



ULTRASONOGRAPHIC EVALUATION OF NORMAL SCAPULA IN THE HORSE

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Summary

Ahrari-Khafi, M. S., A. Tabatabaei Naeini & N. Ajvadi, 2018. Ultrasonographic evaluation of normal scapula in the horse. *Bulg. J. Vet. Med.*, **21**, No 1, 50–58.

Scapular fracture is rare in horse, but if happen can cause severe lameness. Due to overlapping of the contralateral scapula and thorax on the scapula, usually radiography is not helpful in its evaluation except in small amount of distal part. This study was intended to document the normal ultrasonographic appearance of the equine scapula. Right forelimbs of six horses were used. To facilitate image understanding, a zoning system was developed. Ultrasonography was performed using a 5–11 MHz linear array transducer. Ultrasonographic anatomy of scapula in different parts and planes was imaged and documented. This diagnostic imaging technique revealed a high potential in evaluating scapular surface and possible regional injuries. Ultrasonography could be considered an important addition to radiography in diagnosing fractures in the scapular region.

Key words: horse, scapula, scapular fracture, ultrasonography

INTRODUCTION

Equine scapula is a triangular shaped flat bone, situated on the cranio-lateral part of the thorax. It is extended obliquely from the fourth thoracic spine to the distal end of the first rib. It has two surfaces, three borders and three angles. Spine of scapula extends from the dorsal border to the neck of the bone and divides the lateral surface in two fossae: supraspinatus fossa which is smaller and is located cranial to the spine and occupied by the supraspinatus muscle and infraspinatus fossa which is larger and is situated caudally to the spine and lodges the infraspinatus muscle. In-

fraspinatus muscle is covered with the deltoideus muscle. Cranial border is convex and caudal border is slightly concave. Scapular cartilage is placed on the dorsal border. Ventrally, the glenoid angle is joined to the body of the bone by the neck of the scapula (Sisson *et al.* 1975; Budras *et al.* 2009). Because of the appropriate protection of scapula by muscles, scapular fracture is not frequent in horse. Supraglenoid tubercle is the most common site of fracture and is usually the result of trauma (Dyson, 1985; 1986; Pankowski *et al.*, 1986; Bleyaert *et al.*, 1994; Rooney,

1998; Kidd *et al.*, 2007). However complete fractures of the scapular body and neck have been reported uncommonly (Bukowiecki *et al.*, 1989; Shamis *et al.*, 1989). Fractures can occur as a result of direct damage such as falling heavily to one side or not often as a result of a misstep. Fracture of the blade or body of scapula is rare and can occur in racehorses as stress fractures of the scapula. There is no limb preference in fractures (Rooney, 1998; Vallance *et al.*, 2009). There is a history of acute moderate lameness after vigorous exercise in these cases (Davidson & Martin, 2004; Vallance *et al.*, 2009).



Fig. 1. Mediolateral radiograph of the equine shoulder joint. Due to the superimposition of the thorax and contralateral scapula only small part of the scapula in distal region can be depicted by radiography.

As fractures of the scapula can cause lameness and poor performance in horses, its diagnosis has an important value. Radiography is just possible in evaluating

distal parts of scapula such as glenoid cavity and acromion process (Fig. 1). Due to the superimposition of the thorax and contralateral scapula, fractures in upper regions are difficult to identify on radiographs (Davidson & Martin, 2004). Although ultrasonography is mainly used for diagnosis of soft tissue injuries, it also can be used for evaluation of bone surface abnormalities (Redding & Pease, 2010). It is more relevant in diagnosis of fractures in areas where there is difficulty in radiographic imaging, such as pelvis and scapula in large animals. The normal ultrasonographic appearance of equine shoulder region has been described (Tnibar *et al.*, 1999; Kidd *et al.*, 2014), however, according to our best knowledge there is no detailed description on normal ultrasonographic anatomy of the scapula in horse.

The purpose of this study was to describe normal ultrasonographic appearance of the scapula in horse for assisting the diagnosis of scapular fractures.

MATERIALS AND METHODS

Ultrasonographic anatomy of the scapula was obtained from right forelimbs of six mix-breed horses of mean age 5.41 (range 3–8) years. Clinical evaluation of forelimb lameness was performed for all horses. Ultrasonographic images were obtained in longitudinal and transverse planes using a SonoScape (A6 Vet) system with a 5–11 MHz linear array transducer. Sedation was not used and horses examined in the standing position. Using palpation, scapular area was localised and prepared by clipping the hair and applying alcohol and ultrasound coupling gel. To facilitate the interpretation of images and thorough evaluation of the scapula, a zoning system was developed. In longitudinal axis, seven

zones were established from cranial to caudal border of the scapula, namely zone A: cranial border of the scapula to supraspinatus fossa; zone B: supraspinatus fossa; zone C: supraspinatus fossa and having scapular spine on the edge of image; zone D: scapular spine; zone E: infraspinatus fossa and having scapular spine on the edge; zone F: infraspinatus fossa with small overlap with zone E; zone G: infraspinatus fossa to caudal border of the scapula (Fig. 2). By placing the ultrasound probe transversely in the dorsal border of the scapula on each longitudinal zone and sliding ventrally, transverse images were taken from dorsal border to the shoulder joint. In zone D the scapular spine in the mid portion has an orthogonal position to the scapular surface or sometimes is bowed caudally, so both sides or caudal side of the scapular spine cannot be depicted easily so probe fanned caudally or cranially to evaluate cranial or caudal sides of the scapular spine respectively. If the scapular spine be bowed enough, may be its caudal side cannot be seen at all. Going ventrally the width of the scapula progressively decreases, so adjacent zones gradually were overlapped. In transverse axis 10 (1 to 10) zones were also established. Due to the limited width of our ultrasound probe that was about 4.5 cm, every 4 cm length of the scapula considered a transverse zone, starting in dorsal border and continuing to the shoulder joint (Fig. 3). The number of zones may increase in taller or decrease in shorter horses. By placing the ultrasound probe longitudinally in the cranial border of the scapula on each transverse zone and sliding caudally, longitudinal images were taken from cranial to the caudal border. Longitudinal and transverse plane images of all examined parts were saved and transferred to a PC for more evaluation.

All applicable national and institutional guidelines for the care and use of animals were followed during the study.



Fig. 2. Scapular bone craniocaudally is divided to 7 zones (A–G) in longitudinal plane.



Fig. 3. Scapular bone proximodistally is divided to 10, four-centimeter regions in transverse plane.

RESULTS

The zoning system was used in this study to insure complete evaluation of the scapula and ultrasonographic images of the scapula were obtained according to the determined zones. Structures that were examined in these zones included: infra and supra spinatus muscles, deltoideus muscle, infra and supra spinatus fossae and scapular spine.

The surface of the scapula was imaged as linear hyperechoic contour showing acoustic shadowing distally that is characteristic for bone image ultrasonographically (Fig. 4). However mirror-image artifact sometimes prevents the shadowing to be completely clean (Fig. 5). By sliding the probe dorsoventrally and craniocaudally in the defined zones, continuity of the scapular bone could be seen, except about disruption caused by the scapular

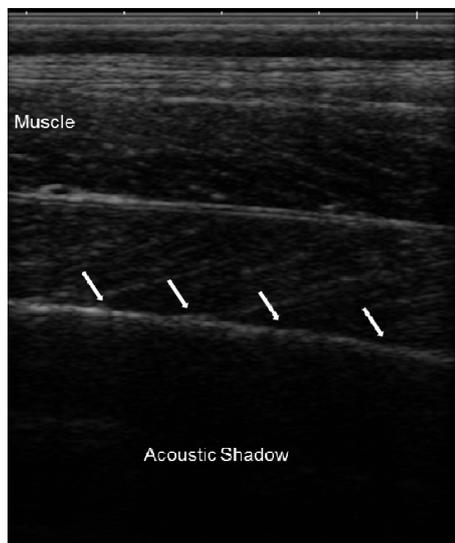


Fig. 4. Surface of the scapula can be seen as a hyperechoic line (arrows) above the acoustic shadow. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

spine in longitudinal images when passing zone D and in transverse images of zone D (Fig. 6).

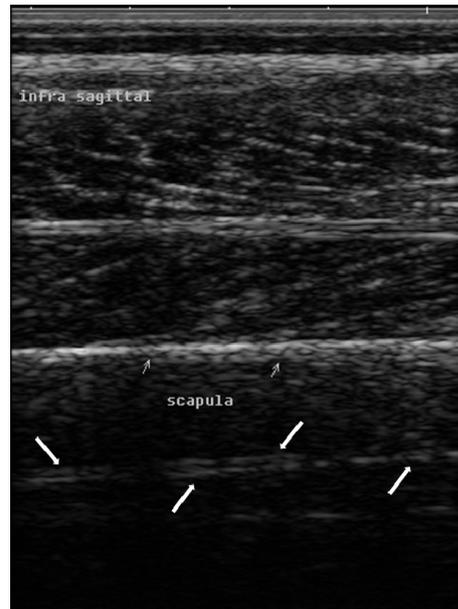


Fig. 5. Below the scapular bone (small arrows) mirror-image artifact can be seen (large arrows). The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

The dorsal border of the scapula was seen in longitudinal plane in zone 1 by sliding the probe craniocaudally from zone A to zone G. Just above the dorsal border, ultrasound waves could pass to the soft tissues and acoustic shadowing caused by scapular bone that could serve as a guideline for locating edge of the dorsal border no longer exists (Fig. 7). By placing the probe in longitudinal plane and sliding craniocaudally in the next transverse zones (2–10) the continuity of the bone surface could be evaluated. In transverse zones cranial and caudal borders could be recognised by sliding of the probe craniocaudally; cranially beginning

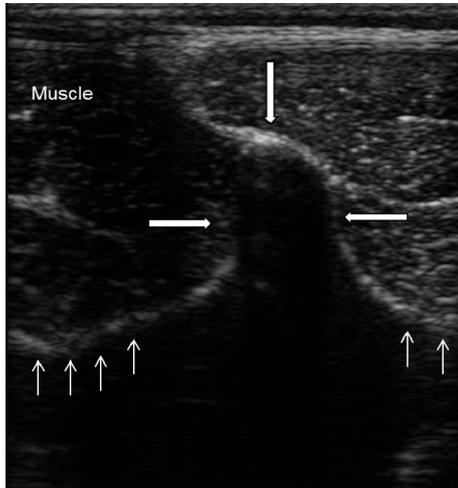


Fig. 6. Transverse image in zones D and 5, showing scapular spine (large arrows) as a disruption in the straight bone surface (thin arrows). Cranial is to the left. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

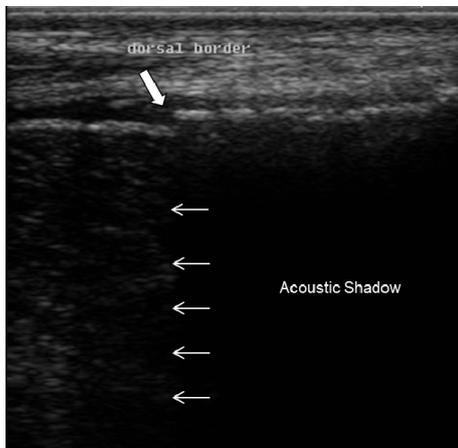


Fig. 7. Longitudinal image in the dorsal border of the scapula (large arrow). Above the dorsal border that is scapular cartilage, ultrasound waves could pass to the soft tissues (thin arrows). Dorsal is to the left. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

of the acoustic shadowing was the cranial border and caudally just before termination of the shadowing was the caudal border. In longitudinal zones cranial and caudal borders could be recognised in zones A and G respectively just next to acoustic shadowing caused by scapular bone (Fig. 8). Dorsoventrally the width of the transverse zones decreased gradually. In zone D the scapular spine initially appeared as a convex surface dorsally, gradually increased in height to the middle of the scapula and thereafter its height decreased gradually (Fig. 6, 9).

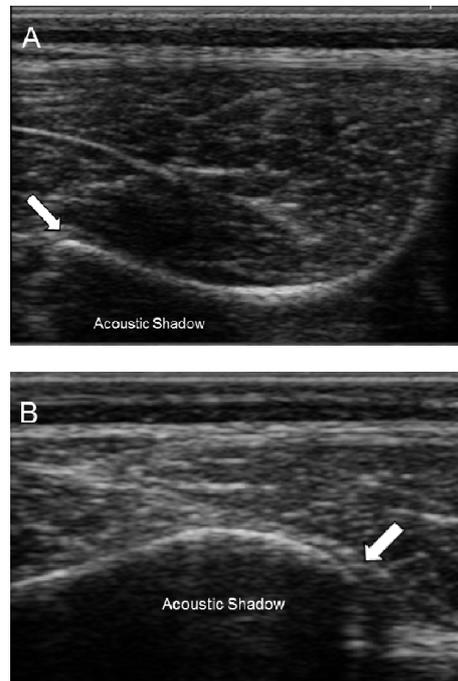


Fig. 8. Cranial (A) and caudal (B) borders of the scapula in transverse images are shown in zones A and G, respectively. Beginning of the acoustic shadowing indicates borders (arrows). Cranial is to the left. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

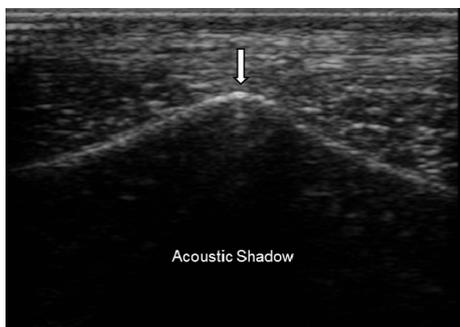


Fig. 9. Transverse image, zones D and 2, showing convexity of the scapula at beginning of the spine development (arrow). The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

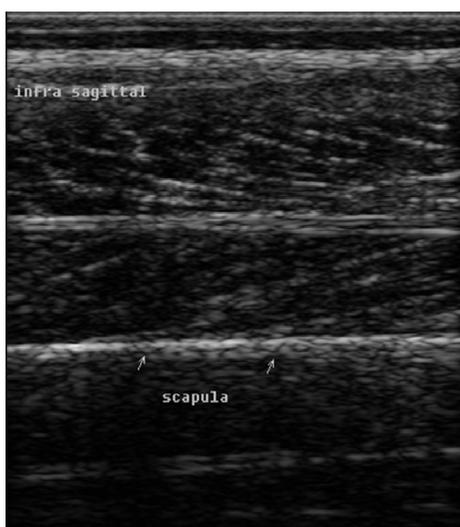


Fig. 10. Infraspinatus muscle is seen between the skin and the scapula (arrows). In longitudinal plane muscle seen relatively hypoechoic with fine, oblique, hyperechoic striations. Dorsal is to the left. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

In all zones muscles could be seen with different thicknesses between skin and bone surface. The supraspinatus mus-

cle seen in the supraspinatus fossa and caudally, the infraspinatus muscle seen in the infraspinatus fossa and covered with the deltoideus muscle. The muscles are thickest in the middle of the scapula and the thickness tapers dorsally and ventrally. In longitudinal planes the fibres of the muscles seen as slabs of irregularly striated hypoechoic tissue contained within the thin hyperechoic lines of fascia (Fig. 10). In transverse planes muscles appeared dotted and punctuate, or formed short lines (Fig. 11).

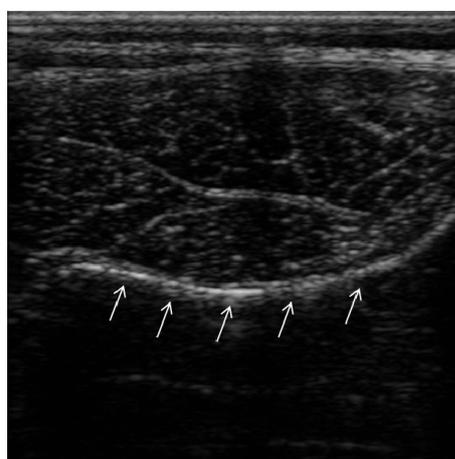


Fig. 11. Supraspinatus muscle is seen in transverse plane above the scapula (arrows). The muscle fibres are seen dotted and punctuate and form short lines. The image was obtained using a linear array transducer with 8–12 MHz frequency and depth was set at 62 mm.

DISCUSSION

Scapular fractures are rare, and most fractures involve supraglenoid tubercle which can be diagnosed by radiography (Dyson, 1985; 1986; Pankowski *et al.*, 1986; Bleyaert *et al.*, 1994; Rooney, 1998; Kidd *et al.*, 2007). Because of superimposition of

the thorax and contralateral scapula, fractures of more proximal regions are difficult to be imaged by radiography. Due to the ability of ultrasonography in evaluation of bone surface, it can be considered as an alternative technique to evaluate these regions. Knowledge of normal ultrasonographic appearance of the scapula is necessary for detecting abnormal conditions. This study intended to provide a complete normal ultrasonographic description of the scapula to help in detecting scapular fractures and soft tissue injuries in scapular region.

Stress fractures are one of main causes of lameness in racehorses (Mackey *et al.*, 1987; Ruggles *et al.*, 1996; O'Sullivan & Lumsden, 2003; Vallance *et al.*, 2009) and lots of them occur without a history of specific trauma (Pilsworth *et al.*, 1994; Shepherd *et al.*, 1994). The reason could be secondary to repetitive mechanical loading of bone that finally lead to resulting bone lysis exceeds bone replacement. Subsequently to this maladaptation microfractures can occur and with continued overload, the bone could be subject to stress fractures (Roub *et al.*, 1979). Stress fractures usually respond favourably to conservative management (Davidson & Martin, 2004). Ultrasonography is useful for the diagnosis of bone surface abnormalities like stress fractures in areas where radiographic evaluation is difficult such as scapula and pelvis (Pilsworth *et al.*, 1994; Shepherd *et al.*, 1994). A displaced fracture is seen as hyperechoic bony structure distracted from the parent bone. Irregularity in bone contour adjacent to the fracture site could be signs of callus formation (Davidson & Martin, 2004; Vallance *et al.*, 2009). Even in distal parts of the scapula, due to minimal fracture displacement related to stress fractures, radiography may be unable to

show the site of injury (Vallance *et al.*, 2009). Over the recent years due to enhanced understanding of bone and joint anatomy and the progress in ultrasound technology, ultrasonography has got considerable application in orthopedic examination (Allen, 2008). Furthermore, as ultrasound machines can be portable and inexpensive, having the ability of dynamic imaging, and lack of ionising radiation, nowadays musculoskeletal ultrasonography has a great application for diagnosis abnormalities.

In addition to skeletally immature cases where bones may not be completely calcified, and therefore radiography is not useful, ultrasonography can be a valuable alternative (McCrary & Schaefer, 2011). In the present study, a 5-11-MHz linear transducer and a zoning system were used. Linear transducer allowed appropriate resolution for all the examined anatomic structures and zoning system guaranteed complete bone evaluation. Ultrasonographic imaging was easily performed and allowed evaluation of the scapular body, neck, spine and borders. Furthermore, ultrasonography of the scapular area allows dimensional and qualitative assessments of the regional muscles and can be useful for diagnosing injuries of the infraspinatus, supraspinatus and deltoideus muscles.

The major weakness of ultrasonography is that it is very user dependent and necessitates high experience and a comprehensive understanding of the normal anatomy (Long & Nyland, 1999). High frequency (7.5–10 MHz or more), linear transducers are generally best for evaluating flat bones surface and muscles.

In conclusion, ultrasonography could be considered an important addition to radiography in diagnosing fractures in the scapular region. If clinical signs indicate

that the source of lameness is the scapular area, absence of radiographic abnormalities should not prevent using ultrasound as an alternative technique for evaluation of scapula and regional muscles.

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Paper received 25.08.2016; accepted for publication 25.11.2016

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