MODELS OF HEADACHE AND THEIR IMPLICATIONS FOR TREATMENT USING MANUAL THERAPIES

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Paper submitted September 14, 2001

ABSTRACT

Headaches represent symptom collections reflecting various mechanisms. True pathology causing headache is comparatively rare and therefore headache symptoms generally reflect functional disturbances. Models of headache pathogenesis may lead to therapeutic interventions, or be extrapolated from successful therapeutic interventions. These can provide a basis for research and case management. If we consider symptom expression as a manifestation of a threshold response and headache sufferers as a population with lowered threshold, therapeutic approaches may be oriented to changing the thresholds. Headache symptoms may also represent the sensitivity to other triggers, which make it easier to reach a similar symptom threshold. Treatment would then be oriented to changing the response to the triggers. This paper presents models of manual therapies related to headache treatment and discusses research directions, relation to medical models of headache and a discussion of clinical considerations for treatment. Since individuals with headaches may represent a broad spectrum of etiologies, these models may be utilized in developing and fine-tuning individual programs of treatment as well as guiding future research. Manual therapies have significant potential relative to managing headaches. There are differences in application and technique that may be considered when approaching individual presentations. Understanding the mechanisms behind different models may provide a basis for fine-tuning therapeutic algorithms for individual presentations. (*J Chiropr Med* 2002;1(2):62–69)

KEY WORDS: Headache; Chiropractic

INTRODUCTION

Headaches represent a common presentation to offices providing manual interventions. In spite of the presence of an ICD-9 code for headache, the symptom does not necessarily define the underlying cause. Investigation into headache etiology may define therapeutic interventions.

Newman and Lipton state “although there are more than 300 medical conditions that can produce headache, fortunately, the majority of headache disorders are benign” (1). The statement (from an article regarding emergency department evaluation of headache) reflects an issue that most manual therapy practitioners are familiar with: clinical evaluation for pathology is typically unrevealing. While the possibility of underlying pathology (other than functional disturbance) does mandate close clinical evaluation for every presentation of headache, in the absence of obvious pathology a basis for therapeutic intervention must be developed in addition to evaluation for pathology.

Manual therapy has been shown to provide relief of headache. This is not only true for cervicogenic headache (2–4) and tension headache (5) but also for vascular headache (6,7). There are reviews available relative to the appropriateness of application for manual therapy specific to the cervical spine (8,9).

The bulk of presentations then are expected to represent a functional disturbance of some sort. Chiropractic techniques of evaluation and treatment represent fairly unique interventions that often differ from medical models and approaches. Perhaps most striking within the context of headaches is that chiropractic approaches often consider the cervical spine as a causative component of headache whereas in allopathic medicine, cervicogenic headache as a distinct entity is still debated (10).

Because of the individuality of each presentation, therapeutic interventions for headaches must be individualized. Individual course of treatment may involve utilization of various models of pathogenesis of headache. Course of treatment must be adapted based on response. That adaptation may include consideration of other models.

This article will review chiropractic models relevant to headache within the context of some selected research models presented within the medical community.

DISCUSSION

Mechanical Deformation of Arteries

Changes in extracranial vascular flow are demonstrable using Doppler ultrasound relative to extreme ranges of

cervical motion. The testing allows a potential relationship to vascular headache to be considered with appropriate consideration given to risk factors. If vascular flow can be compromised as a result of altered cervical biomechanics, even low level changes may combine with other factors compromising flow to provoke symptoms. In addressing the dysfunction, manual approaches may address the biomechanical vascular insult. The anatomical relationship of the vertebral and carotid arteries to the cervical spine has been described not only as a risk factor relative to manual approaches but may also be postulated as a cause of headache, particularly vascular headache. The vertebral arteries enter the transverse foramen generally at C6 and ascend through the transverse foramina of the cephalad cervical vertebra. They course proximate to the rectus capitis posterior minor and suboccipital soft tissues. They turn medially over the atlas to join together as the basilar artery near the lower aspect of the pons.

The common carotid arteries (branching into the internal and external carotids) lie between the cervical anterior musculature and sternocleidomastoids. Mechanical deformation of the arteries is the basis for the functional testing of vertebrobasilar insufficiency; however, there is a question in the field regarding the validity of this testing (11). Recent Doppler ultrasound studies, including extreme ranges of cervical motion, failed to provoke adverse symptoms associated with altered vascular flow in healthy subjects (11). While this argues against a significant vascular risk of vascular damage following neck manipulation, it also argues against mechanical deformation of arteries as an etiology of headache in absence of pathology. However the measured changes may be sufficient to provoke headaches in individuals with greater predisposition than the postulated normal population group (see discussion regarding thresholds below). Pathology-creating risk may include the presence of degenerative spurring affecting the patency of the vertebral foramina. (12) Atherosclerotic plaquing within the arteries also may affect blood flow in the symptomatic patient. These pathologies indicate further vascular testing; they represent risk factors for manual therapy.

In the absence of contraindication, manual approaches relative to this model would be expected to address the cervical spine with particular attention to the upper cervical spine. Manual traction and other myofascial technique relative to the suboccipital musculature should be considered relative to the vertebral arteries. Similarly the cervical anterior musculature including the SCM may be addressed. Specific contact is necessary to avoid iatrogenic mechanical deformation of the ves-

sels. Osseous technique oriented toward function of the occiput, atlas and axis should be considered with recognition of the risk of extreme rotation. Consider emphasizing flexion/extension of the occiput and lateral flexion components first. Minimal force and velocity should be utilized when there is consideration of vascular deformation.

Reflex Autonomic Effects

If manual approaches modulate activity of the autonomic nervous system (a system mediating vasoconstriction) they should be able to modulate that activity as it relates to vascular headache. Autonomic response to manipulation is a basic tenet within chiropractic and has formed the basis for thermal testing with dual probe instruments (nervoscope, neurocalometer etc.) as well as thermographic study relative to the effect of chiropractic. Sato has discussed the autonomic responses relevant to mechanical interventions (13). Recent research has also substantiated the premise that manipulation may cause sympathetic excitation (14). This model may be considered in discussion of the phrase "trigeminal autonomic cephalgia," a proposed headache subclassification. Goadsby and Lipton state: "we hypothesized that the short-lasting headaches with autonomic features are characterized by a nexus of activation between trigeminal afferents (giving rise to pain) and cranial parasympathetic efferents (giving rise to autonomic features), a trigeminal-autonomic activation" (15). One direct autonomic mechanism in association with vascular headache could be due to mechanoreceptor reflex effects on the intermediolateral cell column of the upper thoracic cord, which may alter sympathetic balance of the cranial vasculature. Another would posit that upper cervical mechanoreceptor stimulation affects trigeminal pathways. That may mediate a reflex brainstem connection between the trigeminal nerve and the parasympathetic outflow of the facial nerve (15). These are consistent with models of vasoconstriction-vasodilation mechanisms of vascular and neurogenic headache. Regarding migraines, Vincent states, "the process seems to be fundamentally neuronal in nature" (16). Chemical approaches including triptans have affinity to receptors that are known to cause vasoconstriction (16). Manual approaches may modulate these responses by affecting the neuronal component of vasoconstriction-vasodilation mechanisms of migraine through either of the reflexes discussed above (sympathetic/parasympathetic).

Manual therapy would be oriented toward reflex modulation of autonomic activity. The upper thoracic spine and upper cervical spine would be the first areas to consider. More vigorous osseous technique would be

considered when attempting to stimulate reflexes. Tolerance should be assessed prior to application of more vigorous technique through progressive application.

Direct Mechanical Irritation to Cervical Sympathetic Ganglia

Headache (particularly vascular) may relate to altered activity of the autonomic nervous system. Sitting along the anterior aspect of the cervical spine just posterior to the common and internal carotid arteries are the superior, middle, and inferior cervical ganglia. These house the synaptic connection between the preganglionic and postganglionic sympathetic neurons. Mechanical deformation of nerves may alter neuronal firing. Logically, mechanical deformation and/or inflammatory changes of sympathetic ganglia would be expected to alter sympathetic activity including the vasomotor responses much in the same way as discussed above. Articular dysfunction may secondarily affect the anterior soft tissues (musculature) proximate to these ganglia. Manual interventions to address the articular dysfunction may then reduce mechanical deformation of these ganglia and reduce the irritation causing inflammation. This consideration is particularly important when considering headaches with autonomic components. The SUNCT syndrome (short-lasting unilateral neuralgiform headache with conjunctival injection and tearing) has cervical movement as an exacerbating factor (15). This hypothetical mechanism may represent a part of the puzzle. Cervical movement affecting these ganglia (either mechanically or reflexogenically) may relate to the autonomic components. Consider that the conjunctival injection reflects vasodilation, an autonomic function. Tearing is a result of parasympathetic outflow of facial nerve innervation of the lacrimal gland. Irritation of sympathetic ganglia of the cervical spine may be a causative factor relative to these responses and would be expected to be affected by cervical movement.

Technique relative to mechanical deformation may address both the cervical spine mechanics (the ganglia lie along the anterior aspect of the cervical spine) as well as myofascial components of the anterior cervical musculature. As with consideration of the carotid artery, caution must be exercised relative to addressing the anterior cervical musculature. When considering direct mechanical irritation, force should be minimized.

Myofascial Effects

Headache may be related to muscle and connective tissue dysfunction. Changes in muscle activity following manual treatments have been demonstrated with elec-

tromyography (18–20). The very nature of the term “muscle tension headache” suggests therapeutic approaches oriented toward muscle and connective tissue. Although still controversial, the medical field is beginning to look more critically at this area (21) in developing therapeutic approaches. The relationship of cervical trigger points to cranial pain was outlined over a decade ago (22); however, the terms cervicogenic headache and muscle tension headache are still widely questioned. Even the International Headache Society diagnostic criteria do not consider cervicogenic headache (in the absence of demonstrable neck pathology) to be sufficiently validated as an entity (23). Regardless, myofascial pain referrals (myotogenous pain) causing headaches are routinely addressed with manual therapies.

While intuitively one might consider these presentations to suggest myofascial approaches specifically, muscle responses to osseous technique as measured with EMG supports the use of osseous adjustments. In that studies have shown muscular responses in regions of the body aside from those specifically adjusted (18), full spine techniques should be considered. Rehabilitative parameters and adjunctive therapies relative to the involved tissues should be considered.

Direct Relationships to Joint Functions

Headache may be a result of pain referred from joint dysfunction. That dysfunction may be relieved with manual therapies providing headache resolution. It has been shown that referred pain patterns are not limited to muscle (24). Along the same lines of myotogenous pain referral, cranial pain may be referred from articular structures and other tissues derived from mesoderm (scleratogenous pain referral). Pain referral from joint dysfunction (with consideration of either or both static malposition or motion aberration), strained capsules and/or ligaments certainly may play a role in headache. Restoration of appropriate joint motion would be expected to relieve abnormal mechanical loads on joints and reduce associated pain referrals. Joint dysfunction (particularly unilateral facet dysfunction) may alter axes of motion creating abnormal joint loading. Kinematic radiography investigation into the restoration of joint motion substantiates changes in articular function obtained with manual therapy (25,26). The restoration of appropriate function of zygapophyseal articulations may reduce scleratogenous pain referral from abnormal joint loading and/or connective tissue tensions including ligaments and joint capsules.

Osseous adjustment should be considered as treatment of choice. Therapeutic application should consider not

only motion and static palpation, but also patterns of pain referral relative to the presentation. Consider also application of adjustment using appropriate coupling mechanisms relative to joint function particularly when addressing sclerotomal localizations. Bilateral mobilization may be considered relative to this model.

Pain Blocking Effect of Manipulation

Mechanoreceptor stimulation with manual approaches has been demonstrated as having an inhibitory effect on pain (14). Pathways responsible for the phenomenon have been defined at the segmental level (27). Analgesic actions at the level of the thalamus or primary sensory cortices may be postulated. This analgesic effect is utilized by individuals who shake their hands after hitting a finger with a hammer or dance about the room after stubbing a toe. Many pain management modalities address pain and inflammation as maladaptive responses to common injuries (antiinflammatory, analgesic). They presume that these responses are beyond what is necessary for healing. In managing the acute symptoms, the body's natural processes would then take care of the cause of the problem easier in absence of the guarding responses in response to pain and the congestion of swelling. The effect of NSAIDs has been described as having less of an anti-inflammatory effect than analgesic effect when utilized in over-the-counter dosages (28). NSAIDs are used commonly as over the counter headache remedies. Manipulation may be the analgesic modality of choice when considering side effects of NSAIDs and the potential ancillary benefits of manipulation.

More vigorous osseous technique would be expected to have more quantum mechanoreceptor stimulation and thus more of an analgesic effect. Caution and clinical judgment are necessary to avoid irritating already irritated tissues and again a graded approach should be utilized assessing tolerance.

Mechanical Pressure on Nerves Creating Direct Effect and/or Secondary Neurogenic Effect Modulating Neurogenic Inflammation

Headache may relate to irritation of nerves causing inflammatory changes in related areas. It is known that sensory nerve root stimulation may cause the release of neurotransmitters that mediate neurogenic inflammation (16). The same is true in animal experiments regarding the release of vasoactive peptides in response to greater occipital nerve stimulation (15). Certainly manual approaches have been shown to cause changes in nerve activity in the presence of disc herniation (29).

The early premise of chiropractic treating "pinched nerves" has been modified in favor of other models; however, mechanical deformation of nerves as a result of local foraminal inflammation, venous ballottment or mechanical dysfunction in association with a narrowed foramen should be considered. Direct mechanical effects on the occipital nerves (due to the proximity to the upper cervical spine and suboccipital musculature) may also be considered. Mechanical irritation of sensory fibers is a potential etiology of neurogenic inflammation and resultant pain of neuritis or secondary vascular effects. Of particular consideration is the relationship between upper cervical nerve roots (sensory fibers particularly related with mechanical stimulation) and reflex relationships with the sensory fibers of the trigeminal nerve. These may contribute to vasomotor effects and intracortical inflammatory changes via the trigemino-vascular system (16). Manual therapies may reduce nerve compression (particularly in an intervertebral foramen compromised by spurring) by reducing inflammatory responses of tissues secondary to joint dysfunction, and by allowing appropriate foraminal deformation with tissue gliding.

Manual therapies should be oriented toward opening the IVF (contralateral lateral flexion) to the extent that is tolerated. Rotational considerations guiding application of manual therapy may include the orientation of degenerative spurring as it relates to the IVF. Particularly with degenerative changes and nerve root deformation, force must be applied judiciously. Minimal force as appropriate to the presentation should be utilized.

Cortical Neuronal Activity

Headache may relate to sensitivity of populations of cortical neurons. The mechanism of manual therapy affecting cortical activation is a consequence of the effects of afferent stimulus driving the thalamus. The thalamus contains nuclei for almost all types of sensation (with the exception of olfaction). Mechanical information is a major component of the sensory information reaching the thalamus. Tertiary neurons of the nucleus ventralis posterior of the thalamus affect the activity of somatosensory cortex. Although the thalamus is organized into distinct nuclei, afferent information of one type may affect either global cortical activity (e.g., reticular activating system, affecting alertness), or in theory, areas specific to other sensory modalities. This suggests a model in which the potential to excite cortical areas and achieve sensory awareness (e.g. visual) may be affected by other stimuli (including mechanical) reaching the thalamus. This mechanism may relate to

the phenomenon called spreading depression, originally described by Leao (30). Spreading depression refers to a hyperexcitability of neurons demonstrated experimentally in chick retina through mechanical stimulus to the retina (30). In essence, a focal area of depolarization spreads to the surrounding neurons. Spreading depression is currently receiving attention related to migraine (31). Evidence suggesting hyperexcitability of the occipital cortex (analogous to spreading depression) for migraineurs with aura has been obtained using transcranial magnetic stimulation with blood oxygen level dependent (BOLD) MRI (31). A mechanism is postulated in which the hyperexcitable neurons depolarize followed by repolarization, causing oxygen and high-energy phosphate consumption creating relative hypoxia, which is then followed by reflex vasodilation. Vasodilation (and associated plasma extravasation) may be associated with migraine (31).

The implications for research on manual approaches are obvious, and widespread. If hyperexcitability of the occipital cortex (or other areas) can be modulated through manual approaches, these approaches would be expected to reduce susceptibility to migraine. It would also suggest further formal study of manual therapy regarding the fields of neurology, psychiatry and aspects of health extrapolated from the central nervous system. PET, SPECT and BOLD scanning allow CNS activity assessments. These tools may be utilized to study the ability of manual approaches to modulate cortical activity.

Application of manual therapy in addressing this model will be best guided in conjunction with the specialized studies.

Dural Tensions

There are several techniques that consider meningeal tension related to headache. These are generally based on the attachments to the sacrum and occiput. Discovery of an attachment between the rectus capitis posterior minor and the dura mater (32) suggests that manual approaches addressing upper cervical myofascial function may affect the dura mater as well.

Therapeutic approach certainly should include a consideration of the occiput, atlas and sacrum; however, consideration should also be provided to the effect of the extremities and dural glide. Consider that meningeal stretch testing (eg, Brudzinski's) uses the lower extremities to create pull throughout the dural tube. Manual therapy and assessment strategies relative to them should consider the extremities within that context.

Human Interaction as Opposed to Placebo Effect

Manipulation may provide significant benefit by nature of the interaction between provider and patient. Research articles studying specific conditions responding to manual therapy have documented improvement relative to specific conditions. The improvement is often discounted as placebo affect (2,33). Such assessment discounts the value of human interaction within the therapeutic relationship. In the management of complicated presentations of pain, there may be enormous value from caring human interaction that add to the therapies applied. Recent study has shown that for individuals with chronic headache that their sense of having control over the headache is related to headache intensity as well as their perception of how pain interferes within their lives (34). Certainly this supports the old idea that "an understanding, reassuring physician who accepts the pain is real, not imaginary, helps greatly." (35) Education regarding headache has been shown to provide improvement relative to symptoms and reduced frequency of headache (36).

Ultimately, it may be the insurance industry that steps in on the basis of its own outcome data and comparative cost analysis between maintenance use of medication vs. manual therapeutic sessions. Many presentations of headache are managed with medication on a maintenance basis. Second and third party payers will consider cost comparison analysis when considering trials with manual therapy. Few patients or payers would be expected to complain that cost-effective management of chronic problems results from placebo affect. Although research into the value of manual approaches in management of headache may include caveats regarding placebo affect (33), as we shift the emphasis in health care to outcome assessments, the value of the human interaction inherent to manual approaches may be lauded rather than discounted as placebo.

Clinical Implications for the Field Practitioner

Some of the same mechanisms not only shed light on but provide implications for research relative to manual approaches as part of the therapeutic armamentarium in headache management. Any individual with an intact nociceptive system is a candidate for headache. The onset of symptoms has to do with a predisposition in response to either environmental or internal triggers (16). Headache sufferers may represent either individuals with a lower threshold for triggering symptoms, or greater sensitivity to symptom triggers (see figures 1a,b,c). Symptom triggers or stressors may be physical, chemical or mental. Physical stressors would include

Figure 1a: Normally, the response to environmental stressors is below the threshold to elicit headaches.

Figure 1b: Headache sufferers may have a greater response to stressors in the environment. Therapeutic approaches would focus on modulating the responses (e.g., allergic) and avoiding the triggers.

Figure 1c: Headache sufferers may have a lowered threshold for stressors that provoke headaches. Therapeutic approaches would focus on raising the threshold (e.g., postural predispositions).

Figure 1a: Normal response to environmental stress. Figure 1b. Normal threshold- greater response to stress. Figure 1c. Lower threshold- normal response to stress.

postural demands such as maintaining an awkward position. Examples include looking down at a desk, painting a ceiling looking up or sleeping on an airplane without adequate cervical support. Chemical stressors include environmental allergens (for example pollen or animal dander), toxins (consider solvent fumes from

paint, pest control sprays) food allergies and medication side effects. Mental stressors may include any perceived threat. General Norman Schwarzkopf may have summed it up when, discussing Gulf War Syndrome and the chemicals that soldiers were exposed to relative to pollutants, insecticides and vaccines, he stated “when you put all of the stuff together and the stress of combat, something obviously has made them sick” (37). Perhaps most important is the combination of stressors for an individual reaching the threshold for symptom provocation; one symptom one cause may be too limited an approach.

The idiosyncratic nature of headaches mandates differential trials of treatment for individual presentations. The use of headache diaries in tracking response as well as considering triggers may help to fine tune trials of treatment.

Outcome studies on spinal manipulation may only reflect the particular technique(s) chosen for study. Even within the application of specific technique, there is by necessity variation from practitioner to practitioner. Cost of research, relative to limited funding sources, the number of techniques available, and even the interexaminer variation create challenges in controlling these issues. Given the number of variables, it is unlikely that the research community will be able to address these within the immediate future using controlled studies. Already, the insurance industry (through provider profiling) is working toward making assessments and decisions regarding what procedures will be reimbursed as “reasonable and necessary” when managing care. Certainly carriers are compiling cost relative to outcome data for individual providers for given diagnoses. This information may be used by carriers to determine which providers are chosen to participate in given plans. By choosing providers (who choose techniques they utilize), carriers may ultimately use this data in determining what approaches are indeed reasonable and necessary and ultimately available within an insurance based healthcare market.

The challenge for the field practitioner is to be aware of differing models of headache and utilize appropriate evaluation procedures to determine a trial of treatment. Based on response, treatment may be modified. The models provide considerations regarding specific choices regarding technique, spinal levels to address and ancillary therapies. Combining approaches may move the individual further from threshold of provoking headaches. The key may be to individualize treatment based on response.

For the field practitioner, familiarity with the mechanisms discussed above may provide a conceptual basis on which to fine tune approaches to treatment for given presentations. Combining manual approaches with other neurostimulatory, neuroinhibitory techniques, lifestyle management, ancillary therapies and trials with different manual techniques is suggested.

Also of some importance within the field of manual therapy is the underlying question of how same or similar approaches may affect so many different types of headaches. Although there are numerous classifications of headache (23), ultimately there may be changes in the classifications systems grouping headaches under categories based on mechanism. Again, consider trigeminal autonomic cephalgia (15) a proposed subclassification, which suggests common etiology and/or components for otherwise apparently different classifications of headache. As there is further investigation into the etiology of headache, classification systems may wind up more closely matching models discussed above. Consider that current classifications may be determined more by mechanisms of pharmacologic action rather than these models. Particularly for challenging presentations, unless the success rate of a given treatment approach is 100% (with no side effects), alternative approaches merit consideration.

CONCLUSION

There are many hypothetical mechanisms of action through which manual approaches may provide effective intervention relative to headache. The health care field is working diligently at defining the various mechanisms behind headache and developing appropriate therapeutic interventions. Manual therapy practitioners may utilize different therapeutic techniques based on these mechanisms in association with custom-tailoring programs of therapy to develop outcome assessments and ongoing patient management. Given that there is a population of individuals looking for relief, and given that similar patterns of complaint may warrant different intervention, there is a challenge for providers to be able to adapt treatment to individual presentations using models such as those discussed above.

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