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Random and generic verses selective forces in spinal adjustment or manipulation

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Objective: To illustrate the challenge of selecting optimal directions for the application of adjustments or manipulations by chance or by using a generic, one adjustment fits all type of approach.

Methods: Simple mathematics was used to show the number of possible directions for the application of adjustive or manipulative forces.

Complicating Factors: Confounders introduced by soft tissue, joint mobility and spinal alignment.

Conclusion: A generic, one direction of force application for most or all cases or a random selection for the direction of forces is not an optimum approach to utilise when selecting the vector of force to be applied during chiropractic adjustment or manipulation.

Methods are needed to select appropriate directions for the application of adjustments or manipulations.

Indexing terms: Spine; Chiropractic; Adjustment; Clinical Decision Making; Gonstead

Introduction

Chiropractic care often involves introducing forces into the spine to alter the spinal position or dynamics of a particular area. Some clinicians refer to these forces as manipulations, while others use the term adjustment, and some use the terms interchangeably.

It might seem obvious that performing adjustments or manipulations, which we will at times refer to as SMT (spinal manipulative therapy), to the spine as a treatment in caring for spinal disorders requires certain directions of forces and sites of application of such forces.

However, some have put forth that for spinal related pain in humans, there is little to no evidence that it matters where said forces are applied even though there is some evidence to suggest that functional or neurological effects are specific to the application site. (1)

…practitioners may differentiate between broad, non-specific forces (manipulation) and more targeted interventions (adjustments) aimed at correcting specific biomechanical faults…'

Due to the many sources of information and teachings about SMT, there are various descriptions of what SMT means or what to call it. SMT is used by Chiropractors, osteopaths, physical therapists and medicine. The terms adjustment, manipulation, and mobilisation, and the use of hands only as well as instrumentation, have all been lumped together in the SMT label.

Maigne and Vautravers (2) discussed the differences between long lever, short lever, high velocity, low velocity and other differences in force applications in SMT. They stated that long lever applications were done mostly by osteopaths and short lever applications were done by Chiropractors. These are generalisations but are likely accurate descriptions for the most part. They also stated that there was no evidence showing differences in outcomes between the different methods.

Herzog (3) found that the external forces applied during High Velocity Low Amplitude (HVLA) treatments vary dramatically depending on the treatment site and also vary dramatically across clinicians. Other studies have found similar conclusions. (4, 5, 6)

The variety of descriptions and applications of SMT in general, in addition to a relative lack of substantial funding in research in this area, are likely major reasons why there is still a limited understanding of the different effects of different types of SMT. However, instead of doing substantial research to determine differences in outcomes, the professions involved seem to have progressed largely to the generic approach to SMT by default. This default position may be due to the fact that the outcomes related research that has been done on SMT has largely been focused on symptoms and reflexes and less on the biomechanical effects.

If we focus primarily on biomechanical effects, it is logical that different types of SMT would differ in outcomes. The biomechanical outcomes of generic or random approaches to SMT are likely different than the applications of specific types of forces at particular sites chosen for biomechanical reasons. In this paper, therefore, the probability of a desired biomechanical outcome from a generic or random approach to SMT is considered in theory, since hard data is lacking.

There is little evidence comparing the outcomes of different types of SMT. Although one study found that manual SMT was superior to instrument assisted SMT in low back pain disability outcomes (7) and another comparison of two types of manual SMT showed no difference in low back pain and disability outcomes. (8)

> However, if an applied force is going to create biomechanical changes in spinal structure, it must, a priori, result in work. Therefore, work is performed when a force causes a displacement of the point of application in the direction of the force. That work is a biomechanical change regardless of whether it results in measurable changes in spinal alignment after the force is removed. This leads to a logical conclusion that the magnitude and direction of the applied force, as well as the site of application of said force, matter in terms of biomechanical effects.

The question of whether the location or method of applying SMT force is significant may stem, at least in part, from an emphasis on outcomes related to pain or disability scores. However, there are studies that show it does matter where SMT is applied when the outcome is range of motion. (9,10) Nansel et al, in a series of triple blinded studies, found that using the Gonstead technique upper cervical adjustments specifically applied to levels found using the Gonstead method of spinal assessment resulted in greater improvements of cervical rotation than lower cervical

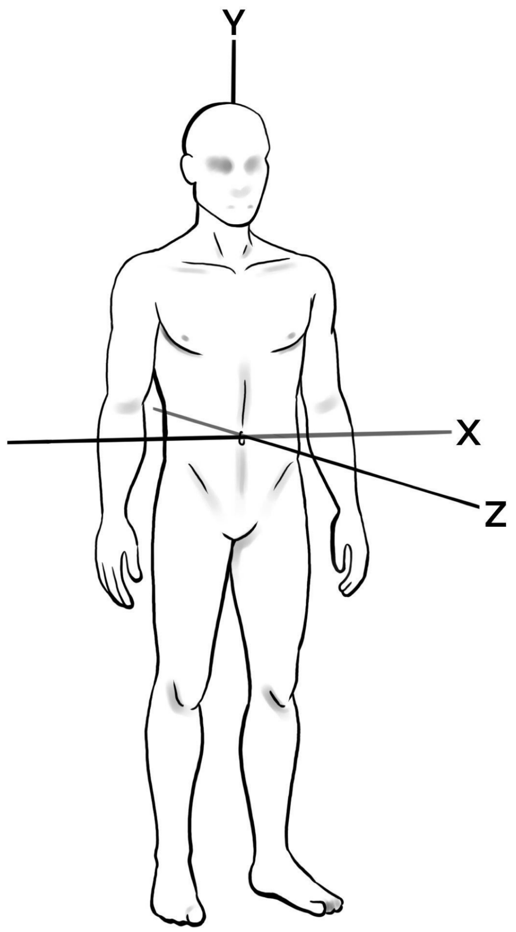
Gonstead Method adjustments, whereas lower cervical adjustments applied to specifically found spinal levels resulted in greater improvements in lateral bending than upper cervical adjustments. (9) They also found that specific adjustments applied on the side of the most restricted lateral bending resulted in greater improvement than specifically applied adjustments on the side opposite of the greater restricted bending. (10)

The goal of this article is to examine the possible number of directions of these adjustive or manipulative forces that are fundamental to SMT and see if there might be advantages in selecting forces by some method as opposed to using random directions of force application or a generic one adjustment sequence for all, type of approach. We offer a rationale based primarily on mathematical probability that the type and directions of SMT forces are unlikely to be found by chance alone, or by generic (one size fits all) approaches to SMT. Spines, like all physical structures, are affected by forces. The introduction of forces into the spine without consideration for the direction of those forces with the thought that they will benefit the patient is illogical.

Cartesian coordinate system

Cartesian coordinate systems are used in many fields. Volkwyn, writing in the European Journal of Physics, notes that 'Learning how to appropriately select and use coordinate systems is central to physics modelling and problem solving'.(11) For our discussion we will utilise the convention established by Panjabi et al and use a coordinate system where positive translation on the y-axis is vertical, positive translation on the x-axis is to the patient's left and positive translation on the z-axis is moving in the direction anterior to the patient. (12, 13)

Figure 1: Body showing the x, y and z axes



The degrees of freedom of an object are the number of axes along which an object can translate plus the number of axes around which it can rotate. (13)

We have x, y and z axes along which an object can translate and around which they can rotate. This gives us 6 degrees of freedom.

Troyanovich (13) reports that the typical vertebra has 6 degrees of freedom although we note that the magnitude of movement in some directions may be small. If one considers that there is a positive and negative direction for translation along each of the three axes and rotation in a positive and negative direction around each of the three axes, then we can describe that as 12 different directions the object can move.

Artwork by Scientific Illustrator, Laurel M Hynes

Directions of Force

When a clinician delivers either an adjustive or manipulative force that force is in a particular direction. There are 12 directions in which a vertebra might move and if the clinician delivers a force they may be doing it with the intention to affect the dynamics and/or the position of one or multiple vertebra(e). If some directions of force application would be more effective than other directions in accomplishing the effect that the clinician desires then direction may be of importance.

We can compute the probability of a particular force direction randomly being selected:

1/x where x is the number of possible choices

This gives us:

1/12 or 1 chance in 12 that a particular vector would be selected randomly.

That would be a 1 in 12 chance for a single selection. However, a treatment program often entails more than one treatment session and multiple adjustments or manipulations may be given in any one treatment session. For two adjustments/manipulations both selecting the same vector in a random fashion there would be a:

1/12x1/12 = 1/144 chance.

For three adjustments 1/12x1/12x1/2= 1/1728 chance.

Thus, every time a manipulative/adjustive force is delivered in a random or generic fashion the probability of selecting the appropriate vector of force is $1/12^{th}$ as great. The chance of selecting the appropriate vectors of force randomly or generically for an entire treatment program soon becomes exceedingly improbable. If one direction of force application is more desirable than the other possible directions, a random or generic application of SMT forces poses a significant problem.

The implications of random or generic approaches to SMT are further illuminated by the many factors that determine the resultant vector of force applied for a manipulation or adjustment. The combination of pre-positioning the spine and the force applied, along with the patient's reactions to the process during the procedure, is complex.

> Yet, the resultant vector of force is the single force which is the combined action of multiple forces acting on it simultaneously.

The resultant vector is determined by the vector sum of all the individual forces acting on the spine, considering all their magnitudes and directions. The consideration of this complexity of actions and the resultant vector of force, along with vertebral malalignment and the presence of a functional impairment of the motion of the spinal unit, is likely a reason why some prefer to use the term specific adjustment versus the term manipulation. Given this complexity, along with the influence of vertebral alignment and the presence of somatic dysfunction, practitioners may differentiate between broad, non-specific forces (manipulation) and more targeted interventions (adjustments) aimed at correcting specific biomechanical faults. Whether or not the application of a specific adjustment or a generalised manipulation will result in better outcomes in individual cases has not been broadly determined. There is a need for more attention in this direction of study in future research which goes beyond the assessments of pain related outcomes.

In 2023 Evans and Lucas, (14) based on available literature, defined manipulation as: '*Separation (gapping) of opposing articular surfaces of a synovial joint, caused by a force applied perpendicularly to those articular surfaces, that results in cavitation within the synovial fluid of that joint*'. (14) In the past, however, definitions of manipulation and adjustment were described differently. In 1994, Shekelle (15) described manipulations as nonspecific and adjustments as specific. Further, in searching the literature for this paper, there were few references to manual treatment of the spine where the term specific adjustment is used compared to the vast majority of the literature utilising some form of the term manipulation.

> It appears that researchers and writers have considered the difference between the terms 'manipulation' and 'adjustment' as insignificant.

Subluxation or Manipulative Lesion

It is not the purpose of this article to enter the controversy regarding the terms subluxation, manipulative lesions or some other similar term. However, it is obvious that the introduction of adjustive/manipulative forces into the spine by the clinician serves a purpose. Whether it is to decrease pain, increase joint mobility, improve spinal alignment or to otherwise improve joint or nervous system function, the direction of the applied force may be important.

Soft tissue

The direction of forces applied during SMT are important to the soft tissues supporting spinal articulations. Spinal supportive soft tissues can be injured by excessive forces when healthy but are even more easily damaged from force loads when they have been weakened by prior injury. (16)

For instance, the higher levels of forces produced in studies of manual SMT to the spine can exceed the lower thresholds of shear strength in non-injured lumbar spines, and pre-injured spines are even more susceptible to these forces. (17) Triano characterised manual procedures of SMT as controlled forces designed to unbuckle deformed motion segments in the spine. (18) To design such an approach to SMT, an examination of the spinal buckling behaviour of a patient's previously injured spine must be performed, such a thing cannot be left to chance if it is expected to be safe and effective.

Joint mobility

Excessive, restricted or abnormal joint mobility are common features of spinal dysfunction. (19, 20) When there is a loss of joint mobility it must occur in one or more directions. Applying forces in many different directions to one particular area might indeed increase motion but it appears that if there is soft tissue injury to the articulation in question that one or more of the directions of movement may create further tissue damage.

Applying a force into the direction of restricted spinal joint motion might improve motion in that direction. However, if that causes already damaged tissues to be further stressed or would worsen spinal malalignment then that sort of force is, a priori, contraindicated. Such an approach is using restricted motion as a guide to select a direction in which to apply SMT forces. This is not a selection of force direction by random chance nor is it doing the same SMT force on every patient without consideration of that patient's spine. But increasing joint mobility is not necessarily the same as improving spinal alignment or improving joint function. Joint function would require the joint to move in a more normal motion not merely having greater motion.

Spinal alignment

When the upright spine is viewed as a structure just as one views a house, tower or skyscraper, it is apparent that an optimum form of alignment relative to gravity is needed. Proper spine alignment helps maintain axial skeletal stability, protect neural components, and maintain an upright posture. (19) Forces that tend to push the spine into a better alignment with gravity appear to have distinct advantages as opposed to forces that push the spine out of alignment relative to gravity. Significant discussion can arise on whether we should place emphasis on local or global alignment and a detailed discussion on that topic is beyond the scope of this article. Presently, we will use the relative alignment between adjacent vertebrae, although we wish to note that the direction of SMT forces is likely equally important whether the clinician is focused on either local or global alignment.

A common example of a case a Chiropractic clinician may face is an unleveling of the vertebral end plates between two adjacent vertebrae when viewed anterior to posterior, with a bulging disc between those vertebrae, which may or may not affect a spinal nerve root. The clinician may not wish to apply forces that would be likely to increase this unleveling and further affect already injured disc fibres.

In this case, for example, clinicians may assess spinal alignment to aid in selecting the direction for SMT forces. This is neither a random nor a generic approach to manipulation or adjustment force selection for an individual case. Spinal alignment is being used to guide force direction. Again, this requires an evaluation to determine the appropriate force application direction. The direction of applied forces to the spine should be of importance to the chiropractic profession.

Discussion

It has been demonstrated that the likelihood of randomly choosing a particular force vector for the application of SMT forces is unlikely to be biomechanically sound. This leads us to the question of choosing a specific force vector. While we agree that some vectors may be quickly disregarded, this would still leave us with several possible choices, and it would appear to necessitate some form of analysis to determine acceptable choices.

> The thought that all or even most patients should be treated with the same SMT directions of force should be questioned. The more accurate the analysis methods the more that care can be individualised to that patient.

Bergman et al (21) stated '... *the physician must first ascertain if there is a clinical basis for treatment. The Chiropractic physician considering manual or adjustive therapy must establish if conditions exist which support this treatment*'.

It is easy to see that a particular diagnostic method can have confounders. An example occurs when in a clinical scenario the patient presents with a reduction in segmental rotation at a specific lumbar motion unit, detected during motion palpation. Upon reviewing the anteroposterior lumbopelvic radiograph, the clinician identifies facet tropism, an anatomical variant wherein the paired articular facets of the same vertebral segment exhibit differing orientations, with one facet aligned in the sagittal plane and the contralateral facet oriented more coronally. This configuration alters the segment's kinematic properties by producing inherent asymmetry in coupled motion patterns. As a result, symmetrical axial rotation at that segment is biomechanically impossible, not due to hypomobility from a functional restriction, but due to structural morphology. If a clinician were to rely solely on motion palpation findings without integrating radiographic and anatomical data, they could misinterpret this asymmetrical movement as a correctable fixation or subluxation. An inappropriate high-velocity, low-amplitude thrust directed at 'restoring' nonexistent symmetry could result in unnecessary intervention, patient discomfort, or increased joint stress.

Confounders can be shown for other diagnostic methods such as radiography and posture. For instance, the imaging employed by most clinicians does not include bending views and therefore lacks information regarding joint function. Posture does not show intersegmental alignment. The key clinical takeaway is that a complete and accurate diagnosis requires synthesising all available objective findings to best analyse the problem and serve the patient.

While researchers may certainly use pain as an outcome measure there would appear to also be a need to further study the effectiveness of directions of SMT forces in the areas of improving spinal dynamics and spinal alignment. In all cases the direction of forces applied to the spine should be considered. Most clinicians already employ physical examinations which can aid in determining injury to soft tissues, joint mobility and spinal alignment. This should be further encouraged. Additionally, many clinicians employ imaging to aid in spinal analysis. However, some may feel restricted in imaging usage due to current guidelines. (22) A better understanding of how projection errors affect radiography would enhance the information obtained from plain film radiography. (23, 24)

Conclusion

It has been shown that generic applications of forces are ill-advised and that it is extremely unlikely that a suitable vector of force for a manipulation or adjustment will be chosen in a treatment program by chance alone.

To those who consider spinal alignment important it is obvious why vector selection is essential. Even to those who do not find spinal position to be important it should be clear that forces of inappropriate direction can detrimentally affect the patient.

Therefore, reliable methods are needed to select appropriate force vectors. Spines are not free from the laws of physics, and the direction in which forces are applied to structures generally matters.

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References

1. Nim CG, Downie A, O'Neill S, Kawchuk GN, Perle SM, Leboeuf-Yde C. The importance of selecting the correct site to apply spinal manipulation when treating spinal pain: Myth or reality? A systematic review. Sci Rep. 2021 Dec 3;11(1):23415. DOI 10.1038/s41598-021-02882-z. PMID: 34862434; PMCID: PMC8642385. https://pubmed.ncbi.nlm.nih.gov/34862434/
2. Maigne JY, Vautravers P. Mechanism of action of spinal manipulative therapy. Joint Bone Spine. 2003 Sep;70(5):336-41. DOI 10.1016/s1297-319x(03)00074-5. PMID: 14563460. https://pubmed.ncbi.nlm.nih.gov/14563460/

3. Herzog W. The biomechanics of spinal manipulation. J Bodyw Mov Ther. 2010 Jul;14(3):280-6. DOI 10.1016/j.jbmt.2010.03.004. PMID: 20538226. https://pubmed.ncbi.nlm.nih.gov/20538226/

4. Triano JJ. Biomechanics of spinal manipulative therapy. Spine J. 2001;1(2):121-130. https://pubmed.ncbi.nlm.nih.gov/14588392/

5. Owens EF Jr, Hosek RS, Sullivan SGB, et al. Establishing force and speed training targets for lumbar spine high-velocity, low-amplitude chiropractic adjustments. J Chiropr Educ. 2016;30(1):7-13. https://pubmed.ncbi.nlm.nih.gov/26600272/

6. Kirstukas SJ, Backman JA. Physician-applied contact pressure and table force response during unilateral thoracic manipulation. J Manipulative Physiol Therapeut. 1999;22(5):269-279. https://pubmed.ncbi.nlm.nih.gov/10395429/

7. Schneider M, Haas M, Glick R, Stevans J, et al. Comparison of spinal manipulation methods and usual medical care for acute and subacute low back pain: a randomized clinical trial. Spine (Phila Pa 1976). 2015 Feb 15;40(4):209-17. DOI 10.1097/BRS.0000000000000724. PMID: 25423308; PMCID: PMC4326596. https://pubmed.ncbi.nlm.nih.gov/25423308/

8. Sutlive TG, Mabry LM, Easterling EJ, et al. Comparison of short-term response to two spinal manipulation techniques for patients with low back pain in a military beneficiary population. Mil Med. 2009 Jul;174(7):750-6. DOI 10.7205/milmed-d-02-4908. PMID: 19685848. https://pubmed.ncbi.nlm.nih.gov/19685848/

9. Nansel DD, Peneff A, Quitoriano J. Effectiveness of upper versus lower cervical adjustments with respect to the amelioration of passive rotational versus lateral-flexion end-range asymmetries in otherwise asymptomatic subjects. J Manipulative Physiol Ther. 1992 Feb;15(2):99-105. PMID: 1564415. https://pubmed.ncbi.nlm.nih.gov/1564415/

10. Nansel DD, Cremata E, Carlson J, et al. Effect of unilateral spinal adjustments on goniometrically-assessed cervical lateral-flexion end-range asymmetries in otherwise asymptomatic subjects. Journal of Manipulative and Physiological Therapeutics. 1989 Dec;12(6):419-27. PMID: 2486560. https://pubmed.ncbi.nlm.nih.gov/2486560/

11. Trevor S Volkwyn, Bor Gregorcic1, John Airey and Cedric Linder. Learning to use Cartesian coordinate systems to solve physics problems: the case of 'movability'. Eur J Phys.2020 41 045701 DOI 10.1088/1361-6404/ab8b54 https://iopscience.iop.org/article/10.1088/1361-6404/ab8b54/meta

12. Panjabi MM, White AA 3rd, Brand RA Jr. A note on defining body parts configurations. J Biomech. 1974 Aug;7(4):385-7. DOI 10.1016/0021-9290(74)90034-7. PMID: 4411698. https://pubmed.ncbi.nlm.nih.gov/4411698/

13. Troyanovich SJ. Structural Rehabilitation of the Spine & Posture: A Practical Approach. Hunnington Beach, CA: MPAmedia; 2001 p.1-6.

14. Evans DW, Lucas N. What is manipulation? A new definition. BMC Musculoskelet Disord. 2023 Mar 15;24(1):194. DOI 10.1186/s12891-023-06298-w. PMID: 36918833; PMCID: PMC10015914. https://pubmed.ncbi.nlm.nih.gov/36918833/

15. Shekelle PG. Spinal manipulation. Spine (Phila Pa 1976). 1994 Apr 1;19(7):858-61. DOI 10.1097/00007632-199404000-00026. PMID: 8202811. https://pubmed.ncbi.nlm.nih.gov/8202811/

16. Gallagher S, Marras WS. Tolerance of the lumbar spine to shear: a review and recommended exposure limits. Clin Biomech (Bristol). 2012 Dec;27(10):973-8. DOI 10.1016/j.clinbiomech.2012.08.009. Epub 2012 Sep 8. PMID: 22967740. https://pubmed.ncbi.nlm.nih.gov/22967740/

17. Lopes MA, Coleman RR, Cremata EJ. Radiography and Clinical Decision-Making in Chiropractic. Dose Response. 2021 Oct 13;19(4):15593258211044844 https://pubmed.ncbi.nlm.nih.gov/34675758/

18. Triano JJ. Biomechanics of spinal manipulative therapy. Spine J. 2001 Mar-Apr;1(2):121-30. DOI: 10.1016/s1529-9430(01)00007-9. PMID: 14588392. https://pubmed.ncbi.nlm.nih.gov/14588392/

19. Kim Ho-Joong, Yeom Jin S, Lee Dong-Bong, et al. Association of Benign Joint Hypermobility With Spinal Segmental Motion and Its Clinical Implication in Active Young Males. Spine 38(16):p E1013-E1019, July 15, 2013. | DOI: 10.1097/BRS.0b013e31828ffa15 https://pubmed.ncbi.nlm.nih.gov/23846448/

20. Oh JY, Liang S, Louange D, Rahmat R, Hee HT, Kumar VP. Paradoxical motion in L5-S1 adult spondylolytic spondylolisthesis. Eur Spine J. 2012 Feb;21(2):262-7. DOI 10.1007/s00586-011-1880-9. Epub 2011 Jun 15. PMID: 21674210; PMCID: PMC3265596. https://pubmed.ncbi.nlm.nih.gov/21674210/

21. Bergmann, TF, Peterson, DH, Lawrence DJ. Chiropractic technique: Principles and procedures. New York; Churchill Livingstone 1993:51.

22. Bussières AE, Peterson C, Taylor JAM. Diagnostic imaging practice guidelines for musculoskeletal complaints in adults-an evidence-based approach: Introduction. J Manipulative Physiol Ther. 2007;30(9):617-683. https://pubmed.ncbi.nlm.nih.gov/18082742/

23. Coleman RR, Bernard BB, Harrison DE, Harrison SO. Correlation and quantification of projected 2-dimensional radiographic images with actual 3-dimensional Y-axis vertebral rotations. J Manipulative Physiol Ther. 1999 Jan;22(1):21-5. DOI 10.1016/s0161-4754(99)70101-6. PMID: 10029945. https://pubmed.ncbi.nlm.nih.gov/10029945/

24. Coleman R, Hynes RJR, Hynes RA, et al. A Further Exploration of a Proposed Method to Determine Axial Rotation on the Anteroposterior Pelvic Radiograph. J Contemp Chiropr 2025;8 https://journal.parker.edu/article/139047