

PRELIMINARY ASSESSMENT OF HOOF DEFORMITIES IN DONKEYS

By

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ABSTRACT

Assessment of hoof wall deformities in 73 working donkeys in brick kilns have high prevalence of foot abnormalities and represented 92.46%. The hoof deformities reported were included sheared heels (75.3%), Flared foot (72.6%), contracted heel (31.5%), club foot (30.1%) and long toe under run heel (24.6%). The morphological features in donkey's hoof deformities were evaluated from dorsal, lateral, palmar /planter and solar surfaces for both front and hind limbs. Objective assessment of hoof deformities in donkeys provides multiple complicated structural features for each deformity mainly in hoof shape, the coronary band slope, condition of hoof wall, heel, and symmetry of ground surface and frog structures. The preliminary assessment provides a database for both veterinarians and farriers for proper management and trimming of the hoof. Future studies will be focused on the changes of hoof capsule, internal structures with different hoof deformities in the present study.

INTRODUCTION

The equine foot provides the contact surface between the horse and the ground (**Wilson and Weller, 2011**). The foot has three main functions: shock absorber during contact with the ground, bear the weight during standing and propulsion during movement (**Parks, 2003**). Similar to the horse, donkey's hoof capsule is formed of the three phalanges, the navicular bone, a series of ligaments and tendons, a digital cushion, the foot cartilages and a complex network of vessels and nerves (**Wilson and Weller, 2011**).

In horses, clinical studies have identified the importance of correct foot conformation in preventing an array of injuries and diseases (**O'Grady and Poupard, 2001**), including catastrophic musculoskeletal injury and suspensory apparatus failure (**Kane et al., 1998 and Holoryd et al., 2013**). Misalignments of the dorsal hoof wall and the dorsal aspect of the pastern may lead to a broken hoof pastern axis in the horses (**Parks, 2003 and O'Grady,**

2013) and can result in tension in the deep digital flexor tendon and concussion of the dorsal sole (O'Grady, 2013). Imbalances between the medial-lateral and dorsal-palmar aspects of the hoof are also common and can result in sheared heels, hoof cracks and lameness (Turner, 1992; Sampaio, *et al.*, 2013).

O'Grady *et al.* (2007) defined horse foot conformation as the shape and size of the foot determined by the shape and size of the individual structures of the foot and the spatial relationship between them. Changes in hoof shape can alter the biomechanical function, in particular the nature of the forces acting on the hoof and around the distal interphalangeal (DIP) joint (Moleman *et al.*, 2006). The biomechanical function of the distal limb can alter the hoof shape as a result of changes. Consequently, this influences the forces acting on the hooves structural components in the horse (Eleishar *et al.*, 2004) as well as the distal interphalangeal joint (DIPJ). Savoldi (2006) suggested that, the form of the external hoof is directly related to the form and function of the internal structures.

Equine distal limb lameness is commonly associated with poor foot conformation and hoof imbalance, change in foot shape and size which may be narrower and more upright than the normal foot (Ross, 2003). Evaluation of the hoof capsule morphology will indicate where the hoof wall is extremely stressed. Abnormal distribution of biomechanical forces will lead to hoof capsule deformation. (O'Grady, 2013). Working donkeys are associated with high prevalence of foot, joint, tendon and conformation abnormalities and chronic foot pathology (Rexis *et al.*, 2014). The foot conformation in horses can be changed through incorrect trimming, shoeing and conformational defects (Kummer *et al.* (2006). There is little scientific information to assess donkey hoof capsule orientation differ from the guideline values for horses in terms of balance and alignment. The purpose of this study was to document the different hoof deformities in working donkeys with special reference to hoof shape, the coronary band shape, and condition of hoof wall, heel, and symmetry of ground surface and frog structures.

MATERIAL AND METHODS

A retrospective studies were carried out on 73 working donkeys in brick kilns of different ages, sex and body weight were used during this study. The mean age was (13.26±0.442) and the mean body weight was 185.29±3.5283. These donkeys have abnormal hoof capsule conformations and signs of lameness. The animals were selected on the basis of verbal

informed owner consent. Visual inspection of foot conformation, palpation of the hooves and gait assessment and lameness were performed according to **Ross and Dyson (2011)**.

All examination were carried by one person (SFF).

Evaluation of donkey hoof capsule:

Evaluation of donkey hoof capsule was carried out according to **O'Grady (2013)**. Donkeys stood square on a concrete surface with equal weight bearing on all four limbs. Changes on the hoof capsule were observed from dorsal aspect, lateral aspect and palmar/planter aspects as well as from distal or solar surface.

Examination of donkey hoof from dorsal aspect:

Ideally, the hoof should be symmetrical related to the distal limb. An imaginary line bisects the metacarpal/metatarsal bones, pastern and comparable points of the coronary band or the ground surface of the foot should be in 2 equal halves. The slope of the coronary band should be parallel to the ground.

Lateral aspect:

Evaluation of the hoof capsule from the side view should begin with the coronet. The healthy coronary band should have a gentle, even slope from the toe to the heels. Proximal or distal displacement of the coronary band or concavity should be noticed. The presence of hoof wall flares or horizontal or vertical fissures were determined.

Palmar aspect:

The cleft of the central sulcus of the frog should extend proximal to the hairline and becomes apparent in the skin of the pastern between the heels. Compare the relative heights of the two heels. The contour of the junction of the heel bulbs with the skin can be evaluated.

Distal or solar aspect:

Changes in the wall of the hoof capsule should be noticed. The width and symmetrical of the ground surface of the hoof and frog should be determined. The frog of a healthy hoof has sufficient depth at its dorsal aspect to reach the bearing surface.

Assessment of different hoof deformities in both the front and hind limbs in donkeys were performed according to the guidelines described in the horses.

RESULTS

The examined donkey hoof deformities in the present study revealed that, donkeys working in brick kilns have high prevalence of foot abnormalities and represented 92.46 %. The prevalence of front limb hoof affections was 48.9% and 51.1% in the hind hooves.

The hoof deformities or abnormalities reported were included sheared heels (75.3%), flared foot (72.6%), contacted heel (31.5%), club foot (30.1%) and long toe under run heel (24.6%) (Table 1).

Table (1): The Distribution of hoof deformities among examined donkeys.

Hoof deformities	Number of Donkeys. (%)	Number of Feet (%)	Incidence /number of deformed feet	
			Fore foot	Hind foot
Sheared heel	55(75.3%)	84	45	39
Flared foot	53(72.6)	88	52	36
Contracted heel	23(31.5%)	38	10	28
Club foot	22(30.1%)	32	3	29
Long toe low heel	18(24.6%)	28	22	6
Total		270	132	138
		92.46%	48.9%	51.1%

Types of different hoof deformity in donkeys:

1-Sheared heel:

Disparity and different in length and heights of lateral and medial heels. The loaded heels displaced proximally and rolled under the foot. The unloaded heel was flared out. The central frog has deep fissures and extended to the hair line of the foot Fig. (1). the dorsal hoof wall appeared curved or convex Fig. (2). The donkey was standing on the frog, the loaded side of the hoof wall rolled under the foot and the unloaded side flared and out of the weight bearing surface. Proximal displacement of the coronary band above the loaded heel was noticed. The ground surface have Mediolateral imbalance, elongated and deformed in shape. The frog and the heel bulbs were collapsed with narrow deep fissures at the base of the frog and extended to the hair line. The frog appeared narrow, shrinkages and associated with thrush.

2-Flared foot:

There was disparity between medial and lateral hoof wall heights. The loaded side, the hoof wall was started to roll under the foot, while the unloaded side the hoof wall was flared out, and became curved in shape and appeared out of the weight bearing surface and associated with toe and quarter cracks and lost pieces of horny materials. Deviation of the hoof wall

away from the central axis of the foot and the donkey was walking on loaded hoof wall. The coronary slope dropped on the unloaded side. Bulging on the coronary band on the flared side was also seen. Flared foot has typical features with sheared heel, long toe under run heel and club foot (Flared foot with club foot, the digital cushion was atrophied; the frog and heel were contracted. Flared foot with long toe under run heel the frog and digital cushion were collapsed. The apex of the frog was deviated and pointed toward the flared side Fig. (3).

3- Contracted heel:

The ground surfaces have deformed sole and frog; the frog appeared contracted with narrow heel width. The loaded heel rolled under. The unloaded heels appeared flared out. The palmar/plantar half of the foot was out of the weight bearing surface and the frog was migrated towards the rear. The donkey was landing on the toe with marked worn toe. The medial and lateral hoof wall lost their normal slope. The dorsal hoof wall was straight, over worn at the toe associated with toe cracks and lost pieces of the hoof wall (4). The dorsal coronary band was bulged; the growth hoof rings were crowded in the unloaded side while divergent on the loaded side. The palmar/plantar view the characteristics features of sheared heels were observed. The frog was contracted and out of the weight bearing surface, deep fissures at the base of frog extended to the hair line. The digital cushion was atrophied.

4-Club foot was classified into mild, moderate and severe form.

Mild degree club foot:

The dorsal hoof wall appeared straight; convex or even segmented into two parts Fig. (5). The coronary band slope from dorsal hoof wall to heel appeared normal or migrated or concave in shape at the quarters or heel areas. The dorsal coronary band slightly bulged with marked wearing of the toe due to dragging. The loaded lateral and medial hoof wall sides appeared rolled under and nearly straighter. The unloaded side appeared curved and flared with quarter cracks. Unsymmetrical ground surfaces. Frog Atrophied, migrated backward, out of bearing weight, contracted heels and the central groove of the frog is deep and extended to the coronary band hair line. Disparity in the two heels and increased in lengths and heights with deep fissure at the base of the frog.

Moderate degree club foot:

The dorsal hoof wall was increased in length with wearing, damaged, quarter cracks and broken. The overloaded toe appeared damaged. The dorsal coronary band is bulged, lost the slope, and appeared parallel to the ground surface and concave in shape.

The heels contracted with increased heights and lengths. Fissures in the bulb of the heels with granulomatous inflammation involved the frog and skin of the pastern.

The solar surface appeared deformed, square in shape and lost its normal shape. The frog deformed, atrophied and displaced backward Fig. (6).

Severe degree club foot:

The entire ground surface of the foot is out of the weight bearing surface, landing and loading mainly on the dorsal wall surface or pastern during walking. The hoof wall showed wearing fragmented and broken. The coronary band appeared bulged, concave and contact with the ground surface during walking associated with proximal migration above the medial and lateral quarters and heels Fig. (7). the solar surface became deformed, square in shape or even irregular. The horn materials of sole, frog and digital cushion were completely disappeared or destroyed and covered by hard keratin materials Fig. (8).

5- Long toe under run heel:

Marked increased in both toe and heel lengths. The heel growing forward and became parallel with the ground, rolled underneath the foot and the heel and frog were collapsed in severe cases. The toe curled proximally and out the weight bearing surfaces. The dorsal hoof wall appeared curved or convex. The donkey was standing on the frog during the loading phase of the stride, in some cases the frog and the toe were out of the weight bearing surface and associated with quarter and/or heel cracks Fig. (9). in long standing cases. The unloaded side there was distal migration of the coronary band at the heel region of the foot so that, the coronary band was convex. While, loaded side the coronary band migrated proximally. The hoof will take an oblong shape as the heels moved forward and the frog moved more rear. The solar surface showed mediolateral imbalance, deformity and elongated in shape. The loaded side of the hoof wall rolled under while unloaded side was flared out, the point of the frog was pushed towards the flared side of the wall Fig. (10).

DISCUSSION

The incidence of hoof deformities in donkeys working in brick kilns in the present study was (93.1%). The high incidence of hoof deformities in working donkeys in the present study were attributed to overloading, overworking, harness lesions and poor treatment from the handlers (Ahmed *et al.*,2015). In addition, these animals are working all the day under hard harsh conditions pulling the carts laden with bricks to and from the firing ovens of the brick kilns along the day (Al-Salihi and Farahat, 2014).

The observed high incidence in the present study was going parallel with the previous reports of **Pritchard *et al.* (2005)** and **Burn *et al.* (2010)**. They reported the prevalence of lameness in working donkeys were 91.7% and 96%, respectively. The different types of hoof deformities recorded in this investigation were included sheared heels (75.3%), flared foot (72.6%), contacted heel (31.5%), club foot (30.1%) and long toe under run heel (24.6%). There is no available data concerning hoof deformities in donkeys could be traced. The finding results of donkey club foot were similar to the previous finding in horses (**O'Grady and Dryden, 2012; O'Grady, 2014; and Redden, 2014 and Carlier *et al.*, 2016**). However, club foot in the present study showed specific findings, the bulb of the heels and the base of the frog have deep fissure extend to the hair line. The digital cushion appeared contracted, atrophied and destroyed were mainly seen in the third degree and the coronary band mainly perpendicular with the ground. The heels started to roll under in the loaded side while flared out in unloaded side associated with granulomatous inflammations.

Several classifications of club foot have been reported (**Redden, 2014 and O'Grady, 2014**). They classified club foot or flexoral deformity into four grades depending on toe angle opposite to the healthy foot. In the present study, club foot was classified into mild, moderate and severe depending on the morphological appearance of hoof structures. There is minimal information in the veterinary literature regarding the management of club foot in donkeys. The managed club foot in the horse is mainly empirical and based on past experience (**O'Grady *et al.*, 2007**). Therefore, the finding data in the present study could be used a guideline for managed club foot in donkeys. Long toe under run heel in the present study was 24.6% in working donkeys and the incidence was more common in front limbs (92.8%). Similar, findings **Balch, Helman and Collier (2001)**. They found long toe under run heel in front limb was 97% in thoroughbred racing horses. In this respect, **O'Grady (2006)** mentioned that, the internal structures of the hind limbs doesn't affected similar to the fore limbs due to the propulsive function of the hind limb hind play an important role versus the fore limbs that weight bearing function. Long toe under run heel in horses have excessive toe length relative to the conformation of the heel. The bulbs of the heels and the heels lose the ability to support weight. The frog atrophied and pushed out toward the rear of the foot. The same findings were reported in the horses (**O'Grady, 2013**). However, in donkeys the shape of the dorsal hoof wall appeared straight, concave and toe curled proximally and out of weight bearing surfaces with toe and quarter cracks on the flared hoof wall side. In addition,

the coronary band lost normal slope and became concave in the unloaded side and migrated proximal in loaded side. Furthermore, the solar surface has deformity, frog elongated and the point of frog pointed toward the flared hoof wall side. Sheared heel in the working donkeys have disparity and different in lengths and heights of lateral and medial heels, the loaded heel displaced proximally and rolled under the foot, the unloaded heel is flared out. The same findings were previously reported in the horses (Turner, 1992; Dyson *et al.*, 2011b). They defined the sheared heel as a hoof capsule distortion due to displacement of one heel bulb proximally relative to the adjacent heel bulb with loss of structural integrity of tissues between the medial and lateral heel bulbs. Dyson *et al.* (2011b) mentioned that, the sheared heel is common with Long toe /low heel imbalance in front limbs because. However, sheared heel in donkeys were seen in both the long toe under run heel and club foot deformities in the front and hind limbs. There is no available information describes the contracted hoof in equines. Therefore, assessment of donkey hoof capsule from the dorsal. Lateral, palmar and solar views provided complete morphological orientation of the foot. The most interesting findings were the medial and lateral hoof wall lost its normal slope; the dorsal hoof wall was straight overgrown in the toe associated with toe cracks and lost pieces of the hoof wall at the toe region. The growth hoof rings was crowded in the unloaded side while divergent in the loaded side of the hoof wall. The palmar/planter view the characteristic feature of the sheared heel was observed the frog was contracted and the digital cushion was atrophied.

In this respect, Redding (2007) and O'Grady *et al.* (2007) concluded that, contracted heel showed decreased width of the palmar/plantar aspect of the foot; the heel bulbs and buttresses are closer together than normal. Decreased frog width was found relative to the length, accompanied with elongated or collapsed heels. Williams and Root (2011) attributed contracted foot to hoof abnormalities such as club feet, under run or sheared heel. In addition, Hill and Klimesh (2011) found that, lack of horse exercise lead to decrease the blood flow in the hoof, causing reduction in the moisture content and drying of the hoof wall capsule. This lead to contract at the heels and damaged the internal structures of the hoof. Therefore, contracted foot in donkeys could be attributed to overworking in stress and harsh environmental conditions in brick kilns industries. O'Grady *et al.* (2007); Parks (2003) and Pavia (2015) defined the flared foot as local or general deviation of the hoof wall away from the central axis of the foot. The flares appeared clearly on the sides and/ or at the toe. Flared foot in donkeys has the similar signs in horses. Pavia (2015) attributed flared foot to

the biomechanical changes in association with the long toe/low heel syndrome, poor trimming, or simply neglected feet, in addition, bending outward or deformation of the hoof capsule. Therefore, flared foot in the present study could be attributed to the same causes in the horse. The interesting findings in donkeys flared foot was observed in cases of the club foot, long toe under run heel; sheared heel and contracted heel. Therefore, flared foot in donkeys could be considered sequel to complicated hoof deformities. In conclusion: assessment of donkey hoof capsule deformities pointed out that, when the sites of hoof wall stressed and abnormal distribution of biomechanical forces on the hoof leading to hoof capsule deformities. The increased load or weight bearing will lead to deviation of the wall outwards (flares) or inward (under-running) and it may cause the wall to move proximally and decreased hoof wall growth. Furthermore, biomechanical changes has an influenced pathological change in the digit, pattern of horn production, and change the shape of hoof capsule and all of that ended by abnormal gait, chronic lameness and hoof deformities. Were seen in working donkeys. Correspondingly, the same findings have been reported in horses (**Eliashar, 2007; Collins *et al.*, 2011 and O'Grady, 2013**).

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Legends of the figures:

- Fig.1:** Sheared heel, palmar/planter aspect, 16 years male donkey, notice disparity between lateral and medial heels, the loaded heel rolled under the foot and became weight bearing surface and the digital cushion more atrophied (yellow arrow).
- Fig.2:** Sheared heel,dorsal aspect, 18 years donkey: deviated dorsal and lateral hoof walls with bulging of the coronary band (red arrow).
- Fig.3:** Flared foot, solar aspect, the ground surface deformed, the apex of the frog pointed toward the flared side (red arrow), the flared side appeared broken and lost pieces of horny materials (yellow arrow).
- Fig.4:** Contracted heel, dorsal aspect, 15 years old donkey, the dorsal lateral and medial hoof wall appeared straighter than normal. The toe increased in lengths, broken and lost pieces of horny materials and the animal landing on the toe.
- Fig.5:** Moderate degree club foot, lateral aspect, male 18 years donkey showing; severe extension on the common digital extensor tendon (yellow arrow), the coronary band lost normal slope, parallel with the ground, concave in shape (Red line).The frog is atrophied and migrated rear (blue arrow). The hoof wall broken and quarter crack (white arrow).
- Fig.6:** Moderate degree club foot, solar surface, male donkey, 19 years, the solar surface deformed, square in shape (red line),the frog lost normal shape and migrated rear (yellow arrow)..Widening lateral sulci (green arrow).
- Fig. 7:** Severe degree club foot, palmar aspect, 19 years donkey showing: the sole, frog and digital cushion were completely destroyed and out of the weight bearing surface. The central sulcus appeared as long narrow fissure extend to the mid pastern area above the base of the frog (red arrow).
- Fig.8:** Severe degree club foot, 19 years male donkey, the solar surface deformed, and frog lost normal shape and wearing at the toe was noticed.
- Fig.9:** Long toe under run heel, lateral aspect, 16 years donkey displayed curvature of the dorsal hoof wall (red arrow), marked increased on the dorsal hoof and heel lengths, distal migration of coronary band on the loaded side (black arrow). The heel growing forward and became parallel with the ground.
- Fig.10:** Long toe under run heel, solar aspect, 14 years male donkey, the solar surface elongated and deformed, the heels and frog were collapsed, the frog increased in lengths (Yellow arrow).The heel width is reduced (red line). There was narrow deep fissure in the central sulcus of the frog (black arrow).

PRELIMINARY ASSESSMENT OF HOOF DEFORMITIES



Fig. 3

Flared foot solar surface



Fig. 2

Sheared heel dorsal hoof wall



Fig. 1

Sheared heel palmar view

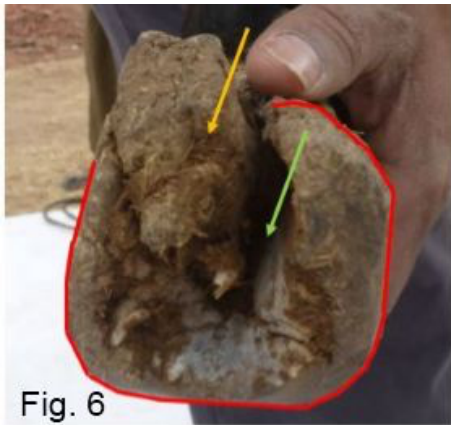


Fig. 6

Club foot solar surface

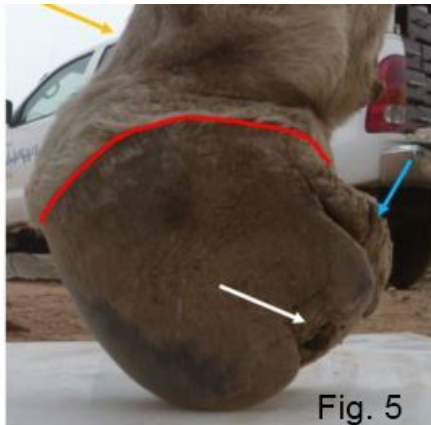


Fig. 5

Club foot lateral view

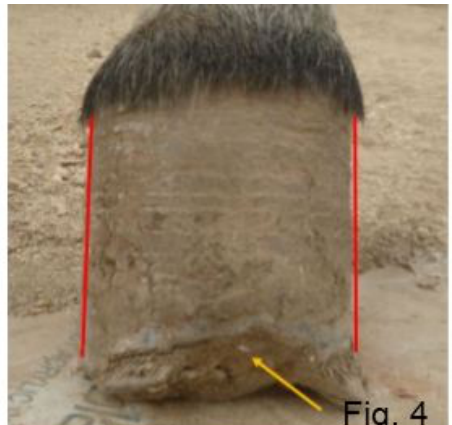


Fig. 4

Contracted heel dorsal view



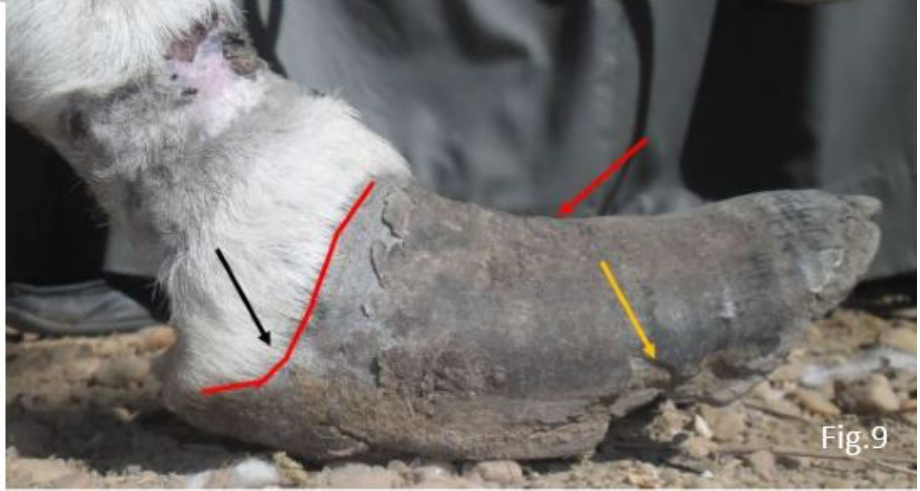
Club foot palmar view



Club foot palmar view



Long toe underrun heel solar surface



Long toe underrun heel lateral view