The possibilities of osteopathic manipulative treatment for dysfunctions of the equine temporomandibular joint

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Introduction

In the literature there is still scarce amount of knowledge about the equine temporomandibular joint (TMJ), compared to the human TMJ which has great research interest and has been thoroughly studied (Rodriguez & Agut & Gil & Latorre 2005: 146). Among other things thorough studies investigating TMJ anatomy variations for asymptomatic horses are lacking (Carmalt et al. 2016: 237).

Somatic dysfunction is an altered or impaired function of related elements of the somatic system which includes arthrodial, skeletal, and myofascial structures with related neural, vascular, and lymphatic components. Somatic dysfunction is considered to be a functional rather than a pathological problem. (Parsons & Marcer 2006: 16-18.) Somatic dysfunction is amenable for manipulative intervention and can be identified by:

- Pain or tenderness on the area.
- Asymmetry of related components of the musculoskeletal system which are either structural or functional.
- Altered range of motion of a joint or region of the musculoskeletal system.
- Tissue texture abnormalities of the soft tissues of the musculoskeletal system. (DeStefano 2017: 9.)

Thus in this paper usage of ‘dysfunction’ will mean a functional rather than a pathological entity. In some cases it is difficult to differentiate somatic dysfunction from a pathology because they can exist at the same time and symptoms and signs could be overlapping. For example, joint arthrosis is a pathology, but symptoms manifest as a somatic dysfunction. Arthrosis is irreversible, progressive condition and no treatment can cure it, but with osteopathic manipulative treatment it is possible, for example, to reduce pain, decrease swelling and inflammation and increase range of motion in the affected joint. Studies concerning the equine TMJ, which were reviewed for this thesis, use terms TMJ pathology or disease because mainly all of those cases describe some form of TMJ pathology. This might be due to the fact that a clear distinction between equine TMJ dysfunction and TMJ pathology is still missing. In this thesis all equine TMJ diseases are included under the term TMJ pathologies.

In humans TMJ dysfunctions are a collective term that includes dysfunctions of the TMJ along with the masticatory muscles and associated structures of the cranio-cervical-mandibular complex in the absence of visceral pathology. TMJ dysfunction can be characterized by restricted mandibular movement, pain, muscle spasms and joint sounds (Cuccia & Caradonna & Annunziata & Caradonna 2009: 180; Detoni et al. 2020: 187).

Number of horse owners are convinced that TMJ pathologies can cause performance issues in their sport horses (Jorgensen & Christophersen & Kristoffersen & Puchalski & Verwilghen 2014: 126). Especially term “poor performance” is increasingly reported as a sign of equine TMJ pathologies and it has become almost a trendy diagnosis (Carmalt 2023: 1). It is often difficult to differentiate TMJ pathologies from other pathologies as symptoms and signs are unspecific. Clinical signs have been reported to include bit problems, change in head carriage, headshaking, problems in swallowing and mastication, dropping food from the mouth, decreased range of motion of the mandible and localized pain. (Jorgensen et al. 2014: 126.)

Clinical signs that are attributed to TMJ pathologies can be easily explained by other more common problems for example lameness or cardiovascular, respiratory, and dental diseases. Lack of extensive scientific evidence between TMJ pathologies and behavioral or performance changes maintains the ambiguity around the subject. However, equine TMJ pathologies have been reported to be a cause of poor performance and they should be included in a differential diagnosis list. (Carmalt 2023: 1.)

Anatomy of the equine temporomandibular joint

The human and equine TMJ has a similar development pattern, and studies report the close relationship of the TMJ between masticatory muscles and middle ear (Rodriguez et al. 2005: 146). Equine TMJ is a complex synovial joint. Temporal part of the joint is formed on the base of the zygomatic process of the temporal bone and consist of articular tubercle, mandibular fossa and retroarticular process. Ventral part is formed by the mandibular head on the condylar process. Shape of the TMJ is incongruent and consists of two independent joint compartments separated by a biconcave intra-articular disc (Adams et al. 2018: 35; Carmalt 2023: 1). Illustration of anatomy of the equine TMJ (Figure 1.).

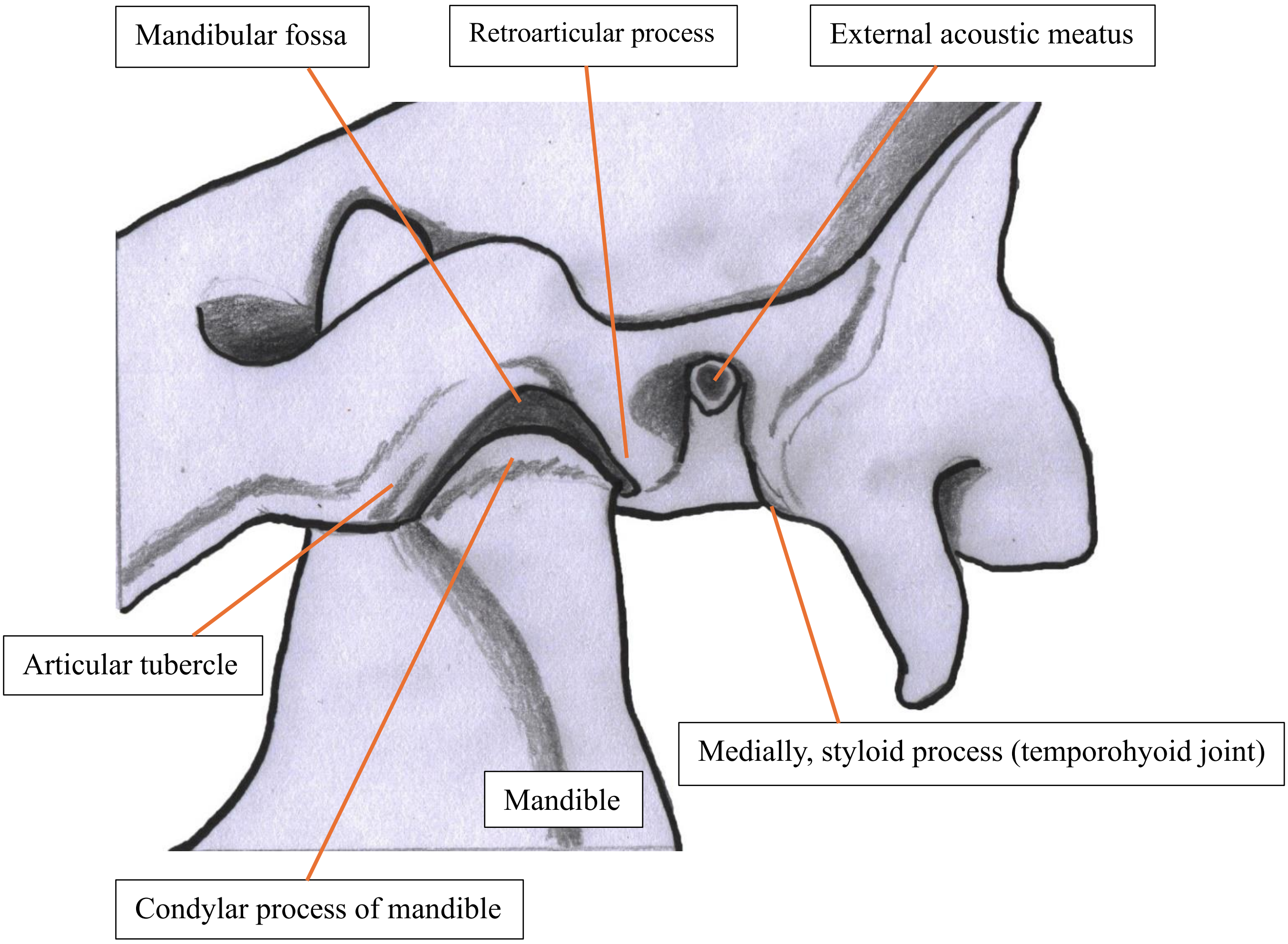

Figure 1. Equine temporomandibular joint (imitaded drawing based on Ruddock-Lange 2018: 36).

The articular structures

Compared to other synovial joints of equine body, articular surfaces of the TMJ are covered with fibrocartilage rather than hyaline cartilage (Adams et al. 2018: 35). Fibrocartilage is described as a transitional tissue between hyaline cartilage and dense connective tissue which makes the fibrocartilage highly resistant to compression (Armiento & Alini & Stoddart 2018: 291). Mandibular fossa is exception from this because it lacks both the fibrocartilage and hyaline cartilage and instead is covered by thin layer of dense connective tissue (Adams et al. 2018: 35).

Equine TMJ has common gross anatomical features with the TMJ in other mammals, but the difference is the unique zoning pattern in the fibrocartilage of the equine TMJ. This cellular characteristic in the equine TMJ is suggesting that the equine TMJ has higher proliferative and regenerative capacities than for example human TMJ. In human TMJ the condylar cartilage has a proliferative mesenchymal cell layer underneath a superficial fibrous zone. This mesenchymal cell layer may be responsible for constant cell proliferation and regeneration. Study findings of Adams et al. (2018) suggest that in the equine condylar cartilage there is no clear distinction between a superficial fibrous zone and a proliferative mesenchymal cell layer. Based on these findings it is assumed that in the equine condylar cartilage proliferative and regenerating cells are dispersed within the superficial fibrous zone. This characteristic cellular feature might be one explanation for rather low number of clinical TMJ pathologies in horses. Also, diagnostic limitations can be a reason. (Adams et al. 2018: 35, 40.)

Equine TMJ has complete articular capsule that is thicker rostrolaterally. There are also two capsular reinforcements, lateral and caudal ligaments. Fibrocartilaginous articular disc is developed with a thick periphery, a thin central part and from its caudomedial aspect a fibrous expansion arises between the retroarticular process and the caudal part of the mandibular condyle. From lateromedial axis the shape of the articular disc is biconcave. The articular disc is inserted laterally on to the joint capsule and the mandibular condyle. Medially the articular disc is inserted on to the joint capsule and temporal bone. Caudomedially the articular disc is inserted retroarticular space and the tympanic part of the temporal bone. (Rodriguez et al. 2005: 143, 146.)

Muscles, vascular and neural components, and other related structures

Muscles affecting the equine TMJ are *m. masseter, m. temporalis, m. pterygoid lateralis, m. pterygoid medialis* and occipitomandibular part of the *m. digastricus*. These muscles are referred to as TMJ stabilizer muscles. *M. parotidoauricularis* is also considered to have relationship to the equine TMJ. *M. temporalis* has attachments onto medial and rostral sides of the articular disc and joint capsule. *M. masseter* has attachments onto lateral side of to the articular disc and the lateral and rostral sides of the joint capsule. *M. pterygoideus lateralis* has attachments rostromedially onto articular disc and joint capsule, while *m. pterygoideus medialis* has a weak attachment onto the joint capsule. (Rodriguez et al. 2005: 143-146.)

Vascular components consist of *a. & v. maxillaris* and its branches *a. & v. facialis transversus* and *a. & v. temporalis superficialis*. Neural components consist of *n. facialis, n. massetericus, n. mandibularis* and *n. auriculotemporalis*. (Rodriguez et al. 2005: 143.) The main innervation for the TMJ comes from mandibular branch of *n. trigeminus* (Carmalt et al. 2016: 237). The caudal segment of the articular capsule is near *n. facialis* and the *a. & v. temporalis superficialis*. Medially, the TMJ is close by the *plexus pterygoid venosus* and *n. mandibularis. N. massetericus* crosses over the mandibular incisure and it is surrounded by fibers of the articular capsule and disc. (Rodriguez et al. 2005: 144-145.)

The equine TMJ has close relationship to temporohyoid joint, dorsal part of the stylohyoid bone, parotid gland, lateral aspect of the guttural pouch, and external auditory meatus (Rodriguez et al. 2005: 143-145). Especially the hyoid apparatus has close interaction with the TMJ via temporohyoid joint and hyoid muscles.

Function of the equine temporomandibular joint

The equine TMJ is under great stress and cyclic loadings, as a horse is estimated to graze for 16 hours per day under natural conditions (Pereira et al. 2016: 49). The exact path of motion of the mandibular head and the articular disc during the masticatory cycle, is still unknown. Especially the distribution of translational and rotational movements, either to the ventral or dorsal joint compartment, remains ambiguous. In humans, thorough knowledge of TMJ function and anatomy has enabled the development of specific diagnostic and therapeutic strategies for TMJ dysfunctions. Therefore, deeper understanding of equine TMJ biomechanics and function is relevant for developing diagnostic and therapeutic strategies for horses. (Adams et al. 2018: 38-39.)

Adams et al. (2018) study reports that the equine articular disc has a similar distribution of glycosaminoglycans (GAGs) as other herbivorous mammals (cattle, rabbits, and goats). GAG content expresses tissue areas that are adapted to withstand higher compressive loads. The equine articular disc has a constant distribution of GAGs across all regions. In several herbivorous mammals throughout distribution of GAGs in the articular disc indicates a predominant translatory movement in the TMJ which is in line with study results in horses. Considerable amounts of GAGs can also be found at bony structures of the mandibular head and the rostral part of the articular tubercle. (Adams et al. 2018: 39.)

Both in humans and horses' the mandibular fossa has almost the same histomorphological characteristics. According to these characteristics mandibular fossa is not exposing to compressive loadings and therefore mandibular fossa is considered to be a resting place for the mandibular condyle. (Adams et al. 2018: 39.)

In humans, initial movement in mouth opening is rotation around a horizontal axis through both condylar heads in mandibular fossa. This movement occurs between condyle and related articular disc. As this hinged movement has reached its maximum, further mouth opening occurs by gliding motion of the condyle and articular disc along the articular tubercle. (Helland 1980: 149.) Based on equine TMJ study findings this same movement pattern can also be assumed to occur in horses (Adams et al. 2018: 39).

Presence of nervous elements in the human articular disc and in the TMJ of the rhesus macaque (Asian Old-World monkeys) has been described in detail in previous studies and is assumed to be connected to TMJ proprioception. According to those findings nervous elements are dispersed within the joint capsule and periphery of the articular disc but are absent from the center of the articular disc and the fibrocartilage lining the bony components. These findings are consistent with observations of the Adams et al. (2018) study of the functional anatomy of the equine TMJ. (Adams et al. 2018: 40.)

Equine temporomandibular joint pathologies and their possible causes

The equine TMJ could be affected by same diseases that affect other synovial joints such as septic arthritis, osteoarthritis or congenital dysplasia. Also tearing of the articular disc has been reported. (Easley & Dixon & Schumacher 2011: 377.) A common cause of equine TMJ degenerative joint disease is trauma, which can be caused by a fracture and/or subluxation of the mandibular condyle and lead to disruption of the articular surface (Smyth & Allen & Carmalt 2017: 72, 75). Lack of clinical studies concerning pathologies of the equine TMJ could be explained by a horse's inherent protective mechanism to adapt to pain (Carmalt et al. 2016: 238). In other words, a horse's species-specific behaviour mode as a prey animal is to mask the pain and thus hide weakness from possible predators. Hiding the pain is possible by developing different kind of compensatory patterns such as postural changes in head, neck, back and pelvis along with changes in leg alignment and shoulder angles. Therefore, it may be difficult to detect possible problems at early stages. Another explanation might be the capacity of the articular cartilage to regenerate due to an undifferentiated mesenchymal cell layer as described earlier. Also, interpretation of possible pathologies from diagnostic imaging is challenging due to the complex anatomical structure of the joint. (Carmalt et al. 2016: 238.)

The equine TMJ could be affected by degenerative joint disease or osteoarthritis, but clinical significance of these pathologies has yet to be determined (Smyth et al. 2017: 72). One computed tomography (CT) study indicated that in asymptomatic horses the TMJ possibly undergo age-related alterations both in terms of shape and density (Carmalt et al. 2016: 244). Because of undetermined clinical signs it is possible that some cases of degenerative joint disease are either unnoticed or incorrectly diagnosed (Smyth et al. 2017: 72).

The possible causes of TMJ dysfunctions in humans are multidimensional, including psychological factors (anxiety, stress, and depression), physical (muscle spasms, trauma, malocclusion, bruxism causing clenching or grinding of teeth) and biochemical (vitamin insufficiency). It is also stated that TMJ dysfunctions may originate from sacral dysfunction. (Cuccia et al. 2009: 180.) As there is a limited number of studies concerning equine TMJ it is difficult to define differences between TMJ pathology and dysfunction. However, the human and equine TMJ have very similar anatomical and functional characteristics. Due to this, it could be hypothesized that also TMJ dysfunctions share the same features. During training a horse wears a bridle, a bit, lunging aids etc. most of the time. This equipment can create tension for example in the mouth, tongue, poll, and neck, i.e. in areas that are in a close interrelationship with the TMJ.

Possible symptoms and signs in horses

In human studies TMJ dysfunctions with adjacent dental occlusions have been reported to affect gaze stability, center of gravity and physical performance. Reports have also shown correlation between TMJ dysfunctions and vertigo in elderly patients. (Reisbig & Pifko & Lanovaz & Weishaupt & Carmalt 2023: 2.) An assumed connection between equine TMJ pathology and dental malocclusion has been made but has not been clinically confirmed (Smyth et al. 2017: 72).

Pain affects greatly in a horse's performance by decreasing it or causing overt lameness. Oral discomfort can lead to "rein- "or "bridle-lameness" when applying pressure to a horse's mouth via reins and bit. One study showed that equine TMJ inflammation can be a source of rein contact avoidance under study conditions. (Reisbig et al. 2023: 2, 6.)

Some studies show that intra-articular TMJ pathology as for example septic arthritis can cause facial pain to horses. Clinical signs in TMJ pathologies could include mastication problems, for example problems during swallowing or dropping food from the mouth. (Carmalt et al. 2016: 238; Smyth et al. 2017: 72.) Additionally, range of motion of the mandible can decrease accompanied with localized pain and swelling (Jorgensen et al. 2014: 126). Some cases may present clicking sound during mastication and recurrent episodes of colic. Severe chronic cases may develop bony enlargement of the TMJ, atrophy of the masseter muscles, weight loss and dental malocclusions. Behavioural issues such as fighting against the bit, changes in head carriage and sometimes headshaking could also be present. (Smyth et al. 2017: 72.) Some stereotypies may emerge, such as lip smacking, frequent yawning or resting with the tongue protruded from the mouth (Carmalt 2023: 1).

Osteopathic manipulative treatment for temporomandibular joint dysfunctions

In humans, thorough knowledge has enabled development of therapeutic strategies for TMJ dysfunctions (Adams et al. 2018: 39). However, no scientific research about osteopathic manipulative treatment for the equine TMJ was available as reference for this thesis. Therefore, studies about osteopathic manipulative treatment for the TMJ dysfunctions in humans were reviewed for this thesis.

General principles of osteopathy

In osteopathy there are four key principles:

- The concept of unity which includes body, mind, and spirit.
- The interplay between structure and function.
- The body possess self-regulatory mechanisms.
- The body has inherent capacity to defend and repair itself.

And supplemented principles:

- The disease can occur when the normal functioning of the body is disrupted, or when factors that adversely affect the health of the environment exceed the body's own health maintenance capacity.
- The flow of body fluids is an essential part of maintaining balance (homeostasis).
- Nerves regulate the flow of body fluids.
- There are somatic components that are not only manifestations of disease but also factors that contribute to maintenance of disease. (Parsons & Marcer 2006: 9.)

Osteopathic manipulative treatment is based on these principles and there are several treatment options to target osteopathic diagnoses. A somatic dysfunction can be treated in a variety of ways depending on a patient’s age, the severity of the diagnosis, the size of the patient, the setting, etc. (Roberts et al. 2022: 3.) This diversity of treatment options makes osteopathy very applicable not only to different kind of human individuals but also to horses and other animals.

Animal osteopathy is applied from human osteopathy and each practitioner will develop his own diagnostic routines and therapeutic techniques, based on training, experience and preference. Animal osteopathy began to gain recognition when practicing osteopaths started to treat animals due to their own interest. It was noticeable that osteopathic treatment so successful in humans could be applied with equal success to animals. (Pusey & Brooks & Jenks 2010: 2-3.)

Treatment for temporomandibular joint dysfunctions

Osteopathic treatment with musculoskeletal manipulations is effective for the treatment of TMJ dysfunctions. Compared to other conservative treatments options such as oral appliances, hot or cold pack, TENS or stretching the musculoskeletal manipulation approaches has better outcome in TMJ dysfunctions. (Martins et al. 2015: 16.) It is possible to reduce pain and improve range of motion in the TMJ dysfunctions with osteopathic manipulation techniques such as myofascial release, strain-counterstrain, balanced membranous/ligamentous tension, muscle energy, joint articulation, high-velocity, low-amplitude thrust, and cranial sacral therapy (Cuccia et al. 2009: 181). Patients with TMJ dysfunctions may present myofascial trigger points in the neck and masticatory muscles. Trigger points are hypersensitive areas in the taut band of skeletal muscles' fascia that can cause sensory, motor, neurological and autonomic nervous system symptoms. (Menéndez-Torre et al. 2023: 2.) Trigger points are very amenable e.g. to osteopathic manipulative therapy interventions.

Studies show that treatment of the TMJ with myofascial release has a strong effect on decreasing the pain in long term, but active range of motion of mouth opening didn't show clinical significance. On the other hand, mobilization and manipulation of the cervical region present significant decrease in pain and increase in the active range of motion of mouth opening, but in this case pain relief is only short term. The effect on increasing the active range of motion of mouth opening by mobilization and manipulation of the cervical region could be explained by a biomechanical relationship between the TMJ and the cervical spine. The movement of the atlanto-occipital (OA) joint and the upper cervical vertebrae (C1-C3) occur simultaneously with the masticatory muscle activation and the positional changes of the mandible. Thus, changes in the cervical joints affects the biomechanics of the TMJ thus affecting the function of the mandible. (De Castro & Da Silva & Basilio 2017: 5-6.)

Researchers suggest that the endorphin system may be elicited by osteopathic manipulative therapy, with anxiolytic, analgesic, sedative, and hemodynamic effects. Therapies targeting the masticatory system may have significant neurologic implication via sensorimotor integration with the brainstem, subcortical and cortical centers, cervical region, body posture and proprioception. Positive therapy effects may be explained by neural plasticity which could have been induced by therapeutic interventions. (Cuccia et al. 2009: 182-183.) It is possible to have an influence on an individual's autonomic nervous system with osteopathic manipulative therapy and for example to decrease stress and anxiety and therefore possibly to have effect on TMJ dysfunction.

Conclusion

As a third-year student of osteopathy in Metropolia University of Applied Sciences' I have found that osteopathic manipulative treatment has almost no limitations at all. Multidimensional approach makes the treatment effective, individual, and easily applicable. When I chose my thesis topic, I was aware about the limitations considering the scientific studies in equine field especially regarding the osteopathic approach. However, animal osteopathy is applied from human osteopathy and research, and therefore I wanted to continue on my path.

Both human and equine TMJ have very similar anatomical and functional characteristics so TMJ dysfunctions could be assumed to share same features. Therefore, osteopathic manipulative treatment protocols could be applied from human TMJ dysfunctions to equine TMJ dysfunctions. Based on reviewed studies osteopathic manipulative treatment could benefit horses with TMJ dysfunctions. The challenge is to differentiate TMJ dysfunction from TMJ pathologies, riding issues, tooth pain, undetected lameness, etc., based on symptoms and signs.

A pathology could manifest symptoms as somatic dysfunction and untreatable somatic dysfunction could lead to manifestation of a pathology. It is noteworthy that somatic dysfunction is treatable with osteopathic manipulative intervention, but pathologies are not. Thus, it is always necessary to consult a veterinary if osteopathic treatment does not improve a horse' symptoms or even before any osteopathic treatment in cases of severe pain or suspected pathological process. Appropriate veterinary diagnostics is required to rule out any underlying pathologies and to initiate necessary medical or surgical treatment. This is essential for animal welfare in cases when only conservative treatment of a dysfunction is not adequate and appropriate. When a diagnosed pathology is under veterinary care, it is possible to support the treatment with osteopathy and alleviate some of the symptoms such as pain, swelling and inflammation.

Osteopathic treatment techniques are very applicable for horses except some techniques that require a patient's intentional muscle contraction and total muscle relaxation such as muscle energy techniques. Other techniques may require some fine adjustments when treating horses but overall, osteopathic principles are the same. Also, when treating a horse, the osteopath must have experience in working with horses and knowledge of anatomic variations of a horse compared to a human.

I have a previous education as a licensed equine massage therapist. Therefore, I have been working with horses for many years. With osteopathic training I have begun to apply osteopathic techniques and principles when treating horses. In line with the topic of this thesis I have osteopathically treated horses with hypertonic masticatory muscles, discomfort when moving the mandible and tension at the hyoid apparatus area. I have used techniques such as TMJ compression and traction, myofascial release, muscle inhibition, and balanced ligamentous tension at the hyoid apparatus (contact at the basihyoid part), and the treatment results have been positive. It should be noted that in these cases, no diagnosed TMJ pathologies were present. Could they have been TMJ dysfunctions? Maybe.

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