Arthrocentesis of the temporomandibular joint in adult horses

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Objective—To develop a method for arthrocentesis of the temporomandibular joint in adult horses.

Animals—7 equine cadaver heads and 6 clinically normal adult horses.

Procedure—Fluoroscopy, contrast radiography, and computed tomography were used on cadaver specimens to locate the temporomandibular joint, identify externally palpable landmarks for joint access, guide needle placement into the joint, and illustrate regional anatomy. The arthrocentesis technique was performed on 6 live healthy adult horses to determine efficacy and safety of this procedure.

Results—externally palpable structures were identified as landmarks for temporomandibular arthrocentesis, including the lateral border of the condylar process of the mandible, the zygomatic process of the temporal bone, and the lateral pericapsular fat pad. Arthrocentesis was successful in all 6 joints in the live horses, and no complications developed.

Conclusions and Clinical Relevance—The technique identified will improve the ability to examine and treat the temporomandibular joint in horses. (Am J Vet Res 2001;62:729–735).

The temporomandibular joint (TMJ) is the diarthrodial articulation between the condylar process of the mandible and the articular tubercle of the temporal bone. A meniscal cartilage compensates for incongruencies between the 2 articular surfaces. Ligaments on the lateral aspect of the joint attach dorsally to the zygomatic arch and retroarticular process of the mandible and the zygomatic process of the temporal bone. A meniscal cartilage compensates for incongruencies between the 2 articular surfaces. The joint is the site of articular incongruencies and a meniscal cartilage that pads the joint. Arthrocentesis is a valuable tool for sampling synovial fluid, providing intrasynovial anesthesia, and administering medication intraarticularly. Techniques for arthrocentesis of joints in the limbs have been described, but to the authors’ knowledge, reports of TMJ arthrocentesis have not been made in the equine literature. Therefore, the purpose of the study reported here was to determine a safe, simple, and reliable technique for arthrocentesis of the TMJ in adult horses.

Materials and Methods

Cadaver study—Seven adult horses that did not have clinical signs of disease associated with the TMJ were euthanatized for reasons unrelated to the skull and digestive system. There were 2 Arabians, 2 Quarter Horses, 1 Morgan, and 2 grade horses; of the 7 horses, 5 were mares, and 2 were geldings. These horses ranged in age from 12 to 35 years and ranged in weight from 400 to 650 kg. The heads were removed at the occipitoatlantal joint and placed on a radiographic imaging table in lateral recumbency. Survey fluoroscopic images were produced to locate the joint, and a 20-gauge 1.5-in needle was placed in the identified region. Periodic reexamination with fluoroscopy was used to guide adjustments in needle positioning and advancement into the TMJ. Negative pressure was applied through the needle with an attached 12-ml syringe for aspiration of synovial fluid, after which 5 to 15 ml of iodinated contrast medium (diatrizoate meglumine) was injected into 1 TMJ and shaving cream was injected into the contralateral joint to create gas opacity for contrast arthrography. Each head was radiographed in right and left lateral recumbency with the x-ray beam centered at the TMJ (100 kV; 8 mA; phototimer-controlled exposure time; 30-cm f/1m focal film distance). A computed tomographic (CT) scan was performed in ventral recumbency through the TMJ region (120 kV; 120 mA; 2 seconds; 0° tilt; 512 matrix; 1.5-mm contiguous slices; large scan field of view). These imaging procedures were performed to confirm correct intraarticular placement of the needle and identify palpable anatomic structures to be used for landmarks for guiding needle placement. Each head was then dissected to identify regional structures and determine the proximity of vascular and nervous tissues to the joint. Tissue from the lateral joint capsule was removed from 1 joint, fixed in neutral-buffered 10% formalin, embedded in paraffin, and sectioned for histologic slide preparation. The slides were stained with H&E and examined by a veterinary pathologist.

Live animal study—Using the externally palpable structures and angle of needle insertion identified in the cadaver study, arthrocentesis was performed on 1 TMJ in each of 6 clinically normal adult horses. The Michigan State University All-University Committee on Animal Use and Care approved all procedures performed on the live horses. Horses were sedated by use of IV administration of detomidine hydrochloride (0.01 mg/kg of body weight) 5 minutes before preparation of the joint. A rectangular region of the hair was clipped from the lateral canthus of the eye to the base of the external ear and from a line dorsal to the zygomatic process of the temporal bone to a line ventral to the facial crest. The skin was cleansed with povidone-iodine and alcohol. Sterile
gloves were used as the zygomatic process of the temporal bone and the condylar process of the mandible were palpated as osseous landmarks to locate the joint. A 20-gauge 1.5-in needle was inserted into the TMJ to a depth of 0.5 to 1.5 in, a 3-ml syringe was attached, and synovial fluid was aspirated. The joint was distended with 5 ml of 2% mepivacaine hydrochloride to confirm correct intraarticular placement of the needle and to induce synovial analgesia. Horses were observed for alterations in the pattern of mastication and facial muscle tone and for signs of complications associated with this procedure.

Results

Cadaver study—Radiographic viewing of the zygomatic arch and the condylar process of the mandible was helpful for initial orientation to the anatomic features of the TMJ. A radiolucent space representing the joint between the condylar process of the mandible and the articular tubercle of the temporal bone was visible on a lateral radiographic view of the skull (Fig 1). Articular cartilage and the meniscus primarily occupied this space, so access to the joint cavity from a direct lateral approach was not successful. Caudal to the condylar process of the mandible, a small soft region that corresponded with the dorsal joint compartment, the lateral joint capsule, and subcutaneous fat was palpable. Needle insertion through these soft tissues allowed access to the joint for injection of contrast media for radiographic and CT arthrograms (Figs 2 and 3). Synovial fluid was recovered from 1 fresh cadaver head but not from refrigerated specimens, so contrast arthrography was necessary to confirm intrasynovial needle placement. Positive contrast arthrography was successful in 6 joints, whereas in 1 joint, incorrect needle placement too far caudal caused injection into the parotid salivary gland. Evaluation of negative contrast arthrograms also confirmed correct needle placement in 7 joints; however, difficulties with the manual injection of shaving cream under pressure caused leakage of contrast medium from the joint. It was difficult to interpret the negative contrast arthrograms because of artifactual gas between muscles caused by postmortem disarticulation of the head. Gross dissection of the cadaver heads was useful for identification of the regional structures. Nerves and
vessels near the lateral surface of the head were protected from accidental needle damage by palpable bony prominences (Fig 4). The superficial temporal artery and vein and the auriculopalpebral nerve crossed the temporal bone rostral to the ear and caudal to the TMJ. The transverse facial artery and vein and the transverse facial branch of the auriculotemporal nerve ran parallel and ventral to the facial crest. The facial nerve was superficial to the masseter muscle and coursed diagonally across the ramus of the mandible in the ventral and rostral direction. The supraoculter artery, vein, and nerve passed through the frontal bone via the supraorbital canal, which was rostral to the zygomatic arch. The parotid salivary gland filled the jugular groove, caudal to the vertical ramus of the mandible and ventral to the base of the ear, but in 1 cadaver the gland extended rostrally to cover the lateral surface of the TMJ bilaterally.

The synovial cavity was divided into 3 pouches. The largest compartment was dorsal to the meniscus and ventral to the articular tubercle of the temporal bone (Figs 2 and 3). Because of the superficial location of this compartment, the arthrocentesis technique described in this report accessed the joint at this location. A smaller compartment of the synovial cavity was ventral to the meniscus and dorsal to the condylar process of the mandible. Little synovial fluid was detected in this compartment at gross dissection and only a small amount of contrast media filled this space after positive contrast arthrography (Figs 2 and 3). The third pouch was a caudal extension of the dorsal compartment located caudal to the articular tubercle of the temporal bone, rostral to the retroarticular process of the temporal bone, and medial to the condylar process of the mandible (Figs 2 and 3). In 3 cadaver TMJ, 3 ml of new methylene blue was injected into the dorsal compartment. On dissection of the joints, the synovial fluid was colored blue in all 3 pouches immediately after the dye injections. This finding confirmed communication of the 3 compartments.

Histologic examination of the soft tissues of the lateral joint capsule in 1 horse revealed a small amount of intracapsular fat between the synovial membrane and the connective tissue of the capsule. There was also a subcutaneous layer of fat located superficial to the connective tissue of the capsule. All of these soft tissues and synovial distention of the dorsal joint pouch contributed to the palpable soft region dorso-caudal to the condylar process of the mandible.

Live animal study—Temporomandibulilar joint arthrocentesis yielded synovial fluid in all 6 horses. In 5 joints, fluid spontaneously filled the needle hub, and in the sixth joint, a 3-ml syringe was attached to the needle for gentle negative pressure to aspirate synovial fluid. Grossly the fluid was translucent, light yellow, and moderately viscous. Back pressure on the plunger was only felt in 2 joints during the injection of 5 ml of 2% mepivacaine hydrochloride solution, whereas separation of the syringe from the needle allowed free flowing fluid to reflux through the needle, suggesting pressure release from all 6 joints. All of the horses were adequately sedated by use of IV administration of 5 mg of detomidine hydrochloride, and none had signs of pain or fear. No alterations in the pattern of mastication or fascial muscle tone were detected within 24 hours, and no clinical signs of complications were observed during a 30-day period after the procedure.

The following technique was determined to be a safe and effective method for arthrocentesis of the TMJ in adult horses:

1) Locate the lateral margin of the condylar process of the mandible at the midpoint between the lateral canthus of the eye and the base of the external ear. This may be readily done by placing the first digit of the hand at the lateral canthus of the eye and the fifth digit at the base of the external ear with the second to fourth digits flexed. The third digit will lie adjacent to the lateral margin of the condylar process of the mandible. This orientation implies using the left hand for the right TMJ and vice versa for the left TMJ (Fig 5).

2) Palpate the zygomatic process of the temporal bone 1 to 2 cm dorsal to the condylar process of the mandible. Imagine a line between these 2 bony prominences (Fig 6).

3) Locate a small soft region or depression midway
between the bony prominences and 0.5 to 1.0 cm caudal to this line (Fig 6). This is the point of entry for the needle.

4) Sedate the horse by administering 5 mg of detomidine hydrochloride IV.

5) An assistant should restrict patient movement by holding the horse's head at the muzzle in a neutral position.

6) Clip the hair from the base of the ear to the lateral canthus of the eye and from the zygomatic arch to the facial crest. Cleanse the skin thoroughly with povidone-iodine and alcohol. Wearing a sterile glove, repeat the palpation steps to identify the landmarks.

7) Insert a sterile 20-gauge 1.5-in needle in the following orientation: begin perpendicular to the skull in the sagittal and dorsal planes, and direct the point of the needle approximately 15° rostrally (caudolateral to rostromedial direction). The needle hub may also need to be elevated to direct the point ventrally about 15°, depending on the individual horse (Fig 7).

8) Advance the needle 0.5 to 1.5 inches into the joint or until fluid is present in the hub. If contact is felt with bone, it is most likely the articular tubercle of the temporal bone, and the needle should be partially withdrawn and redirected slightly ventrally. If the needle is directed too far ventrally, it may become embedded in the meniscus or contact the condylar process of the mandible, in which case it should be partially withdrawn and redirected dorsally.

9) Have a sterile 3-, 6-, or 12-ml syringe available to collect synovial fluid. If no synovial fluid appears in the needle hub, then a syringe may be attached for application of gentle suction.

Discussion

The cadaver study was useful for learning the radiographic and gross anatomy of the TMJ. Periodic examination of the needle and joint by use of fluoroscopy was initially helpful for visual guidance, but palpable landmarks were identified for locating the dorsal joint compartment and eventually eliminated the need for fluoroscopy. Gross dissection of these specimens confirmed the location and accessibility of the dorsal joint compartment and communication of the 3 joint pouches. In the literature, only 2 compartments to the TMJ have been described, which are dorsal and ventral to the meniscus. To the authors’ knowledge, no specific reports addressing communication of these compartments has been published. Perhaps the dorsal and caudal pouches were considered 1 compartment or this caudal pouch was not observed. The potential clinical importance of the caudal pouch is its close proximity to the temporohyoid articulation. Communication of the 3 joint pouches suggests that fluid from the dorsal pouch would be representative of fluid from the entire joint unless a disease process inhibited this fluid exchange. To the authors’ knowledge, a technique for selective arthrocentesis of the caudal or ventral compartments of the TMJ has not been described.

Mild joint distention for synovial analgesia or joint flushing may be achieved with injection of 5 ml of fluid. Back pressure on the plunger or distention of the lateral joint capsule may be associated with the intraarticular injection of 5 ml of fluid. Maximal joint distention was reached with 10 to 15 ml of fluid in the cadaver specimens, but tissue cooling likely caused decreased distensibility of the joint capsule, so the TMJ may be able to hold a greater volume in a live horse. Excessive fluid volume injection (> 15 ml) in the absence of back pressure on the plunger or joint capsular distention suggests that the needle is incorrectly positioned and is most likely in the parotid salivary gland. Accidental injection of iodinated contrast media into the salivary gland did not occur in the live horse study, because contrast arthrography was not performed in these horses. However, if it were to happen, it should not cause a clinical problem, because this agent is intentionally administered into the gland in sialography.

In the live animal study, arthrocentesis of the TMJ was successful in all 6 horses. The technique for locating the lateral margin of the condylar process of the mandible midway between the lateral canthus of the eye and the base of the external ear was repeatable with horses of various sizes. One horse was quite thin and lacked the palpable soft tissue region dorsocaudal to the condylar process of the mandible. In its place, there was a deep indentation that still served as an accurate landmark for needle placement and access to the joint. It was helpful to braid the forelock and tuck it under the halter to avoid contamination of the cleansed skin. The needle insertion was easily performed with 1 gloved hand while the other hand was available to restrain the external ear. Synovial fluid was quickly and easily obtained from all 6 joints. Complications did not develop in any of these horses after the procedure.
In a previous report, investigators did not identify synovial fluid by sonographic examination of the TMJ. This may have been because of the position of the transducer in contact with the head, particularly if the probe was directed at the lateral margin of the condylar process of the mandible. To access the joint cavity for arthrocentesis, the point of needle insertion must be caudal and dorsal to the condylar process of the mandible. From this approach, synovial fluid was readily acquired from all 6 live horses and from 1 fresh cadaver; fluid was not acquired from frozen and thawed specimens. If the cadavers used in the previous report were also frozen, inability to view joint fluid may have been an artifact of tissue preparation.

Only adult horses were used in our study, because the squamous portion of the temporal bone is shaped differently in immature horses, compared with adults. The zygomatic process of the temporal bone is not as prominent and the mandibular fossa is not as deep in foals, compared with adults, so the bony landmarks are more difficult to palpate.3

A minimally invasive means of access to a synovial cavity is a valuable technique for sampling synovial fluid. For synovial fluid, gross and cytologic examination, RBC and WBC counts, bacteriologic culture, and measurement of protein concentrations are useful tests for diagnosing joint diseases.10 Arthrocentesis is also used for intraarticularly administering analgesic agents to localize a source of joint pain and to administer medications such as antimicrobials, anti-inflammatory medications, and hyaluronic acid.

Arthrography of the TMJ in humans has been described, but the technical difficulty of the procedure, patient discomfort, and exposure to ionizing radiation limit its use.11 Computed tomography and magnetic resonance imaging have replaced arthrography for imaging of the TMJ in humans. As these modalities become more available in veterinary hospitals, they will enhance the diagnosis of TMJ disorders. In our study, CT of the cadaver specimens was useful for viewing the contrast media in the synovial cavity. Fistulography and CT were useful imaging studies in 2 cases of septic arthritis of the TMJ in horses.4 Both horses in that report were evaluated because of chronic draining tracts near the TMJ that provided a route of access to the joint for the contrast material. Techniques for positive and double contrast arthrography have been described for radiographic examination of some equine joints but have not included the TMJ.6

References
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