Cervical arterial dysfunction and manual therapy: A critical literature review to inform professional practice

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Abstract

An abundance of literature has attempted to provide insight into the association between cervical spine manual therapy and cervical artery dysfunction leading to cerebral ischaemic events. Additionally, specific guidelines have been developed to assist manual therapists in clinical decision-making. Despite this, there remains a lack of agreement within the profession on many issues.

This paper presents a critical, re-examination of relevant literature with the aim of providing a contemporary, evidence-informed review of key areas regarding the neurovascular risks of cervical spine manual therapy.

From a consideration of case reviews and surveys, haemodynamic principles, and blood flow studies, the authors suggest that: (1) it is currently impossible to meaningfully estimate the size of the risk of post-treatment complications; (2) existing testing procedures have limited clinical utility; and (3) a consideration of the association between pre-existing vascular risk factors, combined with a system based approach to cervical arterial haemodynamics (inclusive of the carotid system), may assist manual therapists in identifying at-risk patients.

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1. Introduction

Manual therapists are aware that cervical spine manual therapy (MT) techniques, particularly those involving full-range, high-velocity, rotational movements, hold inherent risks of insult to the vertebral arteries (VAs) and internal carotid arteries (ICAs), which can result in cerebral ischaemia, stroke, or death. Extensive reviews of contemporary evidence, and reasoned debate, have been undertaken in an effort to provide clinical guidance for the safest implementation of such techniques and for pre-manipulative screening for vertebrobasilar insufficiency (VBI) (Barker et al., 2001; Magarey et al., 2004; APA, 2006). However, there is still widespread uncertainty and controversy regarding the association between cervical spine MT and cervical arterial dysfunction (CAD), the reliability and validity of functional screening tests, the specificity and sensitivity of these tests in identifying at-risk patients, and the medico-legal position of therapists and patients (Australian Journal of Physiotherapy (AJP), 2001; Jull et al., 2002; Kerry, 2002; Refshauge et al., 2002; Brew, 2004; Kerry, 2004).

The purpose of this paper is to present a summarised, critical re-examination of current available published

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literature concerning cerebrovascular accidents (CVAs) in the context of MT. The review is non-systematic and aims to provide a broad picture of evidence and contemporary thought with regards to risks of cervical spine management.

1.1. Data sources and method


The search process resulted in 833 articles, of which 224 were considered relevant to MT (referring to manipulative and non-manipulative techniques) via the themes selected for the discussion. Key clinical and theoretical themes consistent within this literature base are supported by a representation of the search results in this paper. The discussion and conclusions of this review focus on the risk of cervical spine MT, the usefulness of screening tests in assessing at-risk patients, haemodynamic factors, and the nature and signs and symptoms of arterial changes and insufficiency.

2. Reviews and surveys

Reviews and surveys attempt to establish risk factors for, and incidence of, CVAs related to MT.

2.1. Questionnaire surveys

Retrospective and prospective surveys reviewed include reports by both manual therapists and non-manual therapists (neurosurgeons, neurologists, vascular surgeons). Non-manual therapists’ surveys report a higher number of patients suffering post-MT complications or associated symptoms (Dvorak et al., 1993; Lee et al., 1995; Rivett and Milburn, 1997).

Retrospective surveys report estimates of CVA-risk incidence ranging from one in 9122 (Michaeli, 1993) to five in one million (Haynes, 1994). Some estimates have been based on inadequate sample sizes (Haynes, 1994; Rivett and Milburn, 1996), and a probable flaw with retrospective studies is the questionable reliability of recall of past events. Therefore inferences regarding size of risk should be made with caution.

Most prospective surveys do not calculate estimates of risk incidence, some stating explicitly that it would be impossible and misleading to do so (Stevinson, et al., 2001). Prospective studies are also likely to report a higher number of cases of post-MT vascular complications, for example, (Leboeuf-Yde et al., 1997; Nadareishvili and Norris, 1999; Stevinson et al., 2001; Magarey et al., 2004), than retrospective estimates (because of under-reporting, reporting restrictions, non-association of event to treatment, etc) (Stevinson et al., 2001; Dupeyron et al., 2003). Dupeyron et al. (2003) suggest that post-MT VBI could be 30 times higher than published. A recent prospective study on—chiropractors reported no incidents of serious adverse events (Thiel et al., 2007). Although a well-structured, rigorous survey, it must be considered that, as stated above, any study targeted at manual therapists is likely to provide unreliable data due to reporting bias and lack of awareness of what constitutes an adverse event.

2.2. Narrative reviews

These ranged from discursive (Rivett, 1995) to structured reviews (Haldeman et al., 1999), encompassing several themes. Firstly, in considering estimates of incidence, a major confounding variable is that the actual incidence is unknown (Rivett, 1995; Assendelft et al., 1996; Ernst, 2001a, b, 2004), partly because the number of persons in the population receiving MT is unknown or unreported. This apparent under-reporting (Assendelft et al., 1996; Ernst, 2004) may be influenced by MT practitioners’ awareness of post-treatment CVAs, physicians not making the link between MT and CVAs, or a low probability of cases being published (Ernst 2001a, 2002).

As another theme illustrating potential vascular post-MT trauma, Hurwitz et al. (1996) reviewed 145 reports of post-MT complications: of 118 documented cases, 21 patients died and 52 were left with serious neurological deficits. Ernst (2004) reported that between 1995 and 2003 in Britain, 300 patients were adversely affected by cervical spine MT, the most frequently reported complication being stroke following arterial dissection. These reports highlight the necessity of manual therapists to be aware of mechanisms and presentations of vascular trauma, and possible underlying pathology.

Lastly, the validity of movement-based pre-MT screening tests is questioned (Kunasmaa and Thiel, 1994; Rivett, 1997), some authors suggesting that testing should be stopped (Thiel and Rix, 2005). Recent reports have undertaken probability analysis to calculate the sensitivity and specificity of functional tests, using data...
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reported that death occurred in 18% of 177 cases and
39.8 yrs (female) and 36.2 yrs (male).

distributed across the genders, with average ages of
vascular accidents, between 1934 and 1986, equally

2.4. Case reviews

Terrett (1987) reported on 107 cases of post-MT
vascular accidents, between 1934 and 1986, equally
distributed across the genders, with average ages of
39.8 yrs (female) and 36.2 yrs (male). DiFabio (1999)
reported that death occurred in 18% of 177 cases and
concluded that the literature at that time did not
demonstrate that benefits of cervical spine MT out-
weighed the risks. Frisoni and Anzola (1991) concluded
from 39 cases that a priori risk identification cannot be
made in the majority of cases; symptoms may develop
some time after uneventful treatment; mortality/long-
term impairment occurs in 28% of cases, and a history
of previous, transient neurological symptoms or upper
cervical spine laxity should contra-indicate any neck
movement-based treatment.

Haldeman et al. (2002a) looked specifically at the
effect of referral bias on clinical perceptions of VA
dissection risk. Based on analyses of data from an
insurance provider and a chiropractic survey, they
reported that 1 in 48 manual therapists were likely to
be aware of post-MT CVA, compared to 1 in 2
neurologists. This discrepancy could explain the appar-
rent differences in perception and experiences between
these two professions.

Rothwell et al. (2001) conducted a population-based
nested case-control review to test the association
between MT and CVAs. Of 582 cases reviewed, they
suggested that vertebrobasilar accidents were five times
more likely to occur if a patient had MT one week prior
to the stroke, and VA-stroke cases were five times more
likely to have received MT than the control group. This
review concurs with the report of Smith et al. (2003)
who, after comparing 151 arterial dissection cases with a
control group, concluded that arterial dissection was five
times more likely to occur if MT had been administered
within 30 days prior to, and twice as likely to have had
increased neck/head pain preceding the stroke. They
concluded that VA dissection was independently asso-
ciated with stroke and increased neck/head pain.
Haldeman et al. (2002a) reported that 92% of VA cases
presented with neck/head pain, and 25% reported a
sudden onset of pain (suggestive of a dissection in
progress). Haldeman et al. (2002b) concluded that they
were unable to identify risk factors from the 64 medicol-
legal cases and propose that vertebrobasilar dissection
be considered an unpredictable, inherent, idiosyncratic,
and rare complication of MT.

These surveys and reviews show that there is a need
for well-structured, large scale prospective surveys and
trials to be undertaken (Rivett, 1995; Hurwitz et al.,
1996; Shekelle and Coulter, 1997; Ernst, 2001b, 2004)
before a more realistic impression of the neurovascular
risk of MT can be established (Dvorak et al., 1993;
Haynes, 1994; Senstad et al., 1996; Rivett and Milburn,
1997; Stevinson et al., 2001).

3. Haemodynamics, arterial trauma and vascular
pathology

MT has been burdened by its ongoing focus on the
vertebral artery in isolation. Haemodynamic theory is a
relatively new but important area of thinking in MT

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(Taylor, 2001). It is well documented and understood, that blood flow in the VA and ICA systems is intricately linked via the circle of Willis (Cardon et al., 1998). It follows, therefore, that both VA and ICA blood flow and pathology should be considered in pre-treatment risk assessment.

ICA blood flow velocity and volume are significantly greater than in the VAs (Paivansalo et al., 1998; Schoning and Hartig, 1998; Sidhu, 2000; Scheel et al., 2000a, b). Therefore, the ICAs may have a significant compensatory role during cervical spine movement and positioning. A negative pre-manipulative test relies critically on the patency of the ICAs and unaffected VAs (see blood flow studies section) for adequate perfusion and, as such, tests the system as opposed to the concept that this somehow tests the VA in isolation.

This concept is illustrated by Weintraub and Khoury (1998), who examined ICA and VA blood flow changes in patients with known underlying pathology. They reported an absence of overt VBI symptoms on sustained end-range extension for 3–4 min in 160 cases (mean age: 66 years), 25% of whom had VA hypoplasia associated with marked basilar artery flow alteration, whilst unsuspected ICA occlusion occurred in six cases and VA occlusion in two. Welch et al. (2000) also studied the effect of occlusion of the ICAs and VAs on the opposing vessel flow, and reported that flow in one part of the system was significantly influenced by occlusion in the other part. These studies draw attention to the need to be aware of the effects cervical spine positioning and to identify pre-existing vascular disease as a reason for caution in both pre-treatment testing and practice of MT.

Trauma to cervical blood vessels is generally classified as either dissection resulting from direct trauma to the vessel, or localised thrombogenesis and embolus formation in response to endothelial damage (Caplan and Bioussé, 2004). Either pathological state may lead to stroke (Pollanen et al., 1992; Ross, 1999). Arterial dissection may occur after trivial trauma to the vessel, or spontaneously. This may be related to pre-existing, congenital weakness of the vessel wall or acquired vascular pathology (atherosclerosis). The mechanisms are thought to be arterial dissection with an intra-mural haematoma, resulting in vessel lumen narrowing with ensuing reduction in blood flow and ischaemia; an extending dissection, leading to subarachnoid haemorrhage; and/or dissection leading to thrombus formation with secondary emboli, and stroke (Mann and Refsheuge, 2001; Schievink et al., 2001).

ICA dissection has been linked to multiple types of non-penetrating or blunt trauma, including motor vehicle accidents (Miller et al., 2002; Beaudry and Spence, 2003), manipulation (Haneline et al., 2003; Ernst, 2004), hand-held mechanical massagers (Grant and Wang, 2004), soft-ball injuries (Schievink et al., 1998), strangulation (Clarat et al., 2005), effort (running) (Shimada et al., 2005), horse-hoof impact (Fletcher et al., 1995), sneezing (Taylor and Kerry, 2005). These examples, although remarkable in isolation, should alert clinicians to the possibility that traumatic vascular injury may occur in the ICAs as well as the VAs. Furthermore, these arterial pathologies (VA and ICA) are known to present as neuromusculoskeletal symptoms, often isolated neck and head pain, without the commonly described VBI symptoms (Munari et al., 1994; Taylor and Kerry, 2005, Arnold et al., 2006). This concurs with other reports of VA dissection presenting as isolated neck pain (Krespi et al., 2002) and/or headache (Gates et al., 1997), without classical VBI signs.

Although the literature suggests that the pathogenesis of arterial dissection remains uncertain, proposed risk factors include high plasma homocysteine concentrations (Giroud et al., 1994; Pezzini et al., 2002); specific genotypes (Pezzini et al., 2002); hereditary connective tissue disorders (i.e. Ehlers – Danlos syndrome) (Schwarze et al., 2000); connective tissue disorders (Brandt et al., 2001); fibromuscular dysplasia (Van Damme et al., 1999), and recent infections (Grau and Buggle, 1999). There is much debate in the current literature as to the relevance and relative weight of these proposed risk factors and, in particular, why some individuals seem more prone to vascular injury and pathology than others (Rubinstein et al., 2005).

As stroke or death is the ultimate adverse outcome of cervical spine MT (DiFabio, 1999), it is of note that ICA dissection is reported to be the cause of stroke in up to 20% of patients aged 18–44 years (Lisovski and Rousseaux, 1991). Across all age groups, stroke is considered to be the leading cause of morbidity and the third-leading cause of mortality in the Western world (Flossmann et al., 2004). Li et al. (2005) reported that uncontrolled blood pressure is a key factor in the aetiology of stroke. Although the actual pathophysiological mechanisms of post-cervical spine MT stroke are largely unknown, the occurrence of VA and/or ICA dissection, with or without pre-existing vascular pathology, is the most commonly accepted theory. Manual therapists should be acutely aware that patients may present with headache and neck pain as the early warning signs of impending stroke (Arnold et al., 2006).

There are reports which suggest an association between ICA insufficiency/ischæmia and upper cervical spine instability (Volle and Montazem, 2001; Tominaga et al., 2002; Garg et al., 2004; Yamazaki et al., 2004). There are also reports that demonstrate anterior and posterior blood flow dysfunction following road traffic accidents (Chung and Han, 2002; Beaudry and Spence, 2003). These two points are of relevance to MT and should be given consideration, as pre-disposing factors, in the assessment of VA and ICA insufficiency.
Atherosclerosis is believed to be more prevalent in the ICAs than VAs in modern Western societies (Ersoy et al., 2003; Giannoukas et al., 2005). However, VA disease has been reported (Mitchell, 2002) and proposed as a risk factor for MT (Cagnie et al., 2006). VA and ICA disease has been shown to co-exist in the same patients and may be accompanied by coronary and peripheral occlusive disease and hypercholesterolaemia (Caplan et al., 1992). A large body of literature in this area considers potential risk factors such as hypertension, smoking, diabetes, hypercholesterolaemia, hyperhomocysteinaemia, factors affecting blood coagulation, vascular trauma, infection, and migraine (Ross, 1999; Pezzini et al., 2002; Westaway et al., 2003; Migdalski et al., 2005; Arnold et al., 2006; Cagnie et al., 2006). This emphasises the need to incorporate both localised and systemic factors in pre-treatment clinical reasoning and risk assessment for all age groups. Contrary to this line of thinking are the conclusions from a sole MT-specific study which found no association between such risk factors and reported cases of post-MT stroke (Halde- man et al., 2002c). This report of 64 cases over a 16 year period concluded that cerebrovascular accident following manipulation was an unpredictable phenomenon. However, pre-incident data (the most important when considering profiling for chance of adverse event) was only available in 41% of the 64 cases reported, the range of events was restricted (i.e. only those that occurred within 48 h of a manipulation treatment and those which happened to get to the attention of a single physician), and the range of atherosclerotic risk factors was narrow and not representative of contemporary evidence-based risk factors. Considering these points, and the overwhelming amount of literature relating atherosclerosis to stroke, it is difficult to refute the hypothesis that post-MT strokes are associated with vascular pathology.

It is clear that the interaction between mechanisms of vascular injury, underlying hereditary disorders, and proposed risk factors adds a body of new information for consideration. This knowledge may direct both the clinical reasoning process and future research into pre-treatment cervical risk assessment. This may direct research toward the model used in suspected thromboembolism (Fancher et al., 2004), a condition which mirrors VA and ICA dissection in its complex pathogenesis and level of difficulty to diagnose or predict accurately.

4. Blood flow studies

The effects of cervical spine movements upon VA blood flow have long been reported, with little consideration of ICA blood flow and haemodynamic compensatory principles. Initial cadaver experiments showed decreased VA blood flow, particularly on contralateral cervical spinal rotation (Tissington-Tatlow and Brammer, 1957; Toole and Tucker, 1960; Brown and Tissington-Tatlow, 1963; Selecki, 1969). Later in vivo studies, using flowmetry, angiography, Doppler ultrasonography or magnetic resonance angiography, and documenting changes in VA blood flow before and after cervical spine rotation, have produced contradictory results. Some researchers found no changes (Weingart and Bischoff, 1992; Thiel et al., 1994; Haynes and Milne, 2001; Zaina et al., 2003) while others reported a significant reduction in contralateral blood flow (Refshauge, 1994; Rossitti and Volkmann, 1995; Licht et al., 1998a; Li et al., 1999; Rivett et al., 1998, 1999; Mitchell, 2003; Arnold et al., 2004; Mitchell et al., 2004).

This controversy may be because there is no standardisation of methods used. For example, healthy subjects and patients, who may or may not have had signs and symptoms of VBI at the time of measurement, were used. Both young and older subjects were included in some samples, and few authors compared males and females (Sturzennger et al., 1994; Li et al., 1999; Rivett et al., 1999; Haynes et al., 2000; Scheel et al., 2000a, b; Mitchell, 2003, 2007).

Blood flow measurements at pre-transverse, cervical and intracranial parts of the VA have been reported. The cervical VA, as it traverses the bony transverse foramina, is difficult to insonate accurately which may have confounded the findings (Johnson et al., 2000; Khaw et al., 2004). There is a logical argument that it is the change in blood flow in the intracranial part of the VA (distal to the point of constriction) and not in the more proximal extracranial VA, that may correlate with potential hindbrain ischaemia most accurately (Zaina et al., 2003; Mitchell, 2005, 2008). However, few studies report blood flow measurements at this site (Rossitti and Volkmann, 1995; Li et al., 1999; Mitchell, 2003; Mitchell et al., 2004).

Various degrees of cervical spine rotation and extension have been implicated in compromised VA blood flow and associated VBI (Refshauge, 1994; Sturzennger et al., 1994; Licht et al., 1998b; Rivett et al., 1998, 1999; Li et al., 1999; Scheel et al., 2000a; Haynes and Milne, 2001). Reports of the effect of cervical spine rotation on both ICA and VA blood flow found either no significant change in ICA blood flow or a decrease in both VA and ICA blood flow on rotation and extension. (Schoning et al., 1994; Rivett et al., 1999; Scheel et al., 2000a, b; Licht et al., 2002). An increase followed by a decrease in VA and ICA blood flow at 45° and full rotation, respectively, is also reported (Refshauge, 1994). Therefore, it is apparent from these studies that blood flow changes in both the VA and ICA, associated with cervical spine movements, should be taken into account in patient pre-treatment risk assessment.
Some researchers, using patients experiencing mild signs of VBI, found a decrease in blood flow (at mid-cervical levels) on cervical spine rotation (Rivett et al., 1999). Others found no significant decrease in VA blood flow (at the pre-transverse level), despite positive VBI signs reported by their subjects (Licht et al., 2000, 2002). It is not clear from these findings if the VBI symptoms altered with cervical spine rotation. It is notable that most of the studies of decreased blood flow following rotation, using normal subjects aged 20–40 years, report no accompanying signs and symptoms of VBI. Therefore, it is apparent that no correlation between cervical spine rotation and VBI symptoms can be clearly established from this research.

The contradictory findings of these studies preclude definitive conclusions being made and emphasise the need for more rigorous research into the complex relationship between cervical spine movement and blood flow changes which must, at this stage, be regarded as a guide only in pre-treatment assessment.

5. Discussion and conclusions

This review of contemporary literature regarding cervical spine MT and arterial insufficiency highlights several areas of clinical importance and many of the outcomes correspond with previously published reviews in this subject area. There are some findings, however, which add to existing MT knowledge and hence may influence the development of clinical reasoning and research. This review, therefore, serves to inform professional practice.

Most blood flow studies reported refer to VA blood flow in relation to cervical spine movement. Although some studies report negative findings, there is an overall trend suggesting that both VA and ICA blood flow are influenced by full-range cervical spine movements, although there are not always corresponding cerebro-ischaeic symptoms. There is evidence that cervical spine movement, principally rotation, influences VA blood flow. ICA blood flow has been shown to be influenced more by extension with rotation (Scheel et al., 2000a, b), with some other reports implicating extension as the most influential movement for ICA flow (Haneline et al., 2003). It is of interest to note here that the extension component of functional testing has been removed from MT pre-treatment guidelines (Magarey et al., 2004; APA, 2006).

Recent guidelines (Magarey et al., 2004; APA, 2006) aim to assist in identifying patients who are more likely to suffer adverse neurovascular events should a particular treatment technique be used. One of the central components to the guidelines for pre-treatment screening of patients is the performance of a functional positioning test (the VBI test involving cervical spine rotation and observing the reproduction of cardinal signs and symptoms). Many blood flow studies that demonstrate changes in blood flow during cervical spine rotation, for example, conclude that their findings support the use of the functional test (the test uses the position to alter blood flow, altered blood flow has been demonstrated in this study, therefore the test is valid). However, there is little evidence to indicate a correlation between blood flow changes and symptoms of VBI (Licht et al., 1998a; Mitchell, 2003, 2007; Mitchell et al., 2004). Thus, a subject can have reduced blood flow to the brain but display no signs of cerebral ischaemia. It has been reported earlier that the ICA and VA arterial supplies are parts of an interdependent and compensatory system. Therefore, it is unlikely that ischemic signs would be displayed if there is adequate compensatory/collateral blood flow.

The disparity between symptoms and blood flow has been highlighted further by probability analysis regarding utility of the functional test, which has reported its poor sensitivity and variable specificity (Kerry and Rushton 2003; Gross et al., 2005; Ritcher and Reinking, 2005). At the current level of evidence, pre-manipulative screening tests should be considered no more clinically valuable than Homan’s test, for example, which is still used as a small part of wider examination procedures—in lower limb deep vein thrombosis risk assessment protocols despite its known poor reliability (Levi et al., 1999).

The cardinal signs and symptoms of VBI also lack consistent support from the literature reviewed. There is a diversity of presentations demonstrated in the cases reviewed. The most consistent recurring sign of VA and ICA dysfunction is an increase in neck/head pain. Localised, somatic pain referral, related to the ICA (Munari et al., 1994) and the VA (Krespi et al., 2002), has been reported. This presents an obvious diagnostic challenge for the manual therapist. Other symptoms can be attributed to dysfunction of the ICA (e.g. Horner’s syndrome, flashing sensations) and may be erroneously interpreted as VBI, or of more concern, because these symptoms do not form part of the classic cardinal signs, not attributed to a neurovascular cause at all.

An interesting trend in the literature is the distinction between younger patients (<45 years) who have been reported to suffer spontaneous or traumatic dissection but may not demonstrate any of the classical vascular risk factors (Rubinstein et al., 2005), and older patients (>45 years), who show signs of vascular pathology, including atherosclerosis of the cervical vessels (Caplan et al., 1992; Cagnie et al., 2006), who may demonstrate classical (general or systemic) risk factors for vascular disease. However, other reports have suggested that, based on a cadaver study, the presence of VA atherosclerosis in young (<45 years) subjects cannot be excluded (Mitchell, 2002). This illustrates the...
importance of understanding the complexity of CAD, particularly that cerebral ischaemia may occur due to a variety of underlying factors and pathologies.

Considering that there is a risk, it is important to consider the size of the risk. Many reviews attempt to establish a risk ratio, but these are misleading figures based on under-reporting, methodological flaws, and an erroneous perception of probability. The actual risk of post-treatment complications cannot be determined from the available evidence, and neither clinicians nor patients should be misled into believing that the risk is of a particular, established magnitude. The risk should be calculated on all current factors surrounding the particular situation at the particular time, for each patient.

There have been few reports explicitly categorising definitive risk factors for VA and ICA dysfunction. Some have suggested that post-treatment accidents are unpredictable and that there are no definitive risk factors (Haldeman et al., 2002b). There are too few reports, however, which have focussed specifically on risk factors to make a conclusive judgment on this issue. Only well-structured, large prospective investigations could provide this information. There is a consistent suggestion in the literature reviewed that compromised blood flow to the brain and thrombo-embolic events are related to various established vascular disease risk factors (hypertension, hypercholesterolaemia, atherosclerosis, trauma, infection, migraine etc). In the absence of strong evidence against this link, it might be prudent for the manual therapist not to dismiss such risk factors.

Considering the inconsistencies in supporting evidence for: (1) cardinal signs of arterial insufficiency; (2) validity of functional testing; and (3) identification of definite risk factors (for post-manipulation vascular injury), the acceptance of and adherence to clinical guidelines that incorporate inclusion of these areas presents an interesting professional challenge. The present medico-legal climate makes unreasoned compliance to guidelines that are not based on consistent evidence legally indefensible, and the opinions of expert witnesses may be challenged in court (Bolitho v City and Hackney, 1997; Foster, 2002, p. 116).

5.1. Risk versus benefit

This paper has purposefully focussed on potentially serious adverse cervico-cranial events associated with MT. It was not the intention of the authors to report specifically on the suspected benefits of cervical MT. However, in the clinical decision-making process, it is unrealistic to consider risk without benefits, and vice versa.

There have been several randomized controlled trials investigating the effectiveness of cervical MT (e.g. Koes et al., 1992a, b; Boline et al., 1995; Nilson et al., 1996; Bronfort et al., 2001; Hoving et al., 2002; Jull et al., 2002a) with increasing evidence that cervical MT alone, or as part of multi-modal management strategy, is beneficial for the relief of neck pain (Hurwitz et al., 1996; Bronfort et al., 2004; Gross et al., 2004).

In order to make a statistically driven decision on the risk:benefit ratio, valid data are needed on both sides of this analysis. As stated earlier, valid data relating to size of risk is incomplete. Intervention choices must also be made in the context of alternative interventions and their known risks. Commonly, authors compare cervical MT with common medical interventions, such as non-steroidal anti-inflammatories, and state that the risk of MT is less than the known risks associated with medication (Dabbs and Laurerri, 1995; Hurwitz et al., 1996; Jull et al., 2002). Although this is likely, without supporting data such claims should be noted with a degree of caution.

Despite the lack of data, a small number of authors have commented specifically on the risk:benefit judgement and have come to firm conclusions. DiFabio (1999) explicitly states that the risks of cervical manipulation outweigh the benefits. This follows a review of 177 cases of adverse events in the context of selected literature exploring the proposed benefits of cervical manipulation. Conversely, a more recent study states that the potential benefits of cervical therapy do outweigh the risks (Rubinstein et al., 2007). This statement is based on the results of a prospective follow-up survey of clinicians’ reports of responses to treatment (as discussed above). Similarly, whilst this is likely to be the case, such judgements need to be considered in the context of the limitations of the data and methodologies.

Childs et al. (2005) embrace the inherent uncertainties in this clinical area and provide discussion on making reasoned judgements in the absence of good data – not only for risks and benefits, but also in respect of the validity of screening procedures for potential risk. The outcomes of this review reflect this thinking: incorporating knowledge of haemodynamic and vascular pathophysiology into patient assessment may lead the clinician to an informed judgement as to the likelihood of serious adverse events. If the limitations of traditional screening processes are understood and the evidence regarding benefit considered, a sound and reasonable decision may be reached regarding choice of intervention.

5.2. Recommendations

There is a clear need for further research in a number of areas in this field. The indication for large-scale, robust, prospective trials has been consistently reported as the best way to establish a reliable indicator of risk of arterial insufficiency related to cervical spine MT.
However, considering the size of the task, this would be logistically difficult. Until a stronger evidence-base can be established, it is advisable that manual therapists take note of the available evidence supporting all of the possible generic vascular risk factors, prior to cervical spine MT. Based on the findings of this review, the authors make the following recommendations:

1. Considering the limited support for the use of cervical spine functional pre-manipulative screening tests (e.g. the VBI test), as an indicator of either vascular patency or of the propensity of blood vessels to be injured as a result of MT, these tests should be used with caution and the results should be interpreted in the knowledge that the tests have little backing from the evidence base.

2. There is evidence supporting the relationship between vascular disease risk factors and CAD. As such the authors recommend a subjective assessment of vascular risk factors incorporating a ‘system’-based approach (i.e. incorporating ICA and VA knowledge).

3. Headache and neck pain are common presenting signs of vascular dissection. Therefore, careful consideration of the differential diagnosis of these symptoms by the manual therapist is recommended.

4. As cervical artery haemodynamics (inclusive of the ICA and therefore the system) are influenced by movement as a whole, and not exclusively by single thrust manipulative procedures, vascular risk assessment should be considered prior to all manual therapy procedures that induce movement in the cervical spine region (APA, 2006).

5. The evidence suggests that confining pre-treatment risk assessment to the VA in isolation may represent a limitation in clinical reasoning. Consideration of the cervical arterial system, together with the range of vascular pathologies apparent within this system, may enhance the clinician’s reasoning process.

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