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International Journal of Osteopathic Medicine 9 (2006) 4–12
www.elsevier.com/locate/ijosm

Commentary

HVLA thrust techniques: What are the risks?

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Received 13 January 2006; received in revised form 21 February 2006; accepted 22 February 2006

Abstract

High velocity low amplitude (HVLA) thrust techniques are amongst the most commonly used manipulative treatment techniques used by osteopaths. HVLA thrust techniques are considered potentially more dangerous when compared to non-impulse mobilisation type techniques because of the application of a rapid thrust or impulse. This has led to concerns as to the appropriateness of using HVLA thrust techniques in certain regions of the spine and in certain spinal pain presentations. Considerable research has been undertaken on both the effectiveness and potential adverse reactions arising from HVLA thrust techniques. This paper reviews the literature regarding the nature and incidence of transient and the more serious non-reversible impairments associated with the use of HVLA thrust techniques. Consideration is given to the efficacy and appropriateness of pre-manipulative vertebrobasilar artery screening protocols and suggestions are given as to ways in which practitioners may reduce perceived risk.

Keywords: High velocity low amplitude (HVLA); Thrust techniques; Vertebrobasilar insufficiency; Risk; Disc herniation; Informed consent

1. Introduction

In clinical practice high velocity low amplitude (HVLA) thrust techniques are amongst the most commonly used manipulative treatment techniques used by osteopaths.[1] Most patients do not experience significant adverse events following the use of these techniques but HVLA thrust techniques are commonly perceived as being potentially more dangerous when compared to non-impulse mobilisation type techniques because of the application of a rapid thrust or impulse. Most research has therefore been undertaken on the adverse reactions arising from HVLA thrust techniques, but it is acknowledged that all therapeutic interventions carry an element of risk. Adverse reactions can be classified as (1) transient, (2) substantive reversible impairment and (3) serious non-reversible impairment.

Transient side effects resulting from manipulative treatment may remain unreported by patients unless post-treatment patient feedback is explicitly requested. Prospective studies report common side effects resulting from spinal manipulation occur between 30% and 61% of patients.[2–4] Commonly encountered transient side effects include local pain or discomfort, headache, tiredness/fatigue, radiating pain or discomfort, paraesthesia, dizziness, nausea, stiffness, hot skin and fainting. Less common transient reactions include early or heavy menstruation, epigastric pain, tremor, palpitation and perspiration.[5] These transient side effects usually begin within 4 h of receiving treatment and typically resolve within the next 24 h.[4] A study of Australian manipulative physiotherapists reported that most adverse effects associated with examination or treatment of the cervical spine arose as a result of passive mobilising and examination techniques ahead of high velocity thrust techniques.[6] Adverse effects were reported at one per 100 therapist weeks for cervical traction and other cervical techniques and one per 177.5 therapist weeks for high velocity thrust

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doi:10.1016/j.ijosm.2006.02.005

techniques. The rate for high velocity thrust techniques was estimated as one adverse effect per 50,000 high velocity thrust procedures.

Substantive reversible impairment following the application of HVLA thrust techniques includes intervertebral disc herniation, frank disc prolapse, nerve root compression and fracture. Osteopaths regularly treat patients with spinal pain and as the exact aetiology of the pain remains unknown in a large percentage of these cases it is likely that osteopaths, along with other manual therapy disciplines, frequently apply HVLA thrust techniques to patients who may have symptoms arising from disc derangements. While the use of HVLA thrust techniques in these circumstances remains controversial, thrust techniques are cited as a treatment option in a number of texts[7–10] and are probably used judiciously by many osteopaths as part of their overall management plan in patients with symptoms attributable to disc derangement. Research literature lends some support for this approach. One study of 27 patients with MRI documented and symptomatic disc herniation of the cervical and lumbar spine reported that 80% of subjects achieved a good clinical outcome from chiropractic intervention. The author suggests that chiropractic care including spinal manipulation may be a safe and effective treatment approach for patients presenting with symptomatic cervical or lumbar disc herniation.[11] In a single-blind randomised clinical trial comparing osteopathic manipulative treatment with chemonucleolysis for 40 patients with symptomatic lumbar disc herniation confirmed by imaging, a statistically significant greater improvement for back pain and disability was recorded in the first few weeks in the group of patients receiving manipulation. At 12 months the outcomes from both interventions were comparable with manipulation being less expensive. The authors conclude that osteopathic manipulation can be considered as an option for the treatment of symptomatic lumbar disc herniation.[12] While HVLA thrust techniques are undoubtedly applied safely to patients with disc derangements there are case reports of a ruptured cervical disc[13] and lumbar disc herniation progressing to cauda equina syndrome following manipulative procedures.[14,15] What is not known in these case reports is whether the disc herniation would have progressed without manipulation, whether a high velocity thrust technique was the only intervention used or whether the force and torque of a HVLA thrust technique or other mobilising techniques were a factor in the final outcome. A systematic review of the safety of spinal manipulation in the treatment of lumbar disc herniation reported the risk of a patient suffering a clinically worsened disc herniation or cauda equina syndrome following spinal manipulation to be less than 1 in 3.7 million.[16]

Not surprisingly, in relation to safety and the use of HVLA thrust techniques, most attention has been focused upon serious non-reversible impairment and potential serious sequelae resulting from cervical spine manipulation.

There is wide variation in estimated serious adverse reactions arising from cervical manipulation. Various authors have attempted to estimate the incidence of iatrogenic stroke following cervical spine manipulation.[17–29] Estimates vary between one incident in 10,000 cervical spine manipulations to one incident in 5.85 million cervical spine manipulations. Rivett and Milburn[28] estimated the incidence of severe neurovascular compromise to be within the range 1 in 50,000 to 1 in 5 million cervical spine manipulations. Other authors estimate complications for cervical spine manipulation to be 1.46 times per 1 million manipulations[30] and 1 case of cerebrovascular accident (CVA) in every 1.3 million cervical treatment sessions increasing to one in every 0.9 million for upper cervical manipulation.[25] Dvorak and Orelli[19] report a rate of one serious complication per 400,000 cervical manipulations while Patijn[27] recorded an overall rate of one complication per 518,886 manipulations. The published research unfortunately does not make clear the type of neck manipulation techniques used or the competence and training of the practitioner.[31] Magarey et al. in an attitudinal study of Australian Manipulative Physiotherapists, who are required to undertake specific postgraduate study in manipulative therapy, reported no major complications in 4601 physiotherapist years of manipulative/musculoskeletal practice.[6]

Several authors claim that published estimates may not accurately reflect the true incidence of serious cervical spine complications.[26–28,32] The frequency with which complications arise in patients receiving cervical spine manipulation will likely remain an estimate as the true number of manipulations performed and the numbers of patients receiving cervical manipulation remain unknown.[33] Haldeman et al. indicated in relation to vertebral artery dissection that a database of multiple millions of cervical manipulations would be necessary to obtain accurate statistics.[34]

While the osteopathic profession remains concerned about the potential for vertebral artery dissection following manipulation, we must remain cognisant of the fact that vertebral artery dissection does not only result as a complication of cervical manipulation but can also arise as a complication from normal neck movements and trivial trauma.[34,35] Indeed, patients may present to a practitioner with symptoms attributable to an ongoing vertebral artery dissection. Haldeman et al. reviewed the published literature to assess the risk factors and precipitating neck movements causing vertebrobasilar artery dissection. Three hundred and sixty-seven cases were identified, of which 252 were either of spontaneous onset, or related to trivial or major trauma. Less than one third of cases (115) were associated with cervical manipulation (Table 1).[34]

Table 1
Description of trivial trauma associated with vertebrobasilar artery dissection/occlusion cases[34]

Type of trivial trauma	Examples	Number of cases
Sporting activities	Basketball, tennis, softball, swimming, calisthenics	18
Leisure activities	Walking, kneeling at prayer, household chores, sexual intercourse	8
Sustained rotation and/or extension	Wall papering, washing walls and ceilings, archery, yoga	10
Short-lived rotation and/or extension	Turning head while driving, backing out of driveway, looking up	7
Sudden head movements	Sneezing, fair ride, violent coughing, sudden head flexion	7
Miscellaneous minor trauma	Minor fall, "banging" head	2
Miscellaneous	Atlantoaxial instability, postpartum, post-gastrectomy	6
Total		58

Further difficulty may arise in the estimation of risk for vertebrobasilar dissection after neck manipulation as patients may in fact seek treatment for symptoms of a progressing dissection. Smith et al. attempted to address this issue in a case controlled study of the association between neck manipulation and cervical arterial dissection and reported that neck manipulation is an independent risk factor for vertebral artery dissection even after controlling for neck pain.[36] This makes sense as one presumes that if normal daily activities might cause vertebral artery dissection then it is likely that in some instances cervical manipulation may do so also. This may be especially the case if the thrust was inappropriately applied, overly forceful and involved excessive amplitude. However, Williams et al. indicate that estimates for stroke following neck manipulation will always be difficult to quantify as selection and recall bias in case control studies and age related variables have the potential to confound the estimation of the risk of vertebrobasilar dissection after neck manipulation.[37]

Regardless of the actual incidence of vertebrobasilar complications, practitioners should always attempt to limit any potential for harm to their patients when contemplating manipulation to the cervical spine. Attempts to identify patients at risk of a CVA following cervical spine manipulation have led to the development of a number of pre-manipulative assessment protocols.

2. Vertebrobasilar insufficiency

The vertebrobasilar system comprises the two vertebral arteries and their union to form the basilar artery (Fig. 1). This system supplies approximately 20% of intracranial blood supply.[38] Blood flow in the vertebral artery may be affected by intrinsic factors such as atherosclerosis that narrows the vessel lumen, increases turbulence and reduces blood flow and extrinsic factors such as osteophytes, bony anomalies and fibrous bands etc. that can compress or impinge upon the external wall of the vertebral artery.

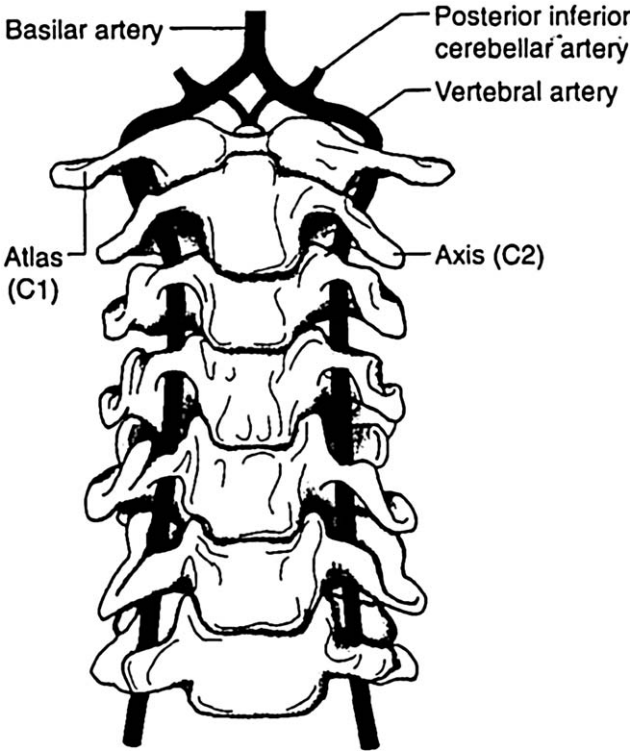

Fig. 1. Relationship of the cervical spine to the vertebral artery. (Reproduced with permission from Gibbons and Tehan.[39, p. 28]).

3. Symptoms and signs of vertebrobasilar insufficiency

The ability to recognize symptoms that may indicate vertebrobasilar insufficiency (VBI) is essential for safe clinical practice. Symptoms of VBI occur because of ischaemia in the structures supplied by the vertebrobasilar system. There are a number of symptoms and signs and that may be suggestive of VBI (Box 1).

3.1. Diagnosis of VBI

For patients presenting with head and neck pain, especially if sudden and severe, it is important to determine if there is associated dizziness or signs of brain stem ischaemia such as nausea or vomiting. Dizziness is a common presenting complaint of vertebrobasilar ischaemia but dizziness is a common patient presentation with multiple aetiologies (Box 2). If dizziness is present, practitioners must take a thorough history from the patient with the aim of distinguishing between the various causes of dizziness. It has been suggested that questioning about nausea during testing is as important as enquiring about dizziness.[40] Diagnosed VBI is an absolute contraindication to HVLA thrust techniques to the cervical spine.

Box 1. Symptoms of VBI

- Headache/neck pain (especially if sudden and severe)
- Dizziness/vertigo
- Nausea
- Vomiting
- Diplopia (patient reports 'double vision')
- Tinnitus
- Drop attacks
- Dysarthria (patients reports difficulty articulating speech)
- Dysphagia (patients reports difficulty swallowing)
- Facial paraesthesia
- Tingling in the upper limbs
- Pallor and sweating
- Blurred vision
- Lightheadedness
- Fainting/blackouts

Signs of VBI

- Nystagmus
- Gait disturbances
- Horner's syndrome

Box 2. Causes of dizziness (reproduced with permission from Gibbons and Tehan[39])

Systemic causes of dizziness

- Medication
- Hypotension
- Diabetes
- Thyroid disease
- Cardiac or pulmonary insufficiency

Central causes of dizziness

- Demyelinating diseases
- Tumours of brain or spinal cord
- Seizures
- Vertebrobasilar insufficiency
- Post-traumatic (concussion) vertigo

Peripheral causes of dizziness

- Benign positional vertigo
- Ménière's disease
- Cervical spine dysfunction
- Labyrinthitis
- Vestibulotoxic medication

One difficulty in recognising the symptoms of VBI is that many of the common symptoms, e.g. headache, pain and stiffness in the cervical spine, are similar to those for mechanical non-specific neck pain.[41,42]

3.2. Pre-manipulative VBI testing

Over the last decade pre-manipulative testing movements for VBI have been advocated as a means of risk management with a view to minimising patient harm.[43] Many physical tests involving combinations of rotation and extension positioning are described in the literature for determining the presence or absence of VBI.[44–49] These tests for VBI have been based upon the premise that cervical spine positioning may reduce the lumen and blood flow in the vertebral arteries[50–55] and allow the practitioner to identify those patients at risk of stroke following cervical spine manipulation. Studies on cadaveric specimens demonstrated reduced flow through contralateral vertebral arteries in combined extension and rotation.[56,57] In vivo studies lent support to the view that cervical spine positioning may reduce vertebral artery blood flow.[52,53,55,58–61] A study on normal volunteers concluded that blood velocity altered significantly at 45° cervical spine rotation, and again at full range cervical spine rotation and in the pre-manipulative position.[52,55] However, other studies of vertebral artery blood flow did not identify significant change in flow related to cervical spine positioning.[62–66] The evidence linking vertebral artery narrowing or occlusion with cervical spine extension and rotation positioning contributed to the development and subsequent use of many pre-manipulative tests for VBI. It was postulated that a reduction in blood flow as a result of cervical spine positioning would produce detectable symptoms or signs in a patient with VBI. Positive tests were assumed to be a predictor of patients at risk from cerebrovascular complications of neck manipulation.

Research over recent years has questioned the continuing role of diagnostic VBI tests. To be clinically useful screening tests should be both valid and reliable predictors of risk. VBI testing procedures have neither of these qualities, with available scientific evidence failing to show any predictive value.[33,63,67] Tests for VBI have low sensitivity and specificity for predicting cerebral ischaemia prior to neck manipulation[68] and the value of these tests in determining VBI has been questioned.[20,49,67–72] Case studies appear in the literature that illustrate the poor performance of extension and rotation pre-manipulative screening tests in clinical practice. Rivett et al. describe a case where a young male student complaining of bilateral neck pain and frontal headaches of 6 weeks duration showed no signs or symptoms of neurovascular compromise on pre-manipulative screening despite the presence of ultrasonographically

demonstrated complete occlusion of the left vertebral artery in full contralateral rotation and combined contralateral rotation/extension.[70] Westaway et al. report a false-negative VBI test in an asymptomatic subject with a radiographically unstable C1-2 segment and a hypoplastic and atretic right vertebral artery further questioning the predictive value of such screening procedures.[72]

There is an expectation that screening tests should not only be valid and reliable but also should not have the potential to be harmful. It has been suggested that the tests themselves, many of which require the patient's head and neck to held in sustained positions of neck extension and rotation, may hold certain risks and could have a morbid effect on the vertebral artery.[73] Indeed, minor adverse effects associated with examination procedures involving rotation, including those related to the use of an established VBI testing protocol, have been documented.[6]

Symons et al. attempted to quantify the internal forces on the vertebral artery during neck manipulation and VBI testing on five un-embalmed post-rigour cadavers. Strains sustained internally by the vertebral artery during neck range of motion testing, VBI screening and HVLA thrust techniques were similar and all were significantly less than the forces required to mechanically disrupt the vertebral artery. They conclude that a single typical HVLA thrust technique to the neck is unlikely to cause mechanical disruption of a normal vertebral artery.[74]

An analysis of the published literature does not support the continuing use of VBI screening tests or protocols in isolation as none of the rotation, extension or combination test movements have been shown to be valid or reliable predictors of risk.

The question arises as to whether it is possible through physical examination or screening procedures to identify patients at risk of vertebrobasilar injury from cervical spine manipulation? Current evidence would suggest that the answer is no.[22,75,76] In 2004, based upon the expert evidence they heard, a Jury in an inquest into the death of a female chiropractic patient following a neck adjustment made the following recommendation "that practitioners … be informed by their respective regulatory bodies that provocative testing (prior to performing high neck manipulation) has not been demonstrated to be of benefit and should not be performed. Universities and Colleges teaching high neck manipulation should also be teaching their students that these tests have not been demonstrated to be of benefit and should not be performed".[77]

If pre-manipulative VBI assessment protocols are neither reliable nor accurate tools for the identification of risk, what, in the light of current research findings, would constitute a suitable approach to the pre-manipulative assessment of the cervical spine and how does one minimise any potential risks?

4. Minimising risk

A significant part of the evaluation will be predicated upon a thorough knowledge of the presenting symptoms and signs of VBI and the completion of a thorough patient history that includes specific attempts to identify any of the potential symptoms of VBI and vertebral artery dissection. If a significant number of symptoms, e.g. sudden and severe headache/neck pain, dizziness, nausea and vomiting, are suggestive of VBI, it would appear advisable to be cautious with testing full range movement of the cervical spine in patients who present with cervical and cervicothoracic spinal syndromes. Such patients should be referred for appropriate medical investigation to confirm or rule out the presence of VBI. The use of HVLA thrust techniques in such patients would be contraindicated until such time as the cause of the symptoms has been clearly established.

If a patient presents with a few symptoms that might be suggestive of VBI, a normal physical examination would include pain free range of motion testing of the cervical spine. Such range of motion testing might include both active and passive movements but would be performed with care and to the point of provocation of symptoms only.

The reports of vertebrobasilar complications in the literature do not make clear what type of manipulative techniques were associated with vertebrobasilar complications, nor how well the techniques were applied. The risks associated with HVLA thrust techniques may be potentially minimised by a thorough understanding of spinal locking and positioning procedures as well as the attainment of a high level of psychomotor skill related to the use of minimal leverages, high velocity, low amplitude and control.

It is reasonable to believe that the safe application of HVLA thrust techniques is critically linked to comprehensive training and skill development in the appropriateness and delivery of these techniques. HVLA thrust techniques are believed to carry a higher risk of vertebrobasilar complications than mobilisation or non-impulse techniques. However research has demonstrated that the strain sustained by the vertebral artery during both the testing of neck range of motion and the application of a single HVLA thrust technique was of a similar magnitude.[74] Practitioners using non-impulse and mobilisation techniques also need to be aware that there is a risk of vertebrobasilar complications with the application of non-thrust techniques. Techniques such as muscle energy (MET), functional and strain-counterstrain techniques can, on occasion, involve sustained positioning that may place an undesirable load on vascular tissues. While published clinical guidelines for pre-manipulative assessment of the cervical spine focus upon minimising risks associated with thrust techniques, it should be noted that these precautions should

apply equally to cervical mobilisation techniques and cervical traction.[78]

Past clinical practice has placed an emphasis on the physical performance of pre-manipulative screening tests in an attempt to minimise the risk of vertebrobasilar complications as a result of HVLA thrust techniques. Current research would suggest that the emphasis should be placed more on the combination of a thorough patient history, a comprehensive physical examination (seeking neurological signs) and the need for a high level of technical skill in the application of HVLA thrust techniques. If a practitioner does not have proficiency in these three areas then they should not use HVLA thrust techniques.

The potential risk to the patient from any manual intervention may be influenced by many factors that include the skill, experience and training of the practitioner, the type of technique selected, the amount of leverage and force used, the age, general health and physique of the patient. Whenever a practitioner applies a therapeutic intervention, consideration must always be given to the risk–benefit ratio.

For any therapeutic procedure to be utilised ethically, the benefit to the patient must outweigh any potential risk associated with the intervention and the patient must be made aware of both the potential benefit and the potential risk. This information exchange constitutes the basis of informed consent which has been defined as "the voluntary and revocable agreement of a competent individual to participate in a therapeutic or research procedure, based on an adequate understanding of its nature, purpose and implications".[79] Informed consent requires (i) an information component that discloses all potential risks and that must be in a form comprehensible to the patient and (ii) a consent component that ensures that the patient is both competent to offer consent and does so voluntarily and free from any controlling or coercive influences.[80] Information should be presented in a relevant and meaningful manner that is comprehensible to the patient.[81] The traditional method of communication in the clinical encounter is verbal but this form of communication can be enhanced by written information. Written information should be both legible and readable.[82] Videotaped material has also been shown to be effective in patient education[83] with Delany advocating a combination of verbal, written and audiovisual information.[84]

Practitioners must make their own decisions regarding how they approach the issue of obtaining informed consent but must be cognisant of existing legal precedents, legislative requirements and advice from professional associations and directives from licensing and registration authorities. The following list is an outline of the key elements for obtaining informed consent in clinical practice.[85]

- "Discussion of the clinical issue and the nature of the decision to be made;
- Discussion of the alternatives;
- Discussion of the benefits and risks of alternatives;
- Discussion of uncertainties associated with the decision;
- Assessment of the patient's understanding; and
- Asking the patient to express their preference."

5. Conclusion

Many of the commonly used osteopathic manipulative treatment techniques have not been subjected to well designed research studies. More substantive research has been undertaken into HVLA thrust techniques often combined with mobilisation and exercise. Patients can experience transient adverse effects from any manual therapy intervention and these are no more common with appropriately applied HVLA thrust techniques than with other manipulative procedures. While patients do not generally experience significant adverse events following the use of HVLA thrust techniques, these techniques are considered potentially more dangerous when compared to non-impulse mobilisation type techniques.

As with all medical interventions, the potential benefits[86,87] for the patient must be weighed against the risks. There is currently no high quality data to enable accurate estimation of the risk of stroke following cervical spine HVLA thrust techniques.[88] While the data identifies a temporal relationship between cervical spine thrust techniques and stroke, it is possible that in a number of instances the cause of the vertebral artery dissection may have preceded the patient's attendance for treatment and not be a consequence of the manipulation. While there is a potential for serious sequelae following cervical spine manipulation, the risk appears extremely low.[89,90] A review of the literature, relating to the risk of neurovascular compromise complicating cervical spine high velocity manipulation, concluded that the risk and benefit analysis supported the continued judicial use of cervical spine HVLA thrust techniques by prudent and appropriately trained practitioners.[89]

The key to safety is dependent upon appropriate training, a thorough patient history and a detailed physical assessment prior to the application of any manipulative procedure. Appropriate training in the use of manipulative thrust techniques and subsequent skill refinement through regular practice are considered key elements for safe practice and professional competence.[91] If a practitioner does not have proficiency in all the above areas then they should not be applying HVLA thrust techniques.

Best practice requires osteopaths to embrace the principles of Evidence Based Medicine which integrates individual clinical experience and expertise with the results from clinical and epidemiological research whilst taking account of patient preferences.[92,93] Since 1979 there

have been in excess of 50 mostly qualitative, non-systematic reviews published relating to manipulation and mobilisation treatment for back and neck pain.[94] A number of systematic reviews and meta-analyses have also been undertaken that attempt to determine the efficacy of spinal manipulation on back and neck pain,[94,95] neck pain,[96–98] and chronic headache.[99]

A Cochrane review of manipulation and mobilisation for mechanical neck pain concluded that when combined with exercise, mobilisation and/or manipulation is beneficial for persistent mechanical neck disorders with or without headache, providing strong evidence for using a multi-modal treatment approach.[96] The evidence review accompanying the national clinical guidelines on acute and recurrent low back pain indicates that the risks of manipulation for low back pain are very low provided patients are assessed and selected for treatment by trained practitioners.[100,101]

There is currently no strong evidence to suggest that HVLA thrust techniques should not continue to be used, where applicable, by appropriately trained and competent practitioners. Evidence that other manual interventions have equal or greater efficacy for any given patient presentation is lacking. All interventions that have measurable outcomes have the potential for adverse effects and all practitioners must be cognisant of the requirement for obtaining informed consent prior to the application of any therapeutic intervention and ensure that they operate within the framework of safe and ethical clinical practice.

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