty five percent of horses had angles lower than 106° till 93° and 25% of horses higher than 119° till 151°. Hock joint angles were measured between gaskin length and hind cannon length. Mean hock joint angles were 148.59° (SD ± 5.3°). Twenty five percent of horses had angles lower than 146 ° till 135° and 25% of horses higher than 152° till 161°.

Hind fetlock joint angles were measured between hind cannon length and hind pastern length. Mean hind fetlock joint angles were 149.84° (SD ± 8°). Twenty five percent of horses had angles lower than 143° till 132° and 25% of horses higher than 155° till 164° (Table 7).

II-2- Measurements of joint angles (Front view) (Table 6, Fig. 25):

Right dorsal shoulder joint angles were measured between breast width and right arm length. Mean right dorsal shoulder joint angles were 74.31° (SD ± 3°). Twenty five percent of horses had angles lower than 72° till 66° and 25% of horses higher than 77° till 80°. Left dorsal shoulder joint angles were measured between breast width and left arm length. Mean left dorsal shoulder joint angles were 74.08° (SD ± 3°). Twenty five percent of horses had angles lower than 73° till 66° and 25% of horses higher than 76° till 80°.

Right and left dorsal elbow joint angles were measured between right and left arm length and right and left fore arm lengths respectively. Mean right dorsal elbow joint angles were 168.27° (SD ± 4°). Twenty five percent of horses had angles lower than 165° till 160° and 25% of horses higher than 171° till 179°. Right dorsal carpus joint angles were measured between right fore - arm length and right fore- cannon length. Mean right dorsal carpus joint angles were 176.47° (SD ± 2.4°). Twenty five percent of horses had angles lower than 175° till 171° and 25% of horses higher than 178° till 180°.

Left dorsal carpus joint angles were measured between left fore - arm length and left fore cannon length. Mean right dorsal carpus joint angles were 176.45° (SD ± 2.2°). Twenty five percent of horses had angles lower than 175° till 171° and 25% of horses higher than 178° till 180°. Right dorsal fetlock joint angles were measured between right fore cannon lengths and right fore pastern lengths. Mean right dorsal fetlock joint angles were 173.53° (SD ± 4.8°). Twenty five percent of horses had angles lower than 169° till 162° and 25% of horses higher than 178° till 180°.

Left dorsal fetlock joint angles were measured between left fore cannon lengths and left fore pastern lengths. Mean left dorsal fetlock joint angles were 174.61° (SD ± 4.4°). Twenty five percent of horses had angles lower than 171° till 164° and 25% of horses higher than 178° till 180°.

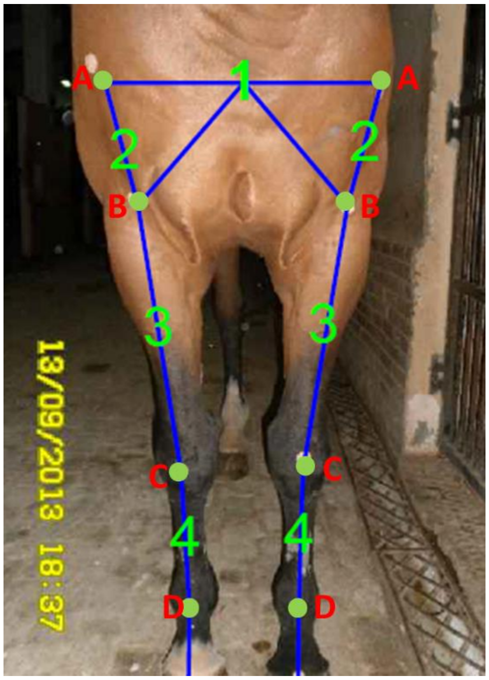


Fig. (25): Reference points, lengths and angles from dorsal view. (A: shoulder joint, B: elbow joint, C: carpus joint, D: fore fetlock joint, 1: Breast width, 2: arm length, 3: fore - arm length, 4: fore cannon length (after Anderson et al., 2004)).

Table (6): Descriptive statistics of the forelimb angles in 51 jumping thoroughbred horses.

Parameters/angle	Mean ± SD	Median	Minimum	Maximum	Percentiles		
					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	138.3±4.70	139.0	126	147	136	139	142
Elbow joint dorsal	168.2±4.00	168.0	160	179	165	168	171
Carpus joint lateral	177.7±2.32	179.0	171	180	177	179	179
Carpus joint dorsal	176.4±2.42	177.0	171	180	175	177	178
Fetlock joint lateral	142.7±6.07	142.0	127	158	139	142	146
Fetlock joint dorsal	173.5±4.83	174.0	162	180	169	174	178

Table (7): Descriptive statistics of the hind limb angles in 51 jumping thoroughbred horses.

Parameters (lateral angles)	Mean± SD	Median	Minimum	Maximum	Percentiles		
					25	50	75
Hock	148.5±5.30	148.0	135	161	146	148	152
Croup	144.6±4.84	144.0	133	157	142	144	149
Hip joint	89.00±8.34	88.00	75	114	83	88	92
Stifle	114.9±13.06	113.0	93	151	106	113	119
Hind fetlock	149.8±8.011	150.0	132	164	143	150	155

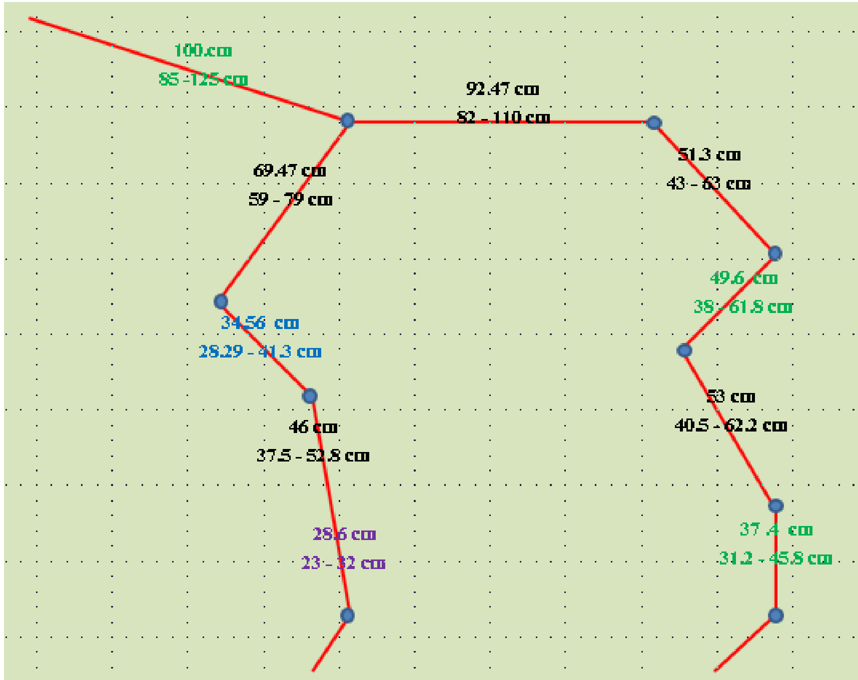


Fig. (26): Stick figure of the lateral view of the left side of the horse with the mean values for length measurements (minimum and maximum) of jumping thoroughbred horses

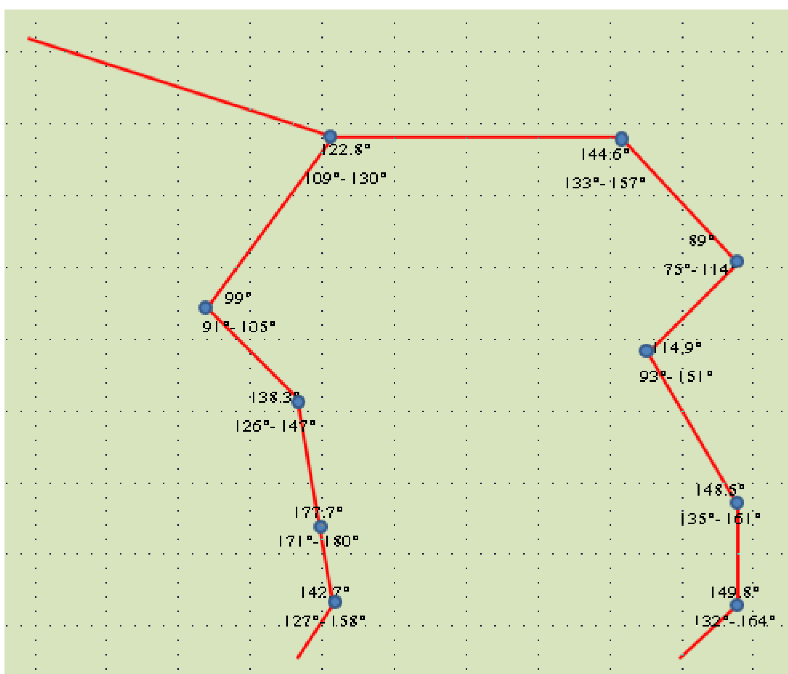


Fig. (27): Stick figures of the lateral view of fore limb and hind limb of jumping thoroughbred horses with the mean lateral angles (minimum and maximum).

III- Measurements of joint angles on computed radiography:

Measurements of joint angles on computed radiography and AutoCAD 2013 program. There was no significant difference between in joint angles measured on computed radiography and **AutoCAD (2013)** v19 program with that obtained by measuring tape and goniometer.

IV- Abnormal conformations in jumping thoroughbred horses:

Abnormal conformations in 51 jumping thoroughbred horses were recorded (Table 8).

Table (8): Abnormal conformations and their percentage.

Conformational Faults	No. of horses	Percentage (%)
Standing under in front	30	58
Steep shoulder	28	55
Carpus valgus	23	45
Toe out	19	37
Narrow breast	20	37
Short pelvis	16	31
Standing under behind	16	31
Calf knee	16	31
Straight hocks	8	16
Buck knee	7	13.7
Camped out behind	4	8
Sickle hocks	4	8

IV-1- Standing under in front (lateral view) (Table 9, Fig. 28 A&B).

Age revealed highly significance (P< 0.05) differences between groups of horses had ' Standing under in front' conformation and group of horses had 'normal fore limbs' conformation from lateral view. Larger ages (14±2.8 years old) were associated with ' Standing under in front' conformation and smaller ages (11.7±3.5 years old) were associated with 'normal fore limbs' conformations. Arm lateral length and hind cannon lengths showed significant (P< 0.05) increased in comparison with normal horses and represented 35.8 ±2.7 cm and 37.8±3.5 cm consequently.

Standing under in front displayed significant (P<0.05) increase in elbow joint lateral angle and significant (P<0.05) decrease in fetlock joint angles and represented 139°±3.7° and 140°±5.6° respectively in compare with normal horse.

Table (9): Mean lengths, angles and age in normal horses and those with standing under in front.

Lengths	**Normal fore limb (front)** Mean ± SD	**Standing under in front** Mean ± SD
Arm	33±2.6	35.8±2.7*
Shoulder length	69±3.5	70±5.3
Fore arm	45±2.3	46±2.5
Fore cannon	27.5±2.7	28.7±2.1
Hind cannon	34.85±2.6	37.85±3.5
Angles (°)	Mean ± SD	Mean ± SD
Shoulder (lateral)	98±3.8	99±3.4
Elbow (lateral)	136±4.3	139±3.7*
Fore fetlock (lateral)	143±3.8	140±5.6*
Age	11.7±3.5	14±2.8*

*Means presence of significant difference between the two groups (P< 0.05).

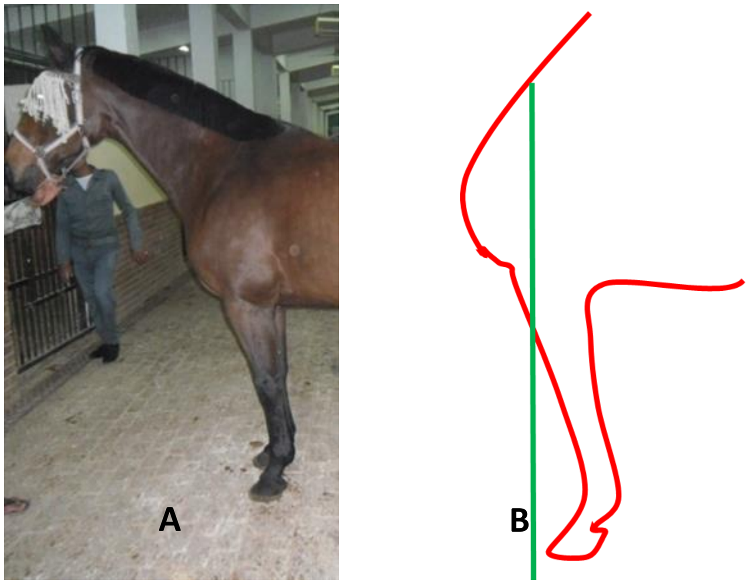


Fig. (28): Jumper showed standing under in front conformation (A&B).

IV-2- Steep shoulder (Figure 29 A&B).

The measured angles and lengths in the horses (Table 10) had Steep shoulder. Steep shoulder displayed significant ($P<0.05$) increased in shoulder joint lateral angle and represented 100° ± 3° in compare with normal horse. Fore arm front length revealed significant ($P< 0.05$) decreased in comparison with normal horses and represented 46.5±2.5 cm.

Table (10): Mean of lengths and angles in sloppy shoulder and steep shoulder.

angles(°) and Lengths (cm)	Sloppy shoulder (Mean ± SD)	Steep shoulder (Mean ± SD)
Shoulder joint lateral angle	97±3.8	100±3*
Elbow joint lateral angle	137±5	139.4±3.5
Shoulder lateral length	69±5.8	69.92±4.19
Arm lateral length	34±2.8	34.89±2.8
Fore arm front length	48.3±2.9	46.5±2.5*

*Means presence of significant difference between the two groups ($P< 0.05$).

Fig. (29): Jumper showed steep shoulder conformation (lateral view) (A&B).

IV-3- Carpus valgus (Figure 30 A&B).

The measured angles and lengths(Table 11) in the horses had carpus valgus revealed significant ($P<0.05$) decreased in right and left carpus joint dorsal angle and represented 174°±2° and 174°±1.3° in compare with normal horses. Fore arm lateral and front lengths showed significant increased ($P<0.05$) in compare with normal horses and represented 48±2.9 cm and 46±2.5 cm respectively.

Table (11): The measured angles and lengths in the normal horses and those with carpus valgus.

Angles(º) and Lengths (cm)	**Normal knee front** (Mean ± SD)	**Carpus valgus** (Mean ± SD)
Right carpus joint dorsal angle	177.8±1.6	174±2*
Left carpus joint dorsal angle	178.5±1	174±1.3*
Fore arm front length	46±2.5	48±2.9*
Fore arm lateral length	44.7±2.4	46±2.5*
Fore cannon lateral length	28.98±2.3	28.15±2.5

*Means presence of significant difference between the two groups ($P< 0.05$).

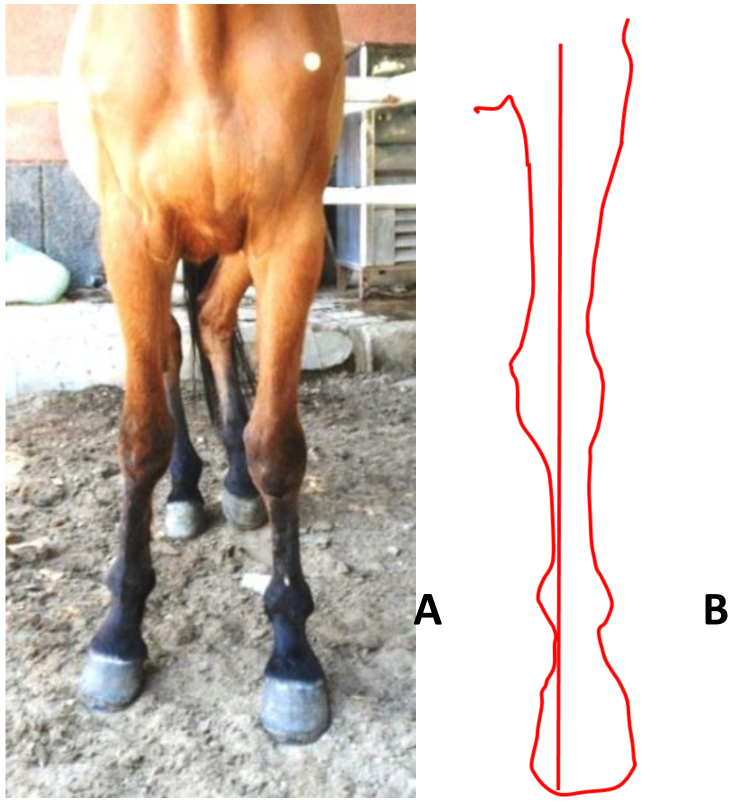


Fig. (30): Jumper showed carpus valgus conformation.

IV-4- Toe out (front view) (Fig. 31).

Table (12) showed the measured angles and lengths in the horses had toe out. Toe out displayed significant ($P<0.05$) decreased in right and left dorsal fore fetlock joint angle and represented 171.5° ± 4.4° and 174° ± 4.4° in compare with normal horses.

Table (12): Fetlock angles and fore cannon lengths in normal horses and those with toe out.

Angles (º) and Length (cm)	**Normal** (Mean ± SD)	**Toe out** (Mean ± SD)
1-Right fetlock joint front angle	178±0.7	171.5±4.4*
2-Leftt fetlock joint front angle	178±0.7	174±4.4*
3-Fore cannon front length	28.57±2.3	29.5±1.5

*Means presence of significant difference between the two groups ($P< 0.05$).

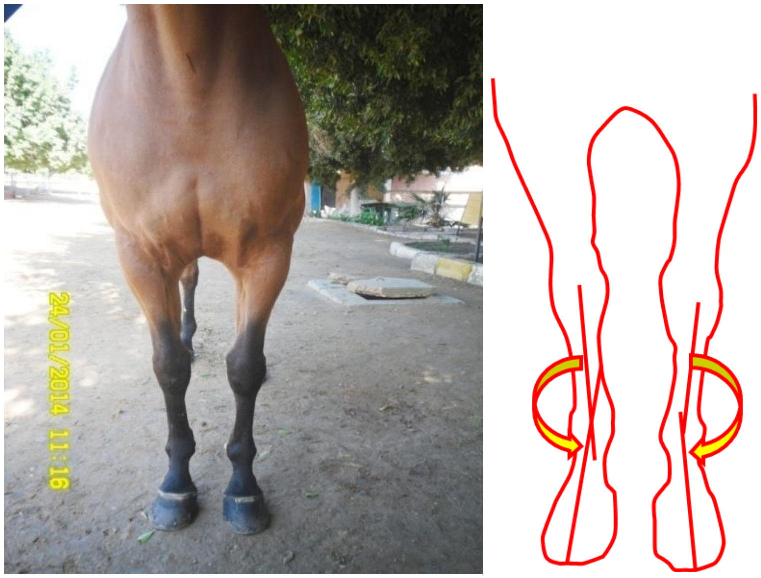


Fig. (31): Jumper showed toe out conformation from front view.

IV-5- Narrow breast (front view) (Fig. 32).

Table (13) showed the measured angles and lengths in the horses had narrow breast. Narrow breast displayed significant ($P<0.05$) increase in right and left dorsal shoulder joint angle and represented 75.5° ± 2.4° and 75.6° ± 2.3° respectively in compare with wide breasted horses. Breast width showed significant decrease in narrow breasted horses ($P<0.05$) and represented 47±5.9 cm.

Table (13): The measured angles and breast width in wide and narrow breasted horses.

	Wide breast (Mean ± SD)	**Narrow breast (Mean ± SD)**
Breast width (cm)	53±3.8	47±5.9*
Right dorsal shoulder joint angle(°)	74±2.5	75.5±2.4*
Left dorsal shoulder joint angle(°)	73.5±2.7	75.6±2.3*

*Means presence of significant difference between the two groups ($P< 0.05$).

Fig. (32): Jumper showed narrow breast conformation.

IV-6- Standing under behind (lateral view) (Fig. 33 A&B).

The measured angles and lengths in the horses had Standing under behind (Table 14). Thigh lateral length and stifle joint lateral angle showed significant increased ($P< 0.05$) in 'standing under behind' group and represented 51 ± 4.2 cm and 119° ±11.6° consequently in compare with normal horse. Gaskin length showed significant decrease ($P< 0.05$) in compare to normal horses and represented 51 ± 4.4 cm.

Table (14): Mean of lengths, angles and age in normal hind limbs and horses with standing under behind.

Lengths(cm)	**Normal hind limbs** Mean ± SD	**Standing under behind** Mean ± SD
1-Pelvis	53±4.7	51±4.4
2-Thigh	47±4.8	51±4.2*
3-Gaskin	56±3.4	51±4.4*
4-Hind cannon	36.5±3.1	36±3.1
Angles(º)	Mean ± SD	Mean ± SD
5-Croup	143±3.8	145±5.8
6-Hip	85±5.8	89±8.4
7-Stifle	105.33±7	119±11.6*
8-Tarsal	147±4.9	148±4.4
9-Hind fetlock	151±8	151±7
10- Age	12.4±2	12±3.8

*Means presence of significant difference between the two groups ($P< 0.05$).

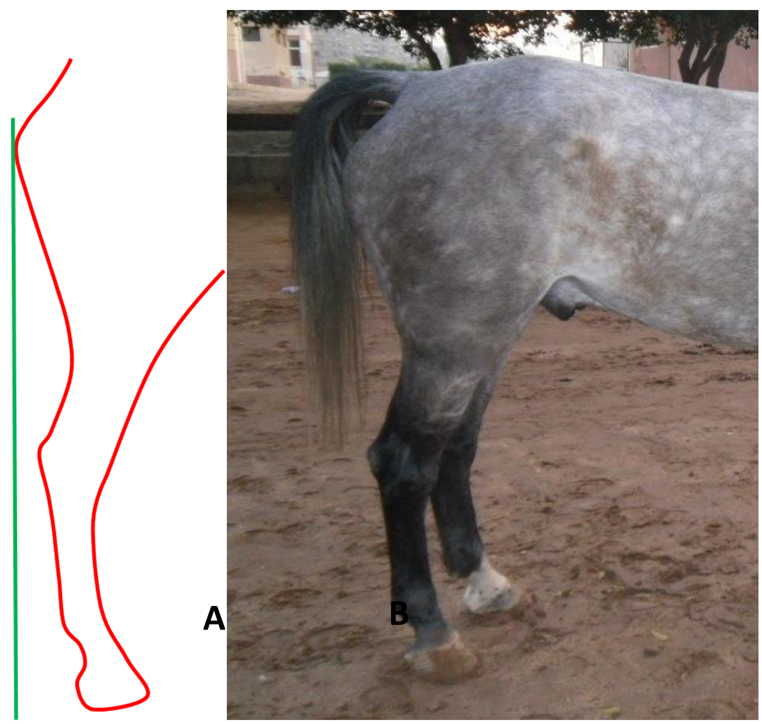


Fig. (33): Jumper showed standing under behind conformation (lateral view**) (A&B).**

IV-7- Calf knee (Backward deviated knees) (Figure 34 A&B).

The measured angles and lengths (Table 15) in the horses with calf knee displayed significant (P<0.05) decreased in carpus joint lateral angle and represented 176.38° ± 2.2° in compare with normal horses.

IV-8- Buck knee (Figure 35 A&B).

The measured angles and lengths (Table 15) in the horses had buck knee displayed significant (P<0.05) decrease in carpus joint lateral angle and represented 181.8°±2.1°. Fore arm front lengths showed significant increase (P<0.05) in compare with normal horses and represented 50±3.1 cm.

Table (15): Carpus, fore arm and fore cannon in normal horses and those with Buck knee and Calf knee.

Conformation	Normal knee lateral	Buck knee	Calf knee
Lengths and angles(º)	Mean ± SD	Mean ± SD	Mean ± SD
Carpus joint lateral angle(º)	178.78±1	181.8±2.1*	176.38±2.2*
Fore arm length(cm)	47.8±2.9	50±3.1*	49±3.2
Fore cannon length(cm)	27±2.3	28±2.9	28.8±2.4

*Means presence of significant difference between the two groups (P< 0.05).

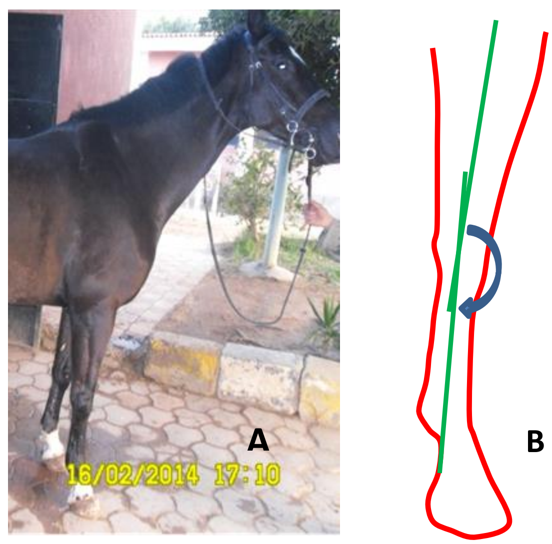


Fig. (34): Jumper showed calf knee conformation (Backward deviated knees) (A&B).

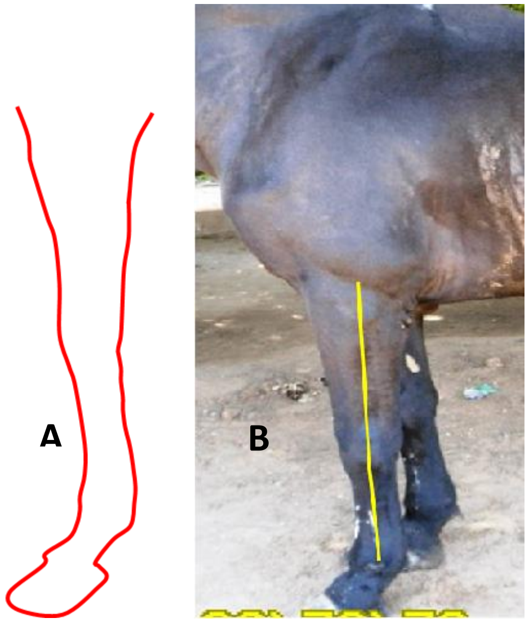


Fig. (35): Jumper showed buck knee conformation (A&B).

IV-9- Camped out behind (lateral view) (Fig. 36).

Table (16) showed the measured angles and lengths in the horses had camped out behind conformation. Age revealed highly significant (P< 0.05) effects between group of horses and ' camped out under behind' conformation and group of horses had 'normal hind limbs' conformation from lateral view.

Larger ages (15±1.9 years old) were associated with ' camped out under behind' conformation and smaller ages (12±2.8 years old) were associated with 'normal fore limbs' conformations. Hind cannon lateral length showed significant (P< 0.05) increased in comparison with normal horses and represented 35.8 ± 2 cm and 41 ± 4 cm consequently (Fig. 28). Camped out under behind displayed significant (P<0.05) increased in hip joint lateral angle and represented 94° ±4.8° in compare with normal horse.

Table (16): Mean lengths, angles and age in normal hind limbs and horses with camped out behind.

Lengths(cm)	Normal hind limbs Mean ± SD	Camped out behind Mean ± SD
Pelvis	54±4.2	58±5.7
Thigh	47±5	51±6.4
Gaskin	56±3.4	53.8±3
Hind cannon	35.8±2	41±4*
Angles(º)	Mean ± SD	Mean ± SD
Croup	141.9±5.5	144±5.8
Hip	85.9±5.7	94±4.8*
Stifle	106±7	111±1.2
Tarsal	148±3.2	148±3.4
Hind fetlock	151±8.4	153±4.9
Age	12±2.8	15±1.9*

*Means presence of significant difference between the two groups ($P < 0.05$).

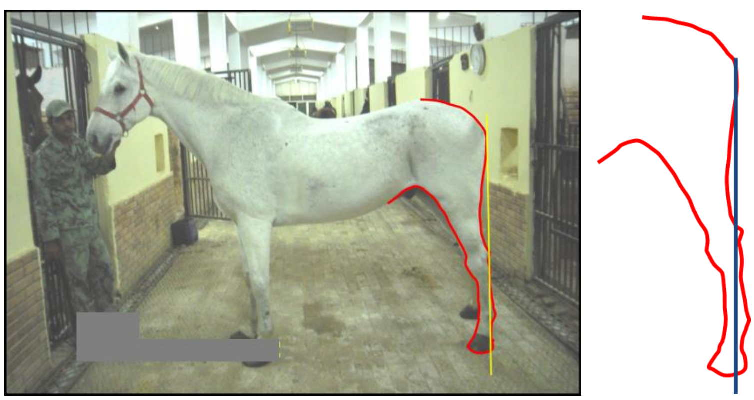


Fig. (36): Jumper showed camped out behind conformation (lateral view).

IV-11- Sickled hocks (Fig. 37):

Table (17) showed the measured angles and lengths in the horses had sickle hocks. Sickle hock displayed mild significant decreased in tarsal joint lateral angle and represented 144° ± 4.8° in compare with normal horses.

IV-12- Straight hocks (Post legged) (Figure 38).

Table (17) showed the measured angles and lengths in the horses had straight hocks revealed that pelvis lateral length and gaskin lateral length showed significant (P< 0.05) decreased in comparison with normal horses and represented 48 ± 4 cm and 48.9±4.9 cm consequently. Straight hocks displayed significant (P<0.05) increased in stifle joint lateral angle and represented 117.8°±11.6° in compare with normal horse.

Table (17): Lengths and angles in normal horses, sickle hocks and straight hocks.

Lengths(cm)	Normal hind limb (Mean ± SD)	Sickle hocks (Mean ± SD)	Straight hocks (Mean ± SD)
Pelvis length	54±4	51.5±4.4	48±4*
Thigh length	47±5	50±8.5	47±5.3
Gaskin length	56±3	57±4	48.9±4.9*
Hind cannon length	35.8±2	37.7±5	37±3.6
Angles(º)	Mean ± SD	Mean ± SD	Mean ± SD
Hip joint angle	85.9±5.7	82.7±2.8	90.5
Stifle joint angle	106±7	103.7±4.3	117.8±11.6*
Tarsal joint angle	148°±3.2°	144°±4.8°*	150.7±4.7
Hind fetlock angle	151±8.4	154.5±5.9	156±6.3

*Means presence of significant difference between the two groups (P< 0.05).

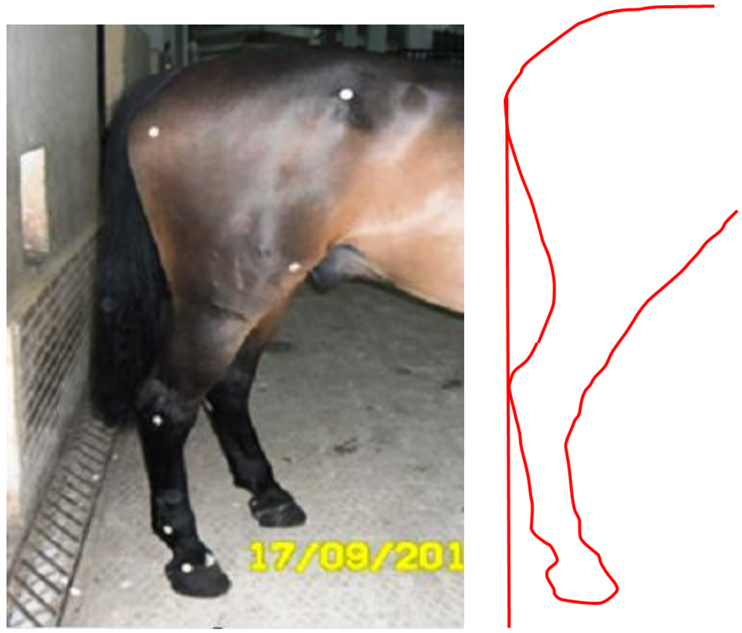


Fig. (37): Jumper showed sickle hock conformation.

Fig. (38): Jumper showed straight hocks (Post legged) conformation from lateral view.

IV-13- Short pelvis (Fig. 39).

Table (18) showed the measured angles and lengths in the horses had short pelvis. Pelvis lateral length showed significant (P< 0.05) decreased in comparison with normal horses and represented 49 ± 4.1cm (Fig. 38 B). Short pelvis displayed significant (P<0.05) increased in croup angle and stifle joint lateral angle and represented 145°± 5.7° and 118°±13° in compare with normal horse.

Table (18): Angles and lengths in horses with long pelvis and those with short pelvis.

Conformation	Long pelvis (Mean ± SD)	Short pelvis (Mean ± SD)
1- Pelvis length (cm)	54± 4	49 ± 4.1*
2-Croup angle(°)	143° ± 5°	145° ± 5.7*
3-Hip joint angle(°)	89.6°± 9°	87.5°± 5.9°
4-Stifle joint angle(°)	110°±9.3°	118°±13*
5-Tarsal joint angle(°)	147°± 3.9°	149°± 5.9°
6-Hind fetlock angle(°)	150°± 6.6°	156°± 7°

*Means presence of significant difference between the two groups (P< 0.05).

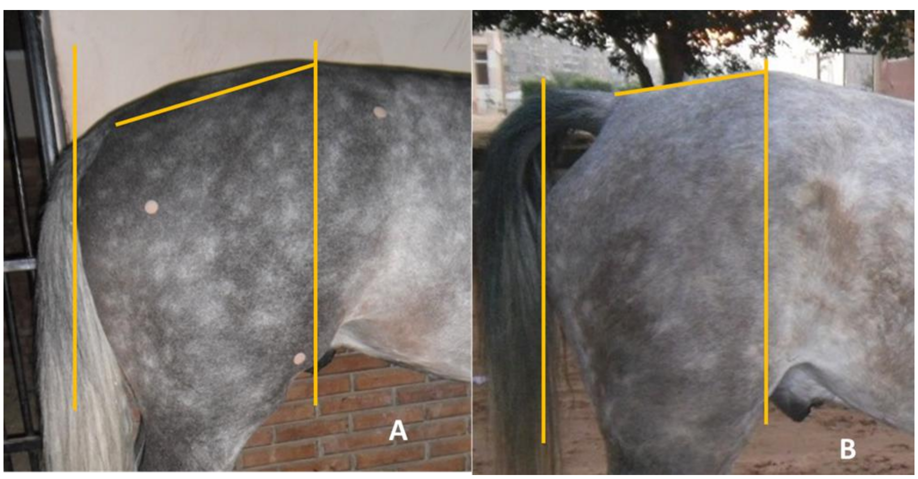


Fig. (39): Long (A) and short (B) pelvis from lateral view.

IV-14- Upright pastern (Figure 40 A&B).

The measured angles and lengths (Table 19) in the horses had upright pastern displayed significant ($P<0.05$) increased in fetlock joint lateral angle and represented 145°±2.5° in compare with wide breasted horses.

Table (19): Fetlock angles and fore cannon lengths in the horses had upright pastern.

Lengths and angles	**Normal fetlock (Mean ± SD)**	**Upright pastern (Mean** ± SD)
1-Fetlock joint lateral angle(º)	138.5±5.2	145±2.5*
2-Fore cannon lateral length(cm)	28±2.5	29±2.3
3-Fore cannon front length (cm)	27.9±2.3	27.4

*means presence of significant difference between the two groups ($P< 0.05$).

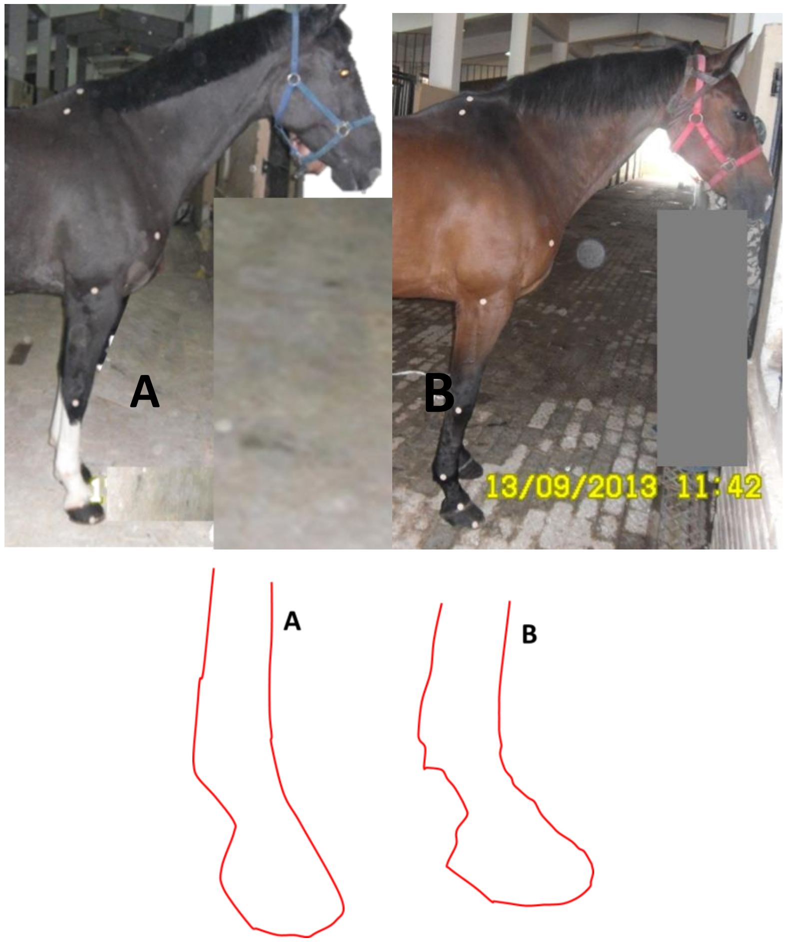
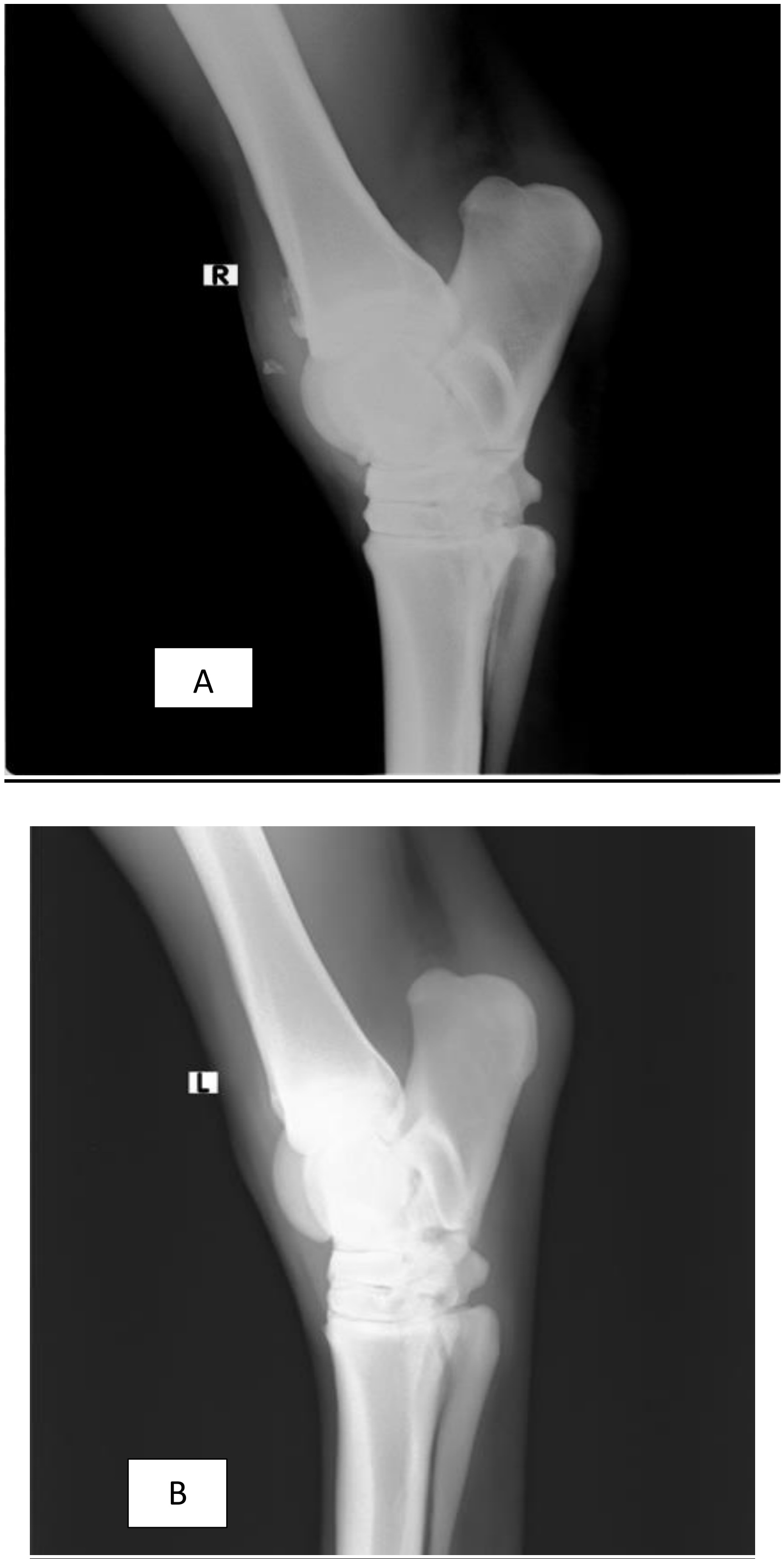


Fig. (40): Two jumpers showed upright pastern conformation (A) and normal fetlock (B).

<u>V- Musculoskeletal disorders in jumping thoroughbred horses (Figures 41-46).</u>

During this study, Clinical examination of 51 jumping thoroughbred horses revealed that 17 clinically normal horses (33%) and 34 had musculoskeletal disorders (67%).The diseased horses revealed 8 horses suffered from ligaments and tendons affections, 20 horses suffered bone and joints affections and 7 horses suffered both affections .



<u>Fig (41)</u>: bone spavin (notice narrowing of tarsal joints and enthesophytes formation A and B).

<u>Fig (42)</u>: high ringbone (osteoarthritic changes in pastern joint).

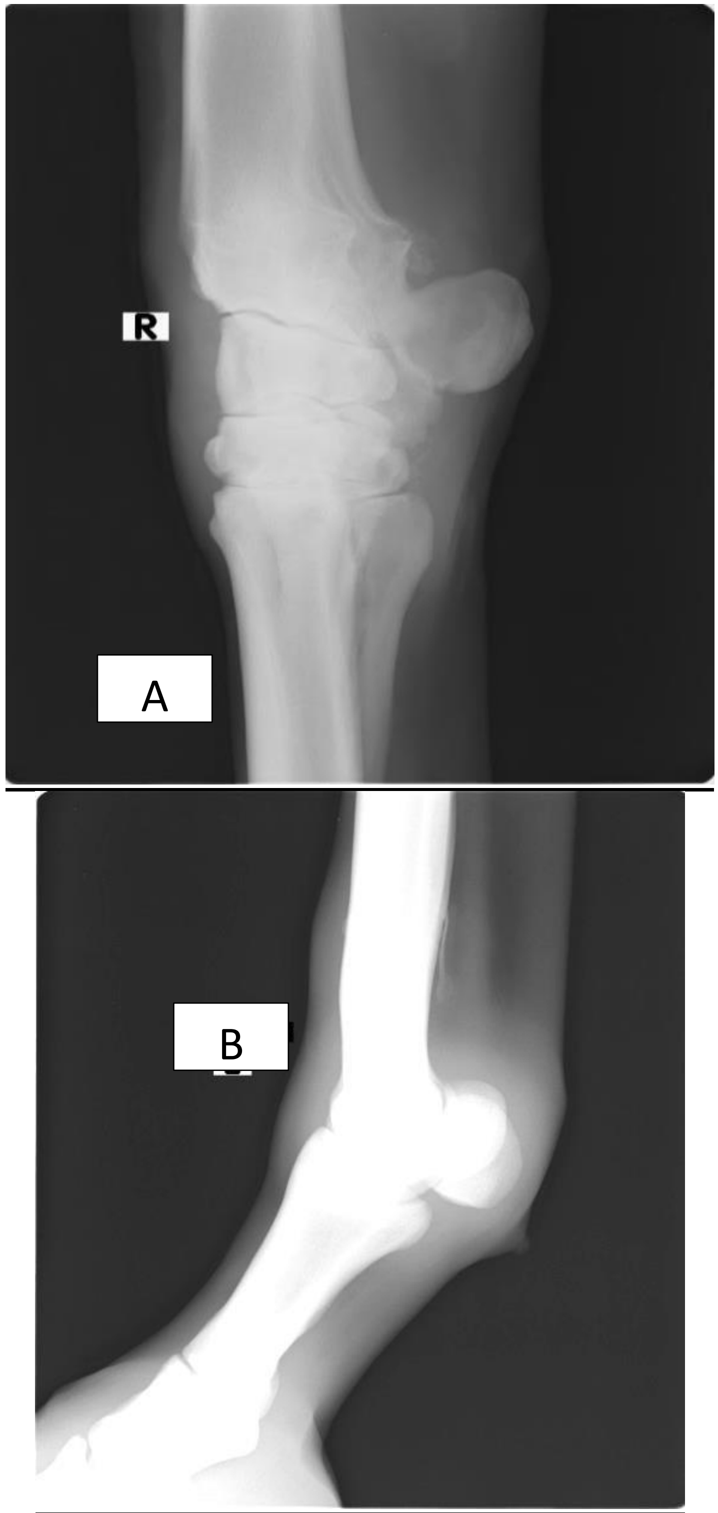


Fig. (43): Osteophyte formation at palmar aspect of distal radius in (A) and suspensory and annular desmitis and synovitis of fetlock joint (B).

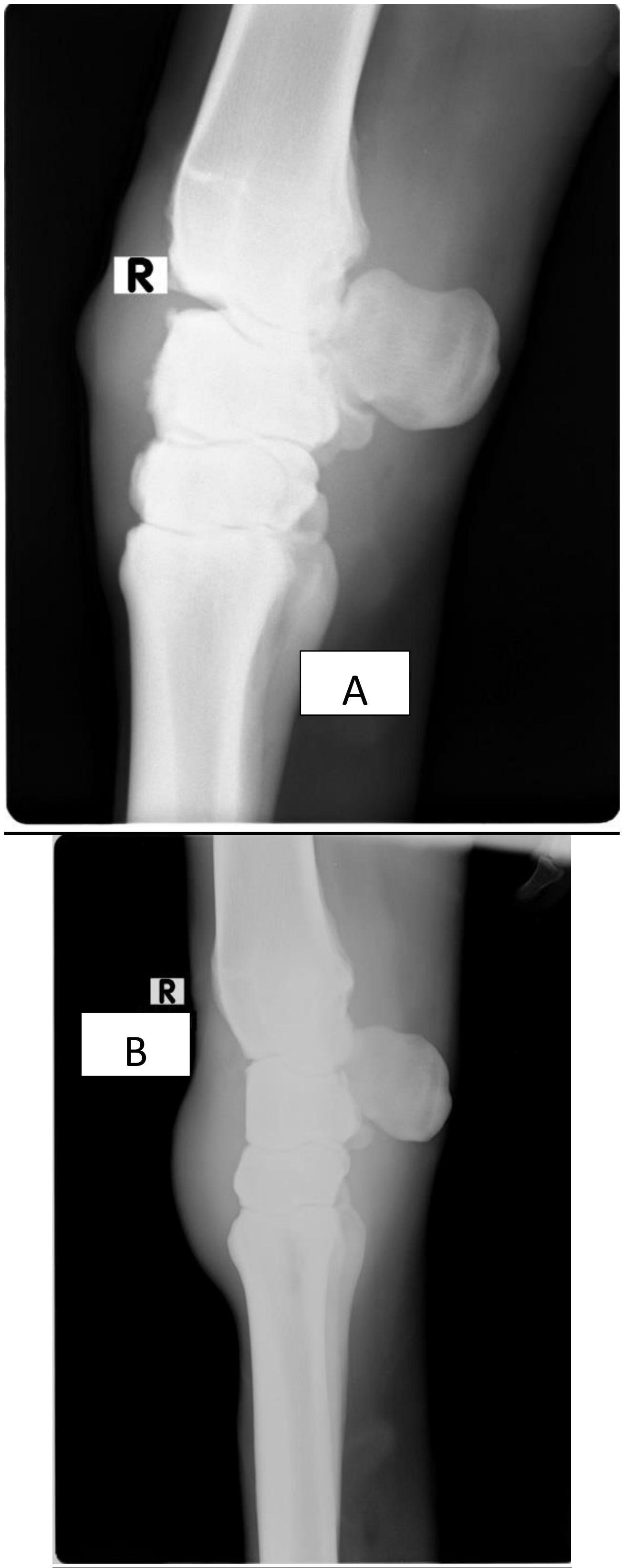


Fig (44): Carpitis (osteoarthritic changes in carpal joints)

Fig (45): chronic tendinitis (with calcification)

Fig (46): False ring bone with synovitis of fetlock joint.

V-1- Measurements of lengths in musculoskeletal disorders:

Table (20) showed that Thoroughbred jumping horses affected with ligaments and tendons disorders (group 2) revealed that lateral neck length highly significant (P< 0.05) decreased and represented 99.01 ± 2.04 cm. Group of horses affected with bone and joints disorders (group 3) showed highly significant (P< 0.05) increased in ages, front arm and neck lengths and represented 15.36 ± .73 years old, 33.8 ± 1.14 cm and 98.72 ± 1.8 cm consequently. Group of horses had both ligaments, tendons and bone and joints disorders (group 4) revealed that front fore arm length showed significant (P< 0.05) increased and represented 50.67 ± 1.07 cm. Lateral neck length, lateral shoulder length and lateral pelvis length showed highly significant (P< 0.05) decreased and represented 97.68 ± 2.65 cm, 66.48 ± 1.82 cm and 48.96 ± .96 cm (Table 20).

Statistical analysis between Musculoskeletal disorders in jumping thoroughbred horses (Diseased groups) and clinically normal horses (group 1) revealed that the lateral neck length, lateral shoulder length and lateral pelvis length showed highly significant (P< 0.05) decreased and represented 98.57 ±1.21 cm, 68.57 ±.79 cm and 50.37 ±.76 cm respectively. Front fore arm length showed significant (P< 0.05) increased and represented 49.50 ±.42 cm.

Table (20): Statistical analysis of lengths between clinically normal horses and musculoskeletal disorders in jumping thoroughbred horses in fore and hind limbs.

Lengths (cm)	**Group 1 (17) (Mean ± S.E)**	**Group 2 (8) (Mean ± S.E)**	**Group 3 (19) (Mean ± S.E)**	**Group 4 (7) (Mean ± S.E)**	**Diseased (34) (Mean ± S.E)**
Age	12.82 ±.78	12.8 ± 1.05	15.36 ± .73*	12.5 ± 1.06	14.20 ±.56
Back	93.10 ±1.77	91.4 ± 2.52	91.7 ± .82	94 ± 1.64	92.15 ±.80
Neck	105.48 ±2.18	99.01 ± 2.04*	98.72 ± 1.8*	97.68 ± 2.65*	98.57 ±1.21*
Shoulder	71.33 ±1.28	69 ± 1.11	69.15 ± 1.17	66.48 ± 1.82*	68.57 ±.79*
Arm lateral	35.16 ±.76	34.6 ± 1.39	34.46 ± .59	33.52 ± .76	34.30 ±.48
Forearm lateral	45.50 ±.75	46.4 ± 1.05	46.34 ± .40	46.33 ± .47	46.36 ±.33
Fore cannon lateral	28.82 ±.56	28.38 ± 0.58	28.82 ± .62	28.48 ± .78	28.65 ±.39
Breast width	50.78 ±1.21	51.67 ± 1.75	51.65 ± 1.41	50.47 ± 2.66	51.41 ±1.019
Arm front	30.88 ±1.07	33.11 ± 2.66	33.8 ± 1.14*	31.7 ± 1.1	33.24 ±.90
Forearm front	47.94 ±.72	49.13 ± 1.06	49.22 ± .48	50.67 ± 1.07*	49.50 ±.42*
Fore cannon front	28.01 ±.62	27.52 ± 0.82	28.37 ± .51	28.9 ± .91	28.28 ±.39
Pelvis	52.99 ±1.42	51.6 ± 2.05	50.35 ± 1.026	48.96 ± .96*	50.37 ±.76*
Thigh	49.78 ±1.56	48.79 ± 2.17	49.13 ± .99	51.037 ± 1.19	49.44 ±.78
Gaskin	53.86 ±1.37	53.36 ± 1.37	53.49 ± 1.05	50.79 ± 1.5	52.90 ±.74
Hind cannon	37.42 ±.9	38.31 ± 1.46	37.38 ± .88	36.69 ± 1.13	37.46 ±.63

*Means presence of significant difference between the two groups (P< 0.05).

V- 2- Measurements of angles in musculoskeletal disorders.

There was no significant difference in musculoskeletal disorders in joint angles between clinically normal horses and group of horses affected with tendon and ligaments and group of horses affected with bone and joints. Group of horses affected with both ligament; tendons; joints and bone disorders revealed significant ($P < 0.05$) decreased in left dorsal elbow joint angles and hind fetlock joint angles and represented 166.14° ± 0.96° and 144.71° ± 3.13° respectively (Table 21).

Statistical analysis between Musculoskeletal disorders in jumping thoroughbred horses and clinically normal horses (Table 21) revealed that right dorsal shoulder joint angles, left dorsal elbow joint angle and lateral carpus joint angles showed highly significant ($P < 0.05$) decreased and represented 73.8° ± .54°, 167.47° ± .67° and 175.20° ± .53° respectively.

Table (21): Statistical analysis in clinically normal group (group 1) and group of horses suffered ligaments, tendons and bone, joint affections in fore and hind limbs.

Angles (º)	**Group 1 (17) (Mean ± S.E)**	**Group 2 (4) (Mean±S.E)**	**Group 3 (7) (Mean±S.E)**	**Group 4 (15) (Mean ± S.E)**	**Diseased (34) (Mean ± S.E)**
Shoulder joint lateral	99 ± 0.91	97 ± 1.8	100 ± 1.5	99.85 ± 1.1	98.88 ± .63
Shoulder dorsal	75.29 ± .63	75.7 ± 1.4	73.4 ± 1.15	73.42 ± 1.65	73.8 ± .54*
Elbow angle lateral	139.7 ± .8	135.5 ± 2.7	138.2 ± 1.5	138.57 ± 2.02	137.73 ± .88
Elbow angle dorsal	169.88 ± .9	169 ± .57	167.7 ± 1.44	166.14 ± .96*	167.47 ± .67*
Carpus angle lateral	178.05 ± .47	179 ± .00	179.14 ± .34	176.71 ± 1.12	177.47 ± .44
Carpus angle dorsal	175.76 ± .57	177.7 ± .62	176.5 ± 1.39	176.42 ± .61	176.82 ± .41
Fore fetlock lateral	141 ± 1.6	145 ± 4.5	146.4 ± 2.6	143.71 ± 1.14	143.7 ± .99
Fore fetlock dorsal	172.88 ± 1.22	173.25±4.02	174.7 ± 1.4	173.57 ± 2.12	173.85 ± .81
Croup angle	144.29 ± 1.3	144.75±1.79	146.8 ± 1.9	147.28 ± 1.44	144.88 ± .78
Hip angle	87.88 ± 1.7	94 ± 6.86	85.2 ± 1.96	87.42 ± 2.4	89.35 ± 1.55
Stifle angle	113.47 ± 2.72	122.5 ± 9.66	115 ± 4.03	117.57 ± 2.83	115.94 ± 2.4
Tarsal angle	148.94 ± 1.2	150.75±2.49	146.8 ± 2.7	151.57 ± 1.30	148.64 ± .93
Hind fetlock angle	152.88 ± 2.04	152.75 ± 3.9	153.7 ± 2.64	144.71 ± 3.13*	149.23 ± 1.37

*Means presence of significant difference between the two groups (P< 0.05) **(Group 1: clinically normal horses, Group 2: horses had ligaments and tendons affections, Group 3: horses had bone and joint affection, Diseased group: sum of horses had musculoskeletal disorders).**

VI- Evaluation of lengths and Angles in jumping thoroughbred horses during competitions:

VI-1- Lengths evaluations:

Competition results (Table 22) revealed that 14 horses played in 1st rank (27%) and 37 horses played in ranks 2nd till 6th (73%). First rank horses characterized by shortest back length (91.97 cm), fore arm lateral (45. 7 cm), fore cannon lateral (28.17 cm), thigh lateral (48.33 cm),arm front length (31.36 cm), fore arm front (47.86 cm), and fore cannon front (26.98 cm). First rank were showed longest neck length (103.88 cm), shoulder length (70.9 cm), pelvis length (53.31 cm), gaskin length (54.11 cm), and wider breast width (52.5 cm). The ranks lengths from (2nd – 5th) were nearly equal.

The length of Horses in fifth and sixth ranks (Table 22) displayed shortest hind cannon lateral (36.57 cm), narrower breast width (47.6 cm), and offset cannon (0.23 cm (SD ± 0.26).

Comparing measurements of lengths between five groups (Table 22) using ANOVA tests revealed that first rank horses had significant ($P<0.05$) increased in the mean neck length and significant ($P< 0.05$) decreased in fore cannon lengths. Horses in Rank 2 showed fore arm front significantly ($P< 0.05$) increased. Rank 3 the front arm, fore arm and fore cannon significantly ($P< 0.05$) increased. Horses in rank 4 showed significant ($P< 0.05$) decreased in neck lengths, and significantly ($P< 0.05$) increased fore cannon front and hind cannon lateral lengths. Horses of rank 5 revealed significant ($P<0.05$) decreased in breast width.

Table (22) showed measured lengths in jumping thoroughbred horses in the five groups of performance.

Lengths (cm)	Rank1**(N=14)**	Rank2**(N=4)**	Rank3**(N=7)**	Rank4**(N=15)**	Rank5**(N=11)**
Neck	104.55 ± 2.35	100.5 ± 1.6	101.7 ± 2.9	96.16 ± 1.70*	102 ± 2.9
Hind cannon lateral	37.38 ± .95	36.4 ± 0.9	40.44 ± 1.37	37 ± 1*	36.5 ± 0.9
Breast width	52.59 ± 1.27	49.5 ± 2	53.5 ± 2.2	51.8 ± 1.4	47.61 ± 1.86*
Arm front	31.36 ± 1.51	31.7 ± 3.6	36.77 ± 1.89*	32.2 ± 1.3	31.69 ± 0.8
Fore arm front	47.86 ± 0.78	48.4 ± 0.9*	51.08 ± 0.76*	49.45 ± 0.7	48.6 ± 0.7
Fore cannon front	26.98 ± 0.75	28.6 ± 0.1	28.53 ± 0.25*	28.87 ± 0.56*	28.42 ± 0.8

*Means presence of significant (P< 0.05) difference between groups.

VI-2- Angles evaluation:

Comparison of angles between groups showed little and convoluted variations in some angles. Lateral shoulder joint angle showed obvious decreased in first, fourth and fifth rank groups and significant increased (P< 0.05) in second and third rank groups. Dorsal shoulder joint angle showed significant increased (P< 0.05) in first and fourth rank groups and obvious decreased in second, third and fifth rank groups (Table 23).

Lateral elbow joint angles showed significant decreased (P< 0.05) in first and fourth rank groups and prominent increased in second, third and fifth rank groups. Dorsal fore fetlock joint angle showed significant decreased (P< 0.05) in first, third and fourth rank groups and prominent increased in second and fifth rank groups.

Croup angles showed significant increased (P< 0.05) in first and third rank groups and significant decreased (P< 0.05) in second, fourth and fifth rank groups. Stifle joint angle showed significant increased (P< 0.05) in first, second, third and fourth rank groups and obvious decreased in fifth rank group. Hind fetlock joint angle showed significant decreased (P< 0.05) in first, second and third rank groups and prominent increased in fourth and fifth rank groups

By other words, first rank horses showed significantly increased (P< 0.05) in dorsal shoulder joint angle, croup angle and stifle joint angle and represented 75.81°± 0.98°, 145.8° ± 1.6° and 115° ± 4° respectively. Each of shoulder joint, elbow joint lateral angles, dorsal fore fetlock joint and hind fetlock joint lateral angle showed significant decreased ($P < 0.05$) and represented 98º ± 1.2º, 135.63°± 1.65°, 176.5°± 0.5° and 148.6°± 2.5° respectively (Table 24).

Table (23) showed measured angles in jumping thoroughbred horses in the five groups of performance.

Angles (º)	Rank1**(N=14)**	Rank2**(N=4)**	Rank3**(N=7)**	Rank4**(N=15)**	Rank5**(N=11)**
Shoulder joint lateral	98 ± 1.2	100.46±0.76*	100±1.5	97 ± 1.8	98 ± 1
Shoulder joint dorsal	75.81±0.95*	74 ± 0.73	73.42±0.92	75.25 ± 0.6*	72.78±0.87
Elbow joint lateral	135.63±1.65*	139.93 ± 1.1	138.28±1.5	135.5 ± 2.7	139.78 ± 1
Fore fetlock dorsal	176.5 ± 0.5	177.8 ± 0.9	176.4± .36*	175.7± .25*	177.48±0.4
Croup	145.8 ± 1.6*	145.2 ± 1.07*	146.85±1.9*	144.75 ± 1.7	142.14±1.27
Stifle joint	115 ± 4	118.06 ± 3.4*	115 ± 4	122.5 ± 9.6	109.9± 3.09
Hind fetlock joint	148.6 ± 2.5	146.6 ± 1.9*	149 ± 2.51	152.75 ± 3.9	153.7± 2.27

*Means presence of significant ($P<0.05$) difference between groups.

While horses of rank 2 revealed significant ($P < 0.05$) increased in lateral shoulder joint angles, croup and stifle joint angles and decreased hind fetlock joint angles. Horses of rank 3 revealed significant ($P < 0.05$) increased in croup angles and significant ($P<0.05$) decreased in fore fetlock joint angles.

Horses of rank 4 revealed significant ($P < 0.05$) decreased dorsal shoulder joint angles and dorsal fore fetlock joint angles. Horses of ranks 5 showed obvious decreased in croup angle and dorsal shoulder joint angle and obvious decreased lateral elbow joint angle.

Discussion

Performance and soundness are the key factors in an equine athlete regardless of whether the horse is used for sport, work or leisure. Conformation assessment is used as indicator of better soundness and for selection of horses with less risk of developing lameness. 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 trainers or veterinarians who are considered experts in their field **(Swedish Warmblood Association of North America, 2006).**

There is great interest in the conformation due to many conformational details are believed to be markers of performance and soundness (**Magnusson and Thafvelin, 1990**). Subjective judging is based on comparing the live horse to certain standard of perfection (**Esensminger, 1969**). Objective methods have been used in research work based on measurements on live horse (**Rosio, 1927**) or from photographs with assistance reference markers and imaging programs according to **Johnston *et al*. (1996), Barrey (1999), Hölmstrom (2001), Clayton and Schamhardt (2001) and McIlwraith *et al*. (2003)**.

Meanwhile, in the present studies measurements of conformation parameters were carried out on live horses and 2D and 3D computer designing program **(AutoCAD, 2013 program).** The differences between the live measurements in lengths and angles in jumping throughbred horses and the photograph were determined and found the average error two centimeters for length measurements in this study. The same findings were reported by **Anderson et al, (2004) and Denham (2007)**.

In this study, neck length was 100.69 cm. Back length was found 92.47 cm. The ratio of back length equaled 91.8% of neck length in jumping thoroughbred horses. Long back reduced flexion forces the horse during jump flatter with less bascule **(Thomas, 2005).** Pelvis length was 51.39 cm. Pelvis length was 51% of neck length and 55.5 % of back length in jumping thoroughbred horses. These findings proved that great attention should be taken to the variations in neck and pelvis length during purchasing jumping thoroughbred horses.

These findings differed from other breeds. **Weller, Pfau, May and Wilson, (2006b)** mentioned that national Hunt race horses had neck length 76cm, back length was 87cm and pelvic length was 35 cm. Furthermore, **Hölmstrom et al. (1990)** found that neck length in Swedish Warmblood breed 71.8 cm in and 75 cm in elite showjumping horses as well as was 71.9 cm in elite dressage horses. Therefore, jumping thoroughbred horses had neck length longer 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 discussed by **Lawrence (2001) and Hölmstrom (2001).**

Wardrope (2006) mentioned that 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.

Shoulder length was found 69.47 cm within the group of the study. Arm length was 34.56 cm in jumping thoroughbred horses. The arm length represented 66.2% of shoulder length. Fore - arm length was 46cm. Arm length was 75% of fore - arm length. Fore cannon length was 28.67 cm. It was 62.3% of fore - arm length in jumping thoroughbred horses. A long fore - arm is best for speed, jumping and long distance riding **(Rooney, 1968).** On other hand, differences in measurements techniques make direct comparison of findings with other authors convoluted.

Back et al, 1996 reported that more horizontal scapula induces the fore - limb to pendulate in a more protracted position so more in front of the body which give more room to saddle and rider **(Bennet, 1992, Hölmstrom, et al., 1990, Knopfhart 1966, Strickland 1992)**. In this way, dressage horses have a more aesthetic appearance, and enable show jumpers to demonstrate and improve fore - limb technique. **Langlois et al., (1979) and Koenen et al., (1995**) reported that a more horizontal scapula is related to higher level of performance.

Accordingly, the findings in fore - limb measurements conformation in thoroughbred jumping horses displayed different variations in lengths the arm, fore - arm and fore cannon showed lowest variation. However, the neck length showed the highest variations.

According to **Edwards (1973) and Loving (1997)** reported that short cannon bones are frequently desirable for soundness. **Rooney (1998) and AAEP (2003)** reported that short cannons is 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 same findings determined short fore cannon in jumping thoroughbred in the present study.

Breast width in jumping thoroughbred horses was 51.2 cm. Other studies reported breast length found 46.5 cm in elite show jumpers and 46.2 cm in elite dressage horses (**Hölmstrom et al., 1990)**. Breast width plays a significant role in endurance and stamina **(Rooney, 1963).**

Lengths for pelvis thigh and gaskin were 51.39 cm, 49.66 cm and 53.09 cm respectively. It is interesting to mention that, Thigh length was 96.6% of pelvis length and 93.5% of gaskin length. Thigh length and pelvis length showed nearly equal variation but gaskin length showed lower variation (44%). Furthermore, fore cannon length was 76.5% of hind cannon length. Accordingly, fore cannon is shorted in jumping thoroughbred horses in comparison with trotters **(Weller et al. 2006a).**

Insufficient length of pelvis will minimize the length of the muscles needed for powerful and rapid muscular contraction. Thus, its 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 **(Rooney, 1968 and Robert, Valette and Denoix, 2013)**. Furthermore, the ideal horse has a long tibia (gaskin) and short cannon with low-set hocks **(Lawrence, 2001)**.

Measurements of fore and hind limbs angles were determined in 51 thoroughbred jumping horses Shoulder joint lateral and dorsal angle were 99° and 74°. Elbow joint lateral and dorsal angle were138.37° and 168°. Carpus joint lateral and dorsal angle were 177° and 176 and Fetlock joint lateral and dorsal angles were 142.73° and 174º respectively. These findings under the investigations showed carpus and fetlock were similar findings with other authors **(Magnusson 1985b; Hölmstrom et al., 1990** and **Weller et al., 2006)**. However, the findings in shoulder joint angles either lateral or dorsal measurements had differences in values and this could be explained to methods of measurements.

Ross and McILwraith (2011) reported that the angles of shoulder is important in determining the stride length and balance. Steep shoulder angle shifts the center of gravity forward predisposing to lower limb lameness. Deviations of the carpus joint angle either medially or laterally had significant predispose the horse to carpus lameness and splints **(Barr, 1994).**

Hind limb angles measurement in jumping thoroughbred showed that, Croup angle was 144.63°. Hip joint angle was 89°. Stifle joint angle was 114.94°. Hock joint angle was 148.59°and hind fetlock joint lateral angle was 149.84°. Jumping thoroughbred horses in this study showed the hock angle and fetlock angle were appeared similar in their values. The difference in breed under study and the methodology of measurements makes comparison with other breeds unclear.

Assessment of measurements in jumper throughbred horses in lengths and angles in the present investigations using tape measurements, goniometer and software AutoCAD 2013 program displayed The ratio of back length equaled 91.8% of neck length in jumping thoroughbred horses. Pelvis length was 51% of neck length and 55.5 % of back length. The arm length represented 66.2% of shoulder length. Arm length was 75% of fore - arm length. Fore cannon length was 62.3% of fore - arm length. Thigh length was 96.6% of pelvis length and 93.5% of gaskin length.

Pelvis, gaskin and hind cannon lengths showed nearly equal variation but thigh length showed higher variation (48%). Furthermore, fore cannon length was 76.5% of hind cannon length. The hock joint angle and hind fetlock joint angle were appeared similar in their values. These measurements were specific for jumping thoroughbred horses.

In this study, abnormal conformations of fore and hind limbs in jumping thoroughbred horses were recorded and categorized. Each conformation was standardized objectively and the corresponding lengths and angles of each were recorded.

'Standing under in front' expressed in thirty horses represented nearly 58% of the population while **Hölmstrom et al. (1990)** found it with frequency 5.6%. The most interesting finding related to that abnormal conformation is that age, arm, hind cannon lengths and elbow joint angle showed significant (P< 0.05) increased in their measurements while, fore fetlock joint angle showed significant decreased. Therefore, standing under in front had significant (P< 0.05) increased in arm, hind canon lengths and elbow joint lateral angle, in addition to significant (P<0.05) decreased fore fetlock joint angles.

These changes in conformation measurements could attribute to standing under in front beside the age of the horses. These finding goes parallel with **Baxter et al. (2011)**. They noticed in standing under in front, the horse showed shortened base of support, so its fore limbs was overloaded. **Stashak (1987)** said that this conformation leads to stumbling, falling, loss of speed and excessive wear on front legs. Meanwhile, the high incidence in this conformation and represented 58% of the population, it seems to be a common conformation of the jumping thoroughbreds. These findings agreed with **Marks (2000)** reported that many of the outstanding jumpers are extremely camped under.

'Standing under behind' was found in sixteen horses representing 31% of the population. **Hölmstrom et al. (1990)** found that the frequency within 4.3% in show jumpers of Swedish Warmblood horses. Thigh lengths and stifle joint angles showed significant (P< 0.05) increased. This was agreed with **Hölmstrom (2001) and Baxter et al (2011)** concluded that, the femur is the most individual conformational detail in sport horses. Both authors agreed that long and forwardly sloping femur allowed the horse to keep its balance more easily by placing the hind limbs more under the horse, closer to the center of gravity.

On other hand, **Magnusson and Thafvelin (1990)** concluded that the better performing horses had straighter stifle angles. Accordingly, Gaskin length was found smaller in 'Standing under behind' in the present study. Furthermore, the most interesting observation in the present study is that pelvis, thigh and gaskin lengths all had equal lengths in standing under behind.

In present study, the shoulder joint angle in **'Steep shoulder'** was 100°± 3° and shoulder length was 69.9 cm. in thoroughbred jumping horses. **Stashak (1987)** and **Marks, (2000)** reported that steep shoulder was more common in jumper horses. The same findings presented in the present studies and represented 55% among the horses examined. **Marks (2000)** observed that long upright scapula with shoulder joint angle of about 105° and laid-back withers provides the vertical propulsion from the front legs that is necessary for jumping big fences.

The most interesting finding is that there were no significant differences in shoulder length between steep and sloppy shoulders in the present investigations. These findings were contrary to the findings of **McIlwraith et al., 2003 and Anderson et al., 2004.** Statistical analysis showed the fore arm length was significantly ($P < 0.05$) decreased in steep shoulder and significantly ($P < 0.05$) increased in sloppy shoulder. This could explain the role of fore arm lengths in the sloppy and steep shoulders, a fact which had been mentioned before.

Elbow joint angle in steep shoulder in jumping thoroughbred horses was 140°. The same findings reported by **Stashak and Hill (2002)** and ranged between 120°-150°. **Hölmstrom, Fredricson and Drevemo (1995)** found that a more flexed elbow with a horizontal scapula results in a longer stance duration, improved gait quality and collection in the fore limbs.

The mean carpus joint lateral angles in jumping thoroughbred horses in the present study was 176.38°± 2.2° in 31% of horses had **'calf knee'**. However, **Hölmstrom et al. (1990)** reported 18.7% in elite show jumpers of Swedish Warmblood breed. **Anderson et al. (2004)** stated that carpus joint angle < 180° considered calf knee and played a major role in carpal fractures and joint diseases.

In contrary, **Marks (2000) and Weller et al. (2006)** found that calf knee was 186° ± 3° and considered 'normal' in national Hunt racehorses and much less of concern for jumpers and dressage horses. **Thomas (2005)** mentioned that calf knees leads to additional stress on the knee joints. Accordingly, the findings in the present study calf knee in thoroughbred horses were agreed with **Anderson et al. (2004).**

'Buck knee' was found in seven horses and representing 13.7% of the population under investigations subjectively. Objectively, the measured carpus joint angle was 181.8°± 2.1°. **Anderson et al. (2004)** considered carpus joint angle in 'buck knee' to be > 180°. Furthermore, **Hölmstrom et al. (1990)** found this conformation with frequency reached 18.5%. **Lawrence (2001)** considered the carpus 'normal' if it was straight and any deviations; forward or backward was considered abnormal. However, the most interesting findings in jumper thoroughbred horses, the forearm length showed significant ($P < 0.05$) increased in those horses had 'buck knee'.

'Carpus valgus' found in twenty three horses representing 45% of the population. The measured mean carpus joint angle was 186°±2°. **Hölmstrom et al. (1990)** found horses with 'narrow at knees' presented with frequency 11.8%. However, **Hölmstrom et al. (1995) and Anderson (2004)** found that carpus valgus represented 11.8% in Swedish Warmblood trotters and considered carpal angles; viewed from the front > 180° represented 'carpus valgus'.

In addition, **Weller et al. (2006a)** found that that a carpus valgus of 5° is normal that doesn't stop horses from pursuing their racing career. Despite, **Kawcak, Zimmerman, Easton, McIlwraith and Parkin (2009)** reported that subtle joint shape characteristics may lead to fractures. Accordingly, carpus valgus in thoroughbred jumping horses was considered normal in conformation and the horse pursuing their jumping capacity. Furthermore, the lateral and front fore arm length had significant ($P < 0.05$) increased in thoroughbred jumping horses.

'Camped out behind' found in 4 horses representing 8% of the population. Each of hind cannon length and hip joint angle showed significant ($P < 0.05$) increased in forming that abnormal conformation. Age showed significant ($P < 0.05$) increased in group of horses showed 'camped out behind' in jumping thoroughbred horses the hip joint angles showed significant ($P < 0.05$) increased in this conformation while croup, stifle, hock and hind fetlock joint angles were within normal limits.

In addition, the hind cannon length was significant ($P < 0.05$) increased comparing with the normal values. Therefore, the hip joint angles and hind cannon lengths played an important role in appearance this conformation. Previous studies revealed controversial findings concerning the role of camped out behind in sport horses **(Hölmstrom et al., 1990; Thomas, 1995 and Marks, 2000).**

'Toe out' in jumping thoroughbred horses presented in this study in 19 horses and represented 37% of the population. The measured dorsal fore fetlock joint angles was

172.5°± 4.4°. **Hölmstrom et al. (1990)** reported **'toe out'** conformation found with frequency of 7.1% in elite show jumpers of Swedish Warmblood horses. **Santschi, Leibsle, Morehead, Prichard, Clayton and Keuler (2006)**found that 30% of thoroughbred of their study had fetlock deviations. A toe-out, base-narrow conformation is thought to increase the likelihood of limb interference and plaiting (**Baxter et al., 2011)**.

Thomas (2005) mentioned that toed-out creates excess strain on the inner side of the hoof, pastern and fetlock predisposing the horse to DJD, ringbone, and foot soreness or bruising. **Stashak (1995) and Anderson (2004)** reported that splints had been considered to be a result of offset knees and base-narrow toed-out conformation. Toe angle showed an important effect on the strain of deep digital flexor tendon and extensors branches of the suspensory ligaments (**Thompson, Cheung and Silverman, 1993 and Ducro, Gorisson, Van Eldik and Back (2009b).**

'Sickle hocks' found in four horses representing 8% of the population. Objectively, hock joint measured smaller (144°± 4.8°) and showed significant ($P < 0.05$) decreased than normal horses. This agreed with **Marks (2000) and Baxter et al. (2011)** found that sickle hocked horses had tarsal joint angle less than 150°-153°. **Hölmstrom et al. (1990)** reported that sickle hock had an angle less than the mean of all horses. He added that the absence of sickle-hocked horses in the elite horse groups must be due to either small hock angles increased the risk of injury, or to the possibility that small hock angles may impair a horse's ability to attain the level of collection required for good performance in advanced classes.

On the contrary, **Muller and Schwark (1979b)** found positive correlations between large hock angles and various performance traits in show jumpers. **Lawrence, 2001** mentioned that sickle hocks placed stress on plantar ligaments in rear of hocks and worn joint out from fatigue. **Rooney (1968), Beeman (1973 and 2000) and Adams (1974)** concluded that closed angulation predisposed the horse to bone spavin, thoroughpin and curb. **Thomas (2005)** called sickle hocks as curby hocks and suggested sickle hocks limited the straightening and backward extension of hocks, which limited the push-off and propulsion. Horses with lameness and back problems usually have significantly smaller hock angles than sound horses **(Black, 1992 and Hölmstrom, 2001).**

A more flexed tarsal joint at square stance appeared more flexed during the stance phase which is wanted to damp concussion and thus to prevent the hind limb from developing spavin **(Stashak, 1987).** On the other hand, more straight tarsal joint should prevent the hind limb from developing curb and related to longer stride and swing duration and an increase range of tarsal joint motion and thus of maximal protraction which improve the gait quality **(Hölmstrom et al., 1990 and Back et al., 1996)**

'Straight hocks' or Post legged found in eight horses representing 16% of the population. It is worth to mention that stifle joint angle showed significant (P< 0.05) increased while pelvis lengths and gaskin lengths showed significant (P< 0.05) decreased in these horses. However, all joints of the hind limbs showed marked increased in their measurements comparing with normal horses. It is interesting to mention that, while the pelvis and gaskin lengths decreased , the hock joint was tend to be straight in thoroughbred jumping horses.

Thomas (2005) stated that straight hock conformation leads to thoroughpin. **Dyson (1995) and Lawrence (2001)** attributed straight hock to cause upward fixation of patella, bone and bog spavin, hoof bruises and quarter cracks.

'Short pelvis' found in sixteen horses representing 31% of the population. Pelvis length in the present study revealed short pelvis measured lower than 49± 4.1 cm. One of the most important observation in this study was that short pelvis found associated with small croup angles significantly (P< 0.05) decreased and increased flatness of the croup and more straight stifle angles significantly (P< 0.05) increased. **Thomas (2005)** said that short pelvis provides less length of muscular attachments to the thigh and gaskin lengths that diminished engine power in jumping events. Flat croup help horses go faster by encouraging long and flowing strides.

'Narrow breast' found in twenty horses representing 39 % of the population. Breast width was significant (P< 0.05) decreased while the dorsal shoulder joint angles were significantly (P< 0.05) increased. This wasn't agreed with **Thomas (2005)** that reported that narrow breast may be from turned-in elbows which can cause toe-out conformation or may cause the forelegs to be too close together. The present investigation showed that narrow breasted horses were associated with poor body condition. **Hölmstrom et al. (1990)** reported that wider breast is characteristic to elite Swedish show jumpers.

'Upright pastern' found in seventeen horses representing 33% of the population. Ideal fetlock joint lateral angle was 138.5°±5.2° representing the normal extension of the joint, while the upright pastern was found 145°±2.5°. Upright pastern is thought to predispose concussion and injuries to the fetlock, phalangeal joints, the navicular region and soft tissue structures behind the third metacarpus **(Marks, 2000 and Stashak and Hill, 2002)**. This should be differentiated from the angle of the hoof that if more upright than that of the pastern, it is referred to as a broken forward hoof-pastern axis **(Hölmstrom, 2001).**

Additionally, a straight shoulder (more vertical) usually accompanies a short upright pastern. **Shepherd and Pilsworth (1997)** reported that upright angle of the hind pastern predisposed to harmful effect to third metacarpal condyles. **Barr (1994)** reported that long sloping pastern predisposed to carpal conformation. However, **Anderson et al. (2004)** did not find such relationship except with carpal effusion.

In brief, measurements of lengths and angles in fore and hind limb abnormal conformations in 51 jumping thoroughbred horses revealed steep shoulder represented 55% among the abnormal conformation studied. There is no significant difference in lengths of shoulder between steep shoulder and sloppy shoulders, however the fore arm lengths play an important role in the appearance of this conformation. The increased in fore arm length in the present study could be explained in the appearance of sloppy shoulder, carpus valgus and buck knee in jumping thoroughbred horses.

The measured fetlock joint lateral angle was 172.5º± 4.4º in toe out conformation. In standing under in front conformation represented 58% of the horses. Age, arm, hind cannon and elbow joint lateral angle showed significant ($P< 0.05$) increased while fore fetlock joint lateral angle was significant ($P< 0.05$) decreased. Camped under behind conformation represented 31% of the horses. Thigh length and stifle joint angle showed significant ($P< 0.05$) increased in comparison with normal horses. Pelvis, thigh and gaskin lengths had nearly equal lengths in these horses.

Straight hocks represented 16% of the horses. Stifle joint angle was significantly (P< 0.05) increased while pelvis and gaskin lengths were significantly (P< 0.05) decreased. The major measured abnormal conformations reported in the present study are a valuable basis in investigating the effect of abnormal conformation on performance and orthopaedic diseases. Whereas, our findings in abnormal conformations in jumping thoroughbred horses suggesting that these abnormal conformations could be considered normal in this population.

In the same respect, **Hölmstrom et al. (1990) and Magnusson and Thafvelin (1985b)** reported that, the conformation defects were mild or moderate, 80% of Warmblood horses had toed out behind and they suggested this may be normal findings in this breed as in the Standerdbred trotter Warmblood (WBL) and elite sports horses. Whereas most of the conformational defects were mild or moderate, 80% of WBL horses were toed out behind, and more than 50% of horses had bench knees and 5% were toed out in front. Suggesting this may be a normal finding in this breed as in the STB trotter.

The methods used for measuring conformation provided an objective method for investigating the relationship between conformation and musculoskeletal disorders were studied. The previous reported relationships are based upon practical experience **(Beeman, 1973; Green, 1976 and Stashak, 1995).** Accordingly, the measured conformation variables associated with musculoskeletal disorders in the present study showed significantly (P< 0.05) decreased neck, shoulder and pelvis lengths and significantly (P< 0.05) increased fore – arm dorsal length.

Thomas (2005) said that short neck hinders the balancing ability of the horse and add more weight on the forelimbs, make it more prone to stumbling. She added that short upright shoulders increased concussion on front limbs, possibly promoting the development of DJD or navicular disease. **Hölmstrom et al. (1990)** stated that short pelvis (croup and hip) provided less length of muscular attachments to the thigh and gaskin. This diminished engine power in speed or jumping events. In addition, this short pelvis is less effective as a muscular lever for collection and to contract the abdominal muscles as the back rounds. Long fore - arm showed significant (P< 0.05) increased and associated with presence of musculoskeletal disorders in jumping thoroughbred horses.

Contrary to that, **Thomas, (2005)** reported that long fore arm is desirable especially with strong fore arm muscles to absorb concussion from the impact and diffuse the strain on tendons and joints on landing.

Statistical analysis between horses had musculoskeletal disorders and clinically normal horses revealed that right dorsal shoulder joint angles, left dorsal elbow joint angle and lateral carpus joint angles showed highly significant (P< 0.05) decreased. Therefore, the decreased dorsal shoulder and elbow joint angles were found predisposed to musculoskeletal disorders (SDF tendinitis, DDF tendinitis, suspensory desmitis, annular desmitis, seasamoditis, ring bone, navicular diseases and bone spavin).

Group of horses affected with bone spavin, carpitis, seasamoditis and ring bone (bone and joint diseased group) showed significantly (P< 0.05) increased age and arm front length while neck length were significantly (P< 0.05) decreased. The most important findings in this study were the conformational variables that did not affect in musculoskeletal diseases including back, arm (lateral), forearm (lateral), fore cannon, breast width, thigh, gaskin and hind cannon lengths.

In group of horses affected with the SDF tendinitis, the DDF tendinitis, the suspensory desmitis and the annular ligament desmitis (ligament and tendons diseased group), the measured lengths showed significantly (P< 0.05) decreased neck length that agreed with **Thomas (2005) and Baxter et al. (2011)**, however, there was no significant changes in other lengths.

Group of horses had bone spavin associated with SDF tendinitis (group had both affections) showed significantly (P< 0.05) decreased neck, shoulder and pelvis length and significantly (P< 0.05) increased in fore arm front length, however there is no significant changes in back, arm (lateral and dorsal), fore arm (lateral), fore cannon, thigh, gaskin and hind cannon lengths that agreed with **Anderson et al. (2004).**

Meanwhile, that group revealed significant (P< 0.05) decreased in left dorsal elbow joint angles and hind fetlock joint angles. **Marks (2000)** reported that sloping hind pasterns are not seen in elite jumpers. This could be explained as small hind fetlock joint angle predisposed affections of the distal limb in jumping thoroughbred horses.

It is worth to mention that measurements of angles in groups of horses had musculoskeletal disorders showed convoluted significant differences in angles. Meanwhile, Group of horses affected with both ligament; tendons, joints and bone disorders revealed significant (P< 0.05) decreased in left dorsal elbow joint angles and hind fetlock joint angles.

Consequently, this study proved that short neck, short pelvis and short shoulder associated with long fore arm may serve as predisposing factors in orthopedic problems in jumping thoroughbred horses.

Performance competitions in jumping thoroughbred in relation to conformation were determined according to Egyptian Equestrian Federation Rules for jumping, 2012/2013. Accordingly these jumping horses were classified into five categories according to Egyptian Federation rules for jumping. These horses were classified and found playing in six classes which categorized into 5 groups (5^{th} and 6^{th} classes put in one group).

Comparing measurements of lengths and angles in five groups proved that rank 1 (first class) horses had significant (P<0.05) increased in the mean neck length and significant (P< 0.05) decreased in fore cannon lengths. Furthermore, First rank horses showed long shoulder, pelvis and gaskin, and wider breast width.

In addition, these horses characterized by short back, arm, fore arm, and fore cannon and thigh lengths. **Magnusson and Thafvelin (1985d)** and **HÖlmstrom et al. (1990)** concentrated on shoulder, pelvis and breast width.Moreover, angles of first class horses had significant (P< 0.05) decreased in dorsal shoulder joint, croup and stifle joint angles and significant (P< 0.05) increased in elbow joint lateral angles. **Back et al. (1996)** mentioned that more flexed elbow joint at square stance results in a longer stance duration improving gait quality with more collection in the forelimb.

Retrospective studies in show jumpers showed that a more horizontal scapula (sloppy) is related to a higher level of performance **(HÖlmstrom et al., 1990, Langlois et al., 1978 and koenen et al., 1995).** However horses with a more vertical position of their scapula (steep shoulder) and a more straight shoulder joint suffer more concussion at landing and thus are at higher risk of developing lameness **(HÖlmstrom and Philipsson, 1993).**

Comparison in other groups or ranking showed little variations in breast width, arm, fore arm and hind cannon lengths among jumping thoroughbred horses.

Conclusion

Conformational measurements of fore and hind limbs in jumping thoroughbred horses established specific features in lengths and angles and represented a base line measurement of conformation range. Some conformational parameters were more variable than others in abnormal limb conformation.

Jumping thoroughbred had musculoskeletal problems displayed short neck; short pelvis and short shoulder associated with long for arm may serve as predisposing factors in orthopedic problems.

Furthermore, Performance competitions revealed that first rank horses showed long neck, shoulder, pelvis and gaskin, and wider breast width. In addition, these horses characterized by short back, arm, fore arm, and fore cannon and thigh lengths. Moreover, these horses had significant decreased in dorsal shoulder joint, croup and stifle joint angles and significant ($P < 0.05$) increased in elbow joint lateral angles.

In this study, data of the jumping thoroughbred horse were evaluated for conformation, musculoskeletal problems and performance competitions. It could be used as indicator of better soundness and for selection of a horse with less risk of developing lameness. Furthermore, these conformation parameters are useful for breeders, trainers and buyers as they can avoid purchasing horses with serious conformation defects and physical handicaps.

Summary

The objective of present study was to determine the base line measurements of lengths and angles in normal and abnormal limb conformations in 51 jumping thoroughbred horses subjectively and objectively using tape meter and photographs of horses with markers at specific reference points and digitally analyzed in computer- image analysis using software AutoCAD 2013 v19 program. In addition to investigate the role of conformation parameters in musculoskeletal problems was studied. The relationships between the measured conformation traits and jumping competition (Ranking) in performance horses were determined.

The measured conformations displayed the ratio of back length equaled 91.8% of neck length in jumping thoroughbred horses. Pelvis length was 51% of neck length and 55.5 % of back length. The arm length represented 66.2% of shoulder length. Arm length was 75% of fore - arm length. Fore cannon length was 62.3% of fore - arm length. Thigh length was 96.6% of pelvis length and 93.5% of gaskin length. Pelvis, gaskin and hind cannon lengths showed nearly equal variation but thigh lengths showed higher variation (48%). Furthermore, fore cannon length was 76.5% of hind cannon length. The hock joint angle and hind fetlock joint angle were appeared similar in their values. These measurements were specific for normal jumping thoroughbred horses.

Measurements of lengths and angles in fore and hind limb in 51 jumping thoroughbred horses were 58% of studied horses had standing under in front conformation. Age, arm, hind cannon and elbow joint lateral angle showed significant ($P < 0.05$) increased while fore fetlock joint lateral angle was significant ($P < 0.05$) decreased. Steep shoulder conformation represented in 55% of the population. There is no significant difference in lengths of shoulder between steep shoulder and sloppy shoulders, however the fore arm lengths play an important role in the appearance of this conformation. Carpus valgus represented 45% of the studied horses. Narrow breast and toe out were 37% of the population. The percentage of horses had calf knee, those had short pelvis and those had standing under behind was 31% for each. Standing under behind had thigh lengths and stifle joint angles showed significant ($P < 0.05$) increased in comparison with normal horses.

The mean measured pelvis length in horses had short pelvis was 49 ±4.1 cm. The increased in fore arm length in the present study could be explained in the appearance of sloppy shoulder, carpus valgus and buck knee in jumping thoroughbred horses.

The measured fore and hind limbs in lengths and angles in jumping thorough bred horses affected with musculoskeletal disorders displayed significantly ($P < 0.05$) decreased neck, shoulder and pelvis lengths and significantly ($P < 0.05$) increased fore arm lengths.

Group of horses had bone and joint affections revealed significantly ($P < 0.05$) increased age, arm front length and significantly ($P < 0.05$) decreased neck lengths. Group of horses had SDF and DDF tendonitis, uspensory ligament desmitis and annular ligament desmitis showed significant ($P < 0.05$) decreased in neck lengths. Group of horses had SDF and DDF tendonitis, and bone spavin, ring bone demonstrated significant ($P < 0.05$) decreased in neck, shoulder and pelvis lengths. In addition to significant ($P < 0.05$) increased in fore arm front lengths.

Musculoskeletal disorders determined no significant differences in angles. Meanwhile, Group of horses affected with both ligament, tendons, joints and bone disorders revealed significantly ($P < 0.05$) decreased left dorsal elbow joint angles and hind fetlock joint angles.

Consequently, this study proved that short neck; short pelvis and short shoulder associated with long fore arm may serve as predisposing factors in orthopedic problems in jumping thoroughbred horses.

Comparing measurements of lengths and angles in five groups performance competitions horses proved that rank 1 (first class) horses had significant ($P<0.05$) increased in the mean neck length and significant ($P < 0.05$) decreased in fore cannon lengths. Furthermore, First rank horses showed long shoulder, pelvis and gaskin, and wider breast width. In addition, these horses characterized by short back, arm, fore arm, and fore cannon and thigh lengths. Moreover, these horses had significant ($P < 0.05$) decreased in dorsal shoulder joint, croup and stifle joint angles and significant ($P < 0.05$) increased in elbow joint lateral angles.

The major measured abnormal conformations reported in the present study were contributed to predict future performance and musculoskeletal problems in jumping thoroughbred horses. Whereas, our findings in abnormal conformations in jumping thoroughbred horses suggesting that these abnormal conformations could be considered normal in this population. The wide range of measured conformation traits in the present study has an important data to inform and advise the horsemen and breeders to take these measurements in consideration for selecting jumping thoroughbred horses with higher speed and forces during performance.

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الملخص العربي

هدفت هذه الدراسة إلي تحديد الأطوال، والزوايا الأساسية المميزة للتكوين الهيكلي السوي، وغير السوي للأطراف. وذلك في عدد واحد وخمسين حصان قفز أجنبي أصيل. وتم هذا، تقليدياً وموضوعياً، بإستخدم المتر القياسي، وتصوير الخيول عند نقاط بعينها. ثم تحليل هذه الصور رقمياً بواسطة برنامج كمبيوتر خاص (أوتوكاد ٢٠١٣،الإصدار ١٩). كما إستهدفت الدراسة إستبيان دور المعايير التكوينية للجهاز الحركي في التمهيد لإصابات الجهاز الحركي، وتأثيره في نتائج سباقات القفز.

وأوضحت دراسة البناء الهيكلي لهذه الخيول أهمية التناسب بين أطوال نقاطه المحددة. وقد مثل طول الظهر إلي الرقبة ما نسبته ٩١,٨%. أما طول الحوض فقد مثل ٥١%، ٥٥,٥% من طولي الرقبة، والظهر بالترتيب. كما أظهرت النتائج أن طول الذراع يمثل ٦٦,٢%، ٧٥% من طولي الكتف، والساعد بالترتيب. أما عن طول عظمة المدفع فوجد أنها تمثل ٦٢,٣% من طول الساعد. وأظهرت الدراسة أن طول الفخذ يمثل ٩٦,٦%، ٩٣,٥% من طولي الحوض، و"الجاسكن" بالترتيب. كما مثلت عظمة المدفع الأمامية ٧٦,٥% من طول عظمة المدفع الخلفية.

وإحصائياً.. أظهر كلاً من الحوض، والفخذ "معامل تغير" متساوٍ تقريباً، أما "الجاسكن" فقد كان أقل تغيراً (٤٤%). كما أظهرت زوايا العرقوب، والرمانة الخلفية تساوياً في القيم المُقاسة. وشكلت كل النتائج السابقة تميزاً، وخصوصية لخيول القفز الأجنبية الأصيلة.

أما عن البناء الهيكلي غير السوي، ومنها الخيول التي أظهرت تواجد الرجل الأمامية أسفل الصدر، فكان عددها يمثل ٥٨% من إجمالي خيول الدراسة، أما الخيول التي أظهرت أكتافاً ذات زاويا منفرجة فقد مثل عددها ٥٥% من إجمالي الخيول. ولم يتبين أن هناك فرقاً معنوياً في طول الكتف بين الخيول التي أظهرت كتف ذو زاوية دون القائمة أو المنفرجة. بينما وجد أن الساعد هو من يلعب هذا الدور. أما عن عدد الخيول ذات "الرسغ الأروح" فوجد أنها تمثل ٤٥% من عدد الخيول. أما الخيول التي أظهرت صدراً ضيقاً، وتلك التي أظهرت أصابع متجه للخارج فكانت نسبة كل منها ٣٧% من إجمالي الخيول. بالإضافة إلي ذلك تبين أن نسبة الخيول التي أظهرت صورة "رسغ العجول" وتلك التي بها أحواض قصيرة، والأخري التي بها أرجل خلفية متموضعة تحت البطن فكانت نسب كلٍ منها ٣١% من إجمالي خيول الدراسة. وفي مجموعة الخيول الأخيرة: أظهرت أطوال أفخادها، وزوايا مفصل ركبها زيادة معنوية بالمقارنة بالخيول السوية.

وقد أظهرت الدراسة أن قياسات أذرع الخيول ذات الرجل الأمامية المتواجدة أسفل الصدر، وعظام المدفع الخلفية، وزوايا كوعها الجانبية كانت أكبر معنوياً عن مثيلاتها السوية. أما زوايا الرمانة الأمامية

الجانبية فكانت علي النقيض. وتبين كذلك أنه بزيادة طول الساعد يظهر كلا من التكوينات الهيكلية التالية: الكتف ذو الزاوية دون القائمة، و"الرسغ الأروح"، و"رسغ الجداء".

وبدراسة أطوال، وزوايا القوائم الأمامية والخلفية للخيول التي عانت من مشاكل العرج، وجد أن هناك قصراً معنوياً في طول الرقبة، والكتف، والحوض. أما طول الساعد فكان علي النقيض. بينما أظهرت زوايا الكوع والرسغ الجانبية نقصاً معنوياً. وتفصيلياً.. وجد أنه في الخيول التي عانت من إصابات المفاصل والعظام، أظهرت قياساتها زيادة معنوية في أعمارها، وأطوال سواعدها الأمامية، وقصراً معنوياً في طول رقابها. وبينما تلك التي عانت من إلتهابات في أوتارها وأربطتها، فأظهرت قصراً معنوياً في طول رقابها. أما الخيول التي كانت مصابة بمثل هذه الإلتهابات فضلاً عن إصابات المفاصل والعظام، فأظهرت قياساتها قصراً معنوياً في أطوال الرقبة، والكتف، والحوض، فضلاً عن زيادة معنوية في طول الساعد.

ومن نتائج هذه الدراسة وجد أنه لا يوجد فرق معنوي في قياسات زوايا الخيول التي عانت مشاكل الجهاز الحركي. أما الخيول التي عانت من مشاكل الأربطة، والأوتار، والمفاصل، والعظم مجتمعة فقد أظهرت قياساتها نقصاً معنوياً في زوايا الكوع الأمامي الأيسر، وزوايا الرمانة الخلفية. وبالتالي.. أوضحت الدراسة أن قصر طول الرقبة، والحوض، والكتف مع زيادة طول الساعد يجب وضعها في الإعتبار عند التنبؤ بحدوث مشاكل الجهاز الحركي في خيول القفز الأجنبية.

ومن نتائج الآداء التنافسي (وفق قواعد الإتحاد المصري للفروسية) لخمسة مجاميع من خيول القفز الأجنبية محل الدراسة، تبين أن خيول الدرجة الأولي تميزت بطول رقابها، وطول أكتافها، وأحواضها، و"جاسكنها". بالإضافة إلي زيادة عرض صدورها. فضلاً عن قصر ظهورها، وأذرعها، وسواعدها، وعظام مدفعها، وأفخاذها. أما عن زوايا هذه الفئة، فأظهرت قياسات زوايا الكتف الامامية، والكفل، ومفصل الركبة زيادة معنوية، أما زواية الكوع الجانبية فكانت علي العكس من ذلك.

وخلصت نتائج الدراسة إلي أن التكوين الهيكلي السوي، وغير السوي يجب الإعتماد عليه في تقييم الآداء المستقبلي لهذه الخيول. وإذا ماكانت ستتعرض لمشاكل في جهازها الحركي، مستقبلاً. بالإضافه إلي أن بعض هذه التكوينات غير السوية قد تعد من جانب أو آخر تكوينات طبيعية في هذه الخيول. وخلاصة القول، أعطت هذه القياسات التكوينية المتعددة معايير ينبغي وضعها في إعتبار كل من له صلة بالخيل.. شراء، وتربيةً، وتدريباً، وعلاجاً.

المستخلص العربي

أجريت هذه الدراسة علي واحد وخمسين حصان قفز أجنبي أصيل (أحصنة مخصية، وأفراس). وهذه الخيول تنتمي لنادي الفروسية بالقوات المسلحة المصرية. وهدفت الدراسة إلي إستبيان التكوين الهيكلي الخاص بخيول هذه السلالة. وذلك بطريقة موضوعية وتقليدية بإستعمال شريط القياس المتري، ومِنقل قياس الزوايا، وتصوير الخيول بواسطة كاميرا رقمية وتحليل الصور حاسوبياً بواسطة برنامج خاص (أوتوكاد ٢٠١٣ الإصدار ١٩).

هذا بالإضافة لدراسة دور التكوين الهيكلي في التمهيد لإحداث إصابات عضلية عظمية، ودوره في نتائج السباقات (الأداء) وفق قواعد الإتحاد المصري للفروسية. تم تحديد القياسات الأساسية للأطوال، والزوايا المميزة للقوائم الأمامية والخلفية لهذه الخيول الأجنبية. كما تمت مناقشة معايير التكوين الهيكلي غير السوي لقوائمها. وأظهرت الدراسة أن كلا من أطوال الرقبة، والكتف، والحوض في الخيول التي تعاني من مشكلات الجهاز الحركي كانت أقصر معنوياً عن مثيلاتها السليمة. أما طول الساعد فوجد علي النقيض من ذلك. وتبين أن زاويا مفاصل الكتف، الكوع الأمامية، والرمانة الخلفية كانت أقل انفراجاً عن مثيلاتها السليمة.

ومن خلال نتائج سباقات القفز المحلية الدورية أظهرت خيول الدراسة ضمن تصنيف الدرجة الأولي تميزاً في مواصفات البناء الهيكلي. وكانت مفردات هذا التميز أنها تتمتع برقبة، وكتف، وحوض، وجاسكن أطول، وصدر أعرض. فضلاً عن أنها تميزت بقصر ظهورها، وأذرعها، وسواعدها، وعظام مدفعها الأمامية، وأفخاذها. أما عن زوايا هذه الفئة فكانت قياساتها أقل (معنوياً) بالنسبة لزوايا الكتف الأمامي، والكفل، والركبة. بينما كانت زواية الكتف، والكوع، والرمانة الجانبية، والرمانة الأمامية أكثر إنفراجاً (معنوياً) عن مثيلاتها في التصنيفات الدنيا.

وخلصت الدراسة إلي أن هذه المعايير القياسية يجب الإعتماد عليها عند إختيار، وشراء خيول سليمة، تكون أقل عرضة لمشاكل العرج. فضلاً عن أن لها أهمية قصوي لكل من له صلة بالخيل.. تربيةً، وتدريباً، وعلاجاً.

كلية الطب البيطري
الجراحة والتخدير والأشعة

دراسات علي شكل القوائم في خيول القفز الأجنبية الأصيلة

رسالة مقدمه من

ط.ب. يحيي مصطفي العزب العماوي

بكالوريوس العلوم الطبية البيطرية

كلية الطب البيطري- جامعة القاهرة (٢٠١١)

للحصول علي درجة الماجستير في العلوم الطبية البيطرية

(الجراحة، والتخدير، والأشعة)

تحت إشراف

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