Novel oblique radiographic projection of the temporomandibular articulation of horses

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A novel radiographic projection is described for assessing part of the temporomandibular articulation of horses. It minimises the superimposition of osseous structures of the cranium that limit the usefulness of conventional projections and permits improved imaging in cases of suspected disease.

A RENEWED interest in equine dentistry has led to the recognition of a variety of disorders affecting the masticatory system of horses. The temporomandibular joint is probably the least well understood component of the system and its anatomy has only recently been fully described (Rodriguez and others 2006). The study of the kinematics of the joint, the key to understanding any dysfunction, is in its infancy (Bonin and others 2006, 2007). Although disease involving the joint is thought to be rare (Ramzan 2006, Carmalt and others 2006), it is often imaged in investigations of abnormal head carriage or disorders of mastication.

Traditionally, the joint has been examined radiographically by means of lateral and dorsoventral views, and just off-lateral oblique views to separate the right and left joints (Butler and others 2000). On lateral and lateral oblique radiographs, the superimposition of the osseous structures of the cranium invariably results in poor differentiation of the anatomical outline of the articulation, and subtle radiographic changes are not detectable. As a result, conventional radiographic projections are generally of use only in the assessment of severe disease such as luxation (Hardy and Shiroma 1991) or fracture (Hurtig and others 1984). Even when there are advanced arthritic changes conventional views can be inconclusive (Warmerdam and others 1997, Weller and others 1999a) and it is this unreliabilty that has prompted the application of other methods, such as ultrasonography (Weller and others 1999b, Rodriguez and others 2007), arthroscopy (May and others 2001, Weller and others 2002), scintigraphy (Weller and others 1999a, Ramzan 2003) and computed tomography (Tietje and others 1996, Smallwood and others 2002). Computed radiography, although enabling better quality cranial radiographs than conventional radiography, has not overcome the problems associated with osseous superimposition in the region of the joint, and several studies of abnormalities of the joint have stressed these difficulties (Tietje and others 1996, Warmerdam and others 1997, Weller and others 1999a). In order to improve radiography as a diagnostic procedure, a novel radiographic projection has been developed to 'skyline' the lateral osseous structures of the articulation.

MATERIALS AND METHODS

Radiographic technique

Horses were radiographed with a ceiling-mounted 700 mA, 175 kV x-ray unit and computed radiography system (Agfa-Gavaert). All personnel wore lead aprons, gloves and thyroid collars. The small area of interest made it possible for the x-ray beam to be precisely collimated and a medium-sized digital cassette in a cassette-holder was used. The horse's chin was generally supported by a lead-gloved hand, distant from the tube and x-ray beam. Other means of supporting the head in the correct position included using a headstand or slinging the chin with a rope. The horses were restrained with a rope head collar but it was often possible to remove it for the actual imaging. A level of sedation sufficient to minimise any reaction to the movement of the cassette and x-ray tube, and to permit the neck to be extended without resistance was required, and it was provided by a combination of approximately 12 µg/kg detomidine hydrochloride. (Domosedan; Pfizer) and 25 µg/kg butorphanol tartrate (Torbugesic; Fort Dodge Animal Health) administered intravenously.

The accurate imaging of the temporomandibular region was facilitated by supporting the horse's head by the chin in a near-horizontal position with the poll extended and mouth closed. The x-ray tube was positioned in front of and below the head to one side, facing caudally. The x-ray beam was directed at 35° to the long axis of the head and angled up at 50°, centering on the ipsilateral temporomandibular joint (Fig 1). A medium-sized digital cassette in a cassette-holder was placed above the poll in a horizontal position. An exposure setting of 70 kV and 10 mAs was used for this rostral 35° lateral 50° proximal-caudal oblique projection.

Images

This radiographic projection allows good visualisation of the lateral osseous structures of the temporomandibular articulation (Fig 2); the radiographic landmarks have been identified by the examination of anatomical specimens. On the projected image the structures axial to the plane of the coronoid process of the mandible are obscured by the superimposition of the calvarium. The temporal condyle of the squamous temporal bone has a flat or slightly concave ventral border, and is confluent dorsally with the superimposed radiopacity of the zygomatic process. The temporal condyle/zygomatic process is bounded axially by the temporal fossa and separated ventrally from the mandibular condyle by the smooth-margined radiolucent joint, comprising the articular cartilage and disc. The mandibular condyle is visible as a shelf presenting a slightly convex dorsal margin to the joint, the convexity increasing axially. Despite the large object-film distance, the quality of the image is satisfactory with the osseous margins and bone trabeculation well defined.

This technique has been applied to 10 to 15 horses per year for several years, approximately half of them being thoroughbred and half non-thoroughbred horses. A quarter of them have been less than five years of age, a quarter five to 10 years of age and the rest older. There have been approximately twice as many females as males. The radiographic features described above have been consistent between animals apart from some variations in the width of the joint space and in the outline of osseous structures, depending on the obliquity of the beam. The images have not been analysed objectively with respect to age, breed or gender, but subjectively the authors have not observed any characteristic differences between the groups.

DISCUSSION

Computed tomography and magnetic resonance imaging are superior to radiographic imaging in the investigation of

Veterinary Record (2008) **162,** 714-716

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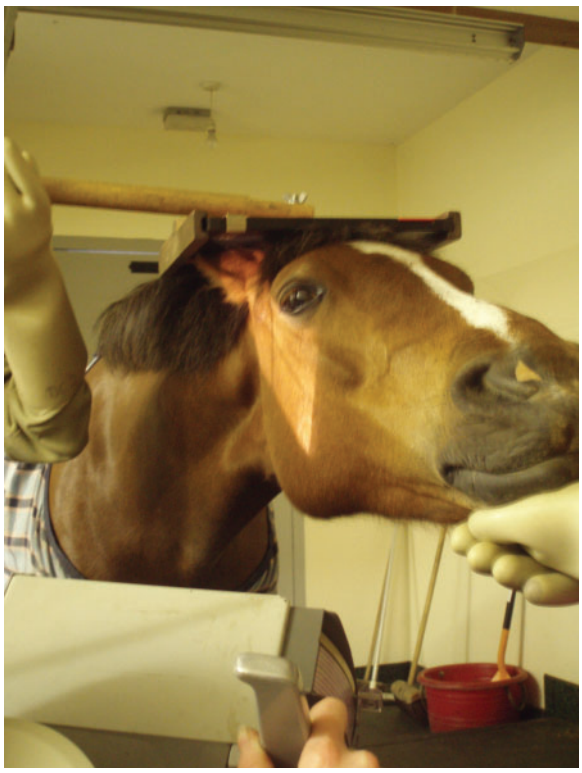

FIG 1: Positioning of the x-ray tube and cassette for an oblique radiographic projection of the temporomandibular joint of a horse

the temporomandibular joint of horses and are likely to be applied more often in future. Static imaging of the joint, particularly by radiography, permits no assessment of soft tissue structures, and is of limited usefulness in the investigation of suspected joint dysfunction. In human beings, temporomandibular disorders are most frequently associated with an internal derangement of the joint, usually a dysfunction of the relationship between the articulating surfaces and the disc (Sommer and others 2003). In horses, similar pathology would not be brought to light by any radiographic examination of the joint, and investigations of the movements of the jaw would be more relevant (Carmalt and others 2003, Bonin and others 2006, 2007).

Nevertheless, radiography has a role in the investigation of suspected temporomandibular disease in horses. In people, panoramic radiography of the temporomandibular joint is used to identify gross osseous changes such as condylar erosion, flattening, sclerosis and osteophyte formation (Crow and others 2005, Shen and others 2005). The radiographic projection described provides a better assessment of the joint than conventional projections, and although a ceiling-mounted unit is used the technique does not require hospital-level facilities. Given that the bulk of the lateral structures of the joint are not superimposed by other osseous structures of the head, this part of the joint can be imaged much as closely as any distal limb articulation might be.

Since the technique was developed, the authors have observed little radiographic evidence of degenerative changes in the horses investigated for disorders of head carriage or mastication; however, it is expected that any degenerative joint disease will be indicated by modelling of the joint margins and/or changes in the appearance of the subchondral bone plate (Baker 2002). More work is required to determine the effect, if any, of age and head-type on the radiographic appearance of the joint. Equally, the effects of the obliquity of the x-ray beam and the degree of mouth opening on the width of the joint space on the projected image needs to be established before any possible link between the radiographic appearance of the joint and dental or occlusal pathology can be investigated. The examination of anatomical specimens suggests that the mouth-closed position is to be preferred but the use of multiple projections in investigations of suspected disease of the joint should not be discounted. In human dentistry it has been observed that some milder radiographic changes, such as condylar sclerosis and flattening, may be due to a positioning artefact (Crow and others 2005) and it is therefore important to view any evidence of subtle radiographic changes in horses with caution. In spite of the need to establish these parameters of normality for the radiographic appearance of the temporomandibular joint, this novel 'skyline' projection should be considered the radiographic technique of choice for the assessment of the joint, given the deficiencies of standard radiographic views.

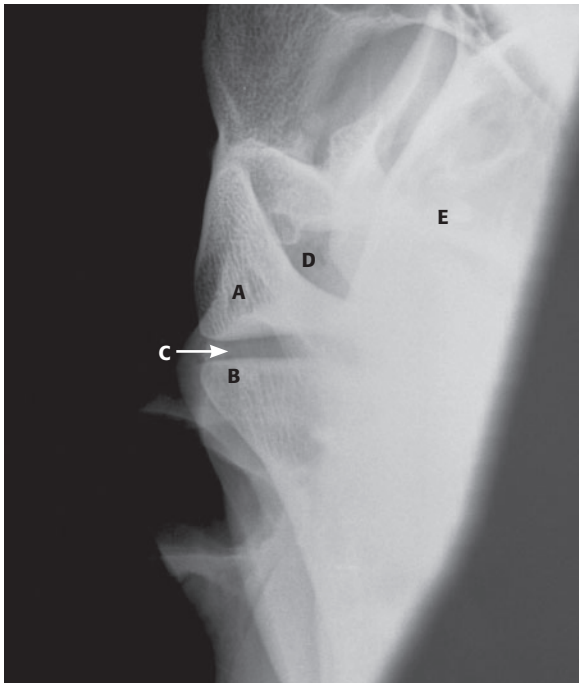

FIG 2: Radiograph of the right temporomandibular region of a horse. A Temporal condyle, B Mandibular condyle, C Temporomandibular joint, D Temporal fossa, E Calvarium

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