

# MOTION PALPATION USED AS A POSTMANIPULATION ASSESSMENT TOOL FOR MONITORING END-FEEL IMPROVEMENT: A RANDOMIZED CONTROLLED TRIAL OF TEST RESPONSIVENESS

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## ABSTRACT

**Objective:** A tenet of motion palpation theory is the ability to confirm postadjustive segmental end-feel improvement (EFI). Only one previous trial has evaluated the responsiveness of EFI; this was a study of the thoracic spine. The purpose of this study was to evaluate the responsiveness of postadjustive end-feel for evaluating improvement in putative segmental spinal motion restriction after spinal manipulative therapy (SMT) of the cervical spine.

**Methods:** A prospective, blinded, randomized placebo-controlled pilot trial was conducted with 20 symptomatic and 10 asymptomatic participants recruited from a chiropractic teaching clinic. The treatment group received SMT, and the control group received placebo detuned ultrasound. Responsiveness was evaluated as the etiologic fraction (% of cases with EFI attributable to SMT) and as the sensitivity and specificity of change.

**Results:** For the entire sample, the etiologic fraction was 63% ( $P = .002$ ), sensitivity was 93%, and specificity was 67%. For symptomatic participants, a strong relationship appeared to exist between receiving SMT and EFI (etiologic fraction = 78%,  $P = .006$ ; sensitivity = 90%; specificity = 80%). A strong relationship was not found for asymptomatic participants (etiologic fraction = 40%,  $P = .444$ ; sensitivity = 100%; specificity = 40%), where EFI was recorded frequently, whether participants received SMT or detuned ultrasound.

**Conclusion:** The findings of this study showed that motion palpation of end-feel assessment appears to be a responsive postmanipulation assessment tool in the cervical spine for determining whether perceived motion restriction found before treatment improves after SMT. This observation may be limited to symptomatic participants. (*J Manipulative Physiol Ther* 2009;32:549-555)

**Key Indexing Terms:** *Research, Evaluation; Chiropractic; Palpation, Reliability, and Validity; Manipulation; Spinal*

**B**ecause palpation plays a major functional role in the chiropractic approach to patient management, it is imperative that palpation be investigated further in a scientifically appropriate manner.<sup>1</sup> Panzer<sup>2</sup> reported that palpatory findings were not used to monitor spinal changes

during clinical trials and suggested that motion palpation be applied to clinical decision making and also to monitoring clinical change.

The “fixation” (motion restriction, joint dysfunction<sup>3</sup>) represents one of the characteristics of a spinal subluxation.<sup>3-5</sup> Motion palpation, a tool that is frequently used to identify this motion restriction,<sup>3</sup> is used to assess accessory joint movement by means of “joint play” and “end-feel.”<sup>6</sup> These terms refer to the springy quality normally present in a joint taken beyond its active motion limits.<sup>6</sup> End-feel is the resistance felt at the end of range of motion, whereas joint play is the resistance felt from the neutral position.<sup>6</sup> This decrease in the springiness or increased resistance in a joint is generally palpated as a hard end-feel and is thus instrumental in the diagnosis of joint dysfunction.<sup>6</sup>

According to Ames,<sup>7</sup> there are many observations that can be made using motion palpation. Apart from using motion palpation to determine the motion segment requiring treatment and the direction of lost motion, one should be able to use motion palpation to confirm after a manipulation whether the manipulation has affected the hypothesized

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outcomes (eg, improvement in joint alignment, range of motion, and quality of movement)<sup>6</sup>. This ability to measure pre-post outcomes of manipulation are expected of chiropractors as health care providers who are required to document and record clinical progress.<sup>8</sup>

Haas et al<sup>9</sup> reported that the motion palpation theory described by Faye<sup>10</sup> incorporates a few assumptions. These include the following: (a) that an indication for spinal manipulative therapy (SMT) is end-feel restriction within the joint, (b) that this restriction within the joint is palpable, (c) that in some cases there is an immediate restoration of motion after SMT, and (d) that this restoration of motion within the joint is palpable. In this study, we define “end-feel improvement” (EFI) as immediate end-feel restoration of the most “fixed” cervical motion segment immediately after SMT. Previous motion palpation research has primarily focused on interexaminer and intraexaminer reliability, with varying results.<sup>9</sup> However, in addressing Faye’s theory,<sup>10</sup> it is imperative to establish whether motion palpation is responsive as a postadjustive assessment tool, allowing one to determine these restorative changes within the joint after treatment.

Many studies have been performed to determine the reliability of motion palpation in the spine,<sup>11-15</sup> and some have been performed on the cervical spine.<sup>16,17</sup> Some studies have tested either interexaminer or intraexaminer reliability, a combination of the two, or a combination of pain and palpation procedures.<sup>18-20</sup> A recent systematic review of palpation studies with high-quality designs reported that the reliability of intra- and interobserver motion palpation procedures generally suggested low reproducibility overall with consistently higher intraobserver reproducibility compared to interobserver reproducibility.<sup>20</sup> However, the reliability of immediate postmanipulation end-feel restoration using motion palpation has not been evaluated. One study has suggested indirect evidence that palpation of immediate EFI may have acceptable reliability.<sup>9</sup>

In an assessor-blind randomized trial, Haas et al<sup>9</sup> assessed the short-term response (ie, perceived change) of manual end-feel to spinal manipulation in the thoracic spine. Two examiners evaluated on 60 students, of whom 60% were symptomatic and 40% were asymptomatic. The sensitivity of motion palpation to clinical change in terms of end-feel was investigated. The treatment group received SMT, and the control group did not receive any treatment intervention. The perceived EFI by examiners was 60% after spinal manipulation, in contrast with 37% response in the untreated control group. The difference in proportions was statistically significant ( $P = .04$ ). Segmental end-feel palpation was found to have moderate use as an immediate posttreatment evaluation procedure for end-feel restoration in the thoracic spine. The authors suggested that further research be done on other patient populations, in other regions of the spine, and with different examiners so that the generalizability of the

study’s results could be determined.<sup>9</sup> This study was initiated to address these issues of generalizability while considering the suggestions for future studies as suggested by Haas et al.<sup>9</sup> In addition, this study supported the need for research in palpation, including motion palpation, which could provide credibility for manipulative techniques and diagnostic procedures used frequently by chiropractors worldwide.<sup>1</sup>

Thus, the purpose of this study was to investigate the responsiveness of end-feel to SMT in the cervical spine, where different examiners performed the palpation and a different patient population was used.

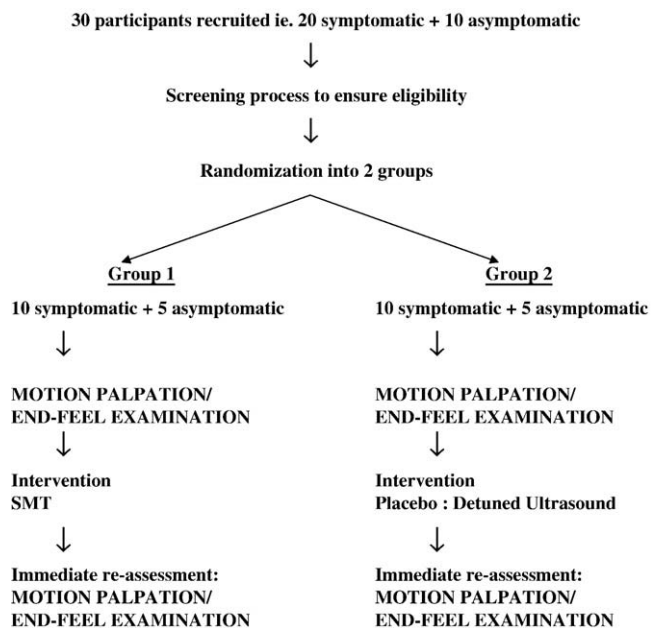
## METHODS

### Overview

Ethical approval to conduct this study was obtained by the Faculty of Health sciences Research Committee (Technikon Natal), indicating that the trial met with the requirements of the Declaration of Helsinki.<sup>21</sup> This pilot study was a prospective, assessor/participant-blind, randomized, placebo-controlled trial of test responsiveness. The test under study was cervical EFI. Randomization to treatment or control group was by equal allocation ( $n = 15$  per group) and stratified by symptomatic and asymptomatic persons. Twenty symptomatic and ten asymptomatic participants were recruited from the Chiropractic Day Clinic of the university. The researcher was responsible for recruitment of participants, determination of study eligibility of participants, randomization, and delivering all the relevant treatment. Participants were randomized by selecting a piece of paper from a box (one for each of the strata) once study eligibility was confirmed. Allocation was concealed from participants “throughout the study” and from personnel responsible for recruiting and screening potential participants “as randomization was only done once study eligibility was confirmed.” The treatment group received SMT, and the control group received detuned ultrasound. The end-feel examiner was blinded to study group and patient symptoms, and the participants were blinded to palpation examination findings so no clues or indications could be inadvertently conveyed to the blinded end-feel examiner (Fig 1).

### Participants

Participants for this study were obtained by means of advertisements placed in local newspapers, on notice boards in and around the university campus, and in shopping malls, beauty salons, and community centers. Respondents to these advertisements arrived at the Chiropractic Day Clinic for screening at the outset of the initial consultation. The sample of this study included 30 participants. All participants signed an informed consent form before inclusion into the study.



**Fig 1.** Flow chart for participants through the research process.

Potential participants were first screened for end-feel restriction by the supervising clinician who was on duty in the clinic at the time and not by the researcher or the end-feel examiner participating in the study. The researcher then screened the participants for contraindications to SMT<sup>6,22,23</sup> by means of case history, full physical examination, regional examination for the cervical spine, and in pertinent cases radiographic examination. Common contraindications to SMT included, but were not limited to, carcinomas, blood dyscrasias, severe osteopenia, significant recent trauma, fractures, infections, instability, vertebrobasilar arterial insufficiency, certain arthritides, collagen disorders, and disk infections. Only those participants with at least one cervical end-feel restriction (as confirmed by the supervising clinician) and without any contraindications to manipulation were included in the study. Participants were defined as symptomatic if they reported any neck pain and asymptomatic if they did not.

### Assessment

Before motion palpation being carried out, all the cervical segments were marked and labeled with a marker pen by an independent person (not the researcher nor the end-feel examiner). This was to ensure better reliability and responsiveness by reducing technical errors. This helped prevent the researcher from performing manipulation in the wrong place and the blinded end-feel examiner from reassessing the wrong spinal segment.

The blinded end-feel examiner (second author) had 16 years of clinical and teaching experience in motion palpation. End-feel assessment technique was used to

determine the level, the side, and the direction of restricted motion in the most or primarily fixated joint.<sup>24,25</sup> The level of the fixation (C0-C7), the side of the fixation (right or left), and the direction in which the fixation felt most restricted (flexion, extension, lateral flexion, posterior to anterior rotation or anterior to posterior rotation) were recorded onto a data recording sheet.

### Intervention

The participants in the control group received detuned ultrasound, and those in the treatment group received SMT. All treatments were carried out by the researcher who had 6 months of outpatient clinical experience at the Chiropractic Day Clinic. Detuned ultrasound was administered after the application of ultrasound gel at the primary fixation for 5 minutes with the participant in the seated position. Spinal manipulative therapy constituted a high-velocity, low-amplitude manual manipulation and was applied in the seated position in most instances, to the most fixated joint identified by the end-feel examiner.<sup>24,25</sup> Because the remnants of the ultrasound gel would have given the end-feel examiner a clue that a particular participant belonged to the placebo group, the researcher also applied ultrasound gel to participants receiving manipulation after completion of SMT.

### Follow-Up Assessment

After intervention, the blinded end-feel examiner conducted a follow-up end-feel examination on the motion segment where the primary fixation was originally found and recorded whether the fixation in that segment was still present or had improved. That is, the examiner evaluated whether there was EFI. The study outcome was EFI evaluated immediately after the first treatment.

### Statistical Analysis

In the context of clinical trials, the measurement that is of primary concern is responsiveness. This is the capacity of a tool or instrument to detect significant changes in health status even if those changes are quite small.<sup>26</sup> End-feel improvement was a dichotomous variable (yes or no). The primary analysis was responsiveness, evaluated as in Haas et al<sup>6</sup> with the etiologic fraction.<sup>27</sup>

Etiologic fraction was computed as the percentage of EFI attributable to SMT: (% treatment group EFI – % control group EFI) / % treatment group EFI. The numerator was the percentage of cases with end-feel responding to treatment minus the percentage of cases with end-feel responding to the placebo control (detuned ultrasound). The denominator represented the total percentage of cases receiving spinal manipulation with EFI. The etiologic fraction was therefore the percentage of response caused by spinal manipulation itself as a fraction of the total percentage of end-feel response

**Table 1.** End-feel improvement for the most restricted cervical motion segment

	Asymptomatic (n = 10)		Symptomatic (n = 20)		All (N = 30)	
	SMT	No SMT	SMT	No SMT	SMT	No SMT
	EFI	5	3	9	2	14
No EFI	0	2	1	8	1	10

in the treatment group.<sup>6</sup> Fisher exact test was used to test the null hypothesis indicating that there was no relationship between receiving SMT and EFI at the  $\alpha = .05$  level of significance. The primary analysis included the first of 6 treatments in the entire sample. The analysis was repeated for the symptomatic and asymptomatic subgroups.

Responsiveness was also evaluated with the sensitivity to change and specificity of change, for EFI (change after treatment). The positive likelihood ratio = sensitivity / (1 - specificity) and the negative likelihood ratio = (1 - sensitivity) / specificity were also computed. These indices were computed using SMT as a surrogate gold standard for EFI.

The estimates of etiologic fraction, sensitivity, specificity and likelihood ratios were probably conservative because of the possibility of classification error in the surrogate gold standard. End-feel improvement may not have occurred in all SMT participants and may have occurred in some control participants.<sup>6</sup>

An etiologic fraction equal to 0 (or equivalently likelihood ratio = 1) indicated test performance that was equivalent to chance. Etiologic fraction equal to 1 indicated a perfect test performance (sensitivity = specificity = 1). Data analysis was conducted using the SPSS statistical package (SPSS Version 10.0, Chicago, IL).

RESULTS

This study included 22 females and 8 males, with a mean age of 33.86 (most participants [n = 18] were between 20 and 29 years old). Table 1 presents the raw data, and Table 2 shows the responsiveness evaluated with etiologic fraction, change sensitivity, change specificity, and likelihood ratios of the EFI palpation test.

For the entire sample (Table 2), the sensitivity to change was excellent (93%) and the specificity of change was fair (67%). The positive and negative likelihood ratios were 2.8 and 0.1 respectively. The etiologic fraction also showed a moderately good test performance (64%,  $P = .002$ ). The etiologic fraction was calculated as follows: (% treatment group EFI - % control group EFI) / % treatment group EFI = (93% - 33%) / 93% = 64%. This meant that there was a 93% true positive test rate in the SMT group with presumptive EFI. Of these positive tests for improvement, 64% were attributable to the performance of the end-feel palpation test itself. The remaining 36% of the positive

**Table 2.** Responsiveness for immediate EFI<sup>a</sup>

	Asymptomatic	Symptomatic	All
Sensitivity	100%	90%	93%
Specificity	40%	80%	67%
Positive likelihood ratio	1.7	4.5	2.8
Negative likelihood ratio	0.0	0.1	0.1
Positive EFI test rate	100%	90%	93%
SMT group / % treatment group EFI			
Positive EFI test rate	60%	20%	33%
no-SMT group / % control group EFI			
Etiologic fraction ( $P$ ) <sup>a</sup>	40% (.444)	78% (.006)	64% (.002)

<sup>a</sup> The etiologic fraction is defined as (positive EFI test rate for SMT - positive EFI test rate for no SMT) / positive EFI test rate for SMT. It is the percentage of positive tests attributable to the functioning of the test (palpation of EFI).

tests in the SMT group are attributable to background noise, that is, spurious positive results that would be found in unchanged people.

Subgroup analysis (Table 2) showed better test performance for symptomatic participants than for asymptomatic participants. For symptomatic participants, there was 90% change sensitivity, 80% change specificity, 4.5 positive likelihood ratio, 0.1 negative likelihood ratio, and an etiologic fraction of 78% ( $P = .006$ ). The etiologic fraction was calculated as follows: (% treatment group EFI - % control group EFI) / % treatment group EFI = (90% - 20%) / 90% = 78%. In other words, EFI/responsiveness was noted in 90% (9 of the 10) receiving SMT (% treatment group EFI) and in only 20% (2 of the 10) receiving placebo (% control group EFI), with the difference being statistically significant ( $P = .006$ ). The response in this group to detuned ultrasound/placebo was far less than the group receiving spinal manipulation. Thus, overall improvement upon posttreatment motion palpation was noted in the group that was adjusted, compared to the group that was not adjusted. For asymptomatic participants, there was 100% change sensitivity but only 40% change specificity. The positive and negative likelihood ratio were 1.7 and 0.0, respectively, and the etiologic fraction was 40% ( $P = .444$ ). The etiologic fraction was calculated as follows: (% treatment group EFI - % control group EFI) / % treatment group EFI = (100% - 60%) / 100% = 40%. In other words, EFI/responsiveness was noted in 100% (all 5 participants) receiving SMT (% treatment group EFI) and in 60% (3 of the 5) receiving placebo (% control group EFI), with the difference not being statistically significant ( $P = .444$ ). Thus, in this group, overall improvement upon posttreatment motion palpation was noted in the group that was adjusted but was noted in the group that was not adjusted as well.

It can be seen from the results above (and in Table 2) that the response in the asymptomatic population to placebo was 3 times higher than to the response to placebo in the symptomatic population. More than 3 quarters of the

response (78%) was attributable to spinal manipulation in the symptomatic group, whereas less than half of the response (40%) was attributable to spinal manipulation in the asymptomatic group. The EFI attributable to the palpation procedure in symptomatic participants was almost twice than for asymptomatic participants. However, the subgroup sample sizes were too small to make meaningful comparisons of responsiveness indices, so chance differences between these groups cannot be ruled out.

## DISCUSSION

This was the second randomized trial to evaluate the responsiveness of motion palpation and the first to be conducted on the cervical spine. In this context, the results indicated that end-feel assessment was a useful tool for monitoring clinical progress in terms of improvement or lack thereof noted in fixation(s) found before treatment. Therefore, in this context and in terms of Yeomans'<sup>8</sup> recommendation for establishing clinical progress tools, these results would indicate that end-feel assessment could be used as one of these tools. Results showed that the sensitivity was excellent (93%) and the specificity was adequate (67%). The test performed well, with much of the positive findings attributable to the palpation exam itself (etiologic fraction = 64%).

For symptomatic participants in this study, a strong relationship existed between receiving SMT and EFI. This shows that a blinded end-feel examiner's putative EFI was greater in those participants that received SMT (9 of 10), and lesser in those participants that did not receive SMT (2 of 10). This was in contrast to the findings for asymptomatic participants, where low specificity (large false-positive test rate) was observed. The tendency to positive tests suggested that it may be more difficult to rule in EFI in an asymptomatic participant population.

These results differed from those of Haas et al,<sup>9</sup> whose overall EFI is 39% for the thoracic spine and the results were comparable for symptomatic and asymptomatic participants. The overall etiologic fraction was 50% greater in this cervical study, twice the magnitude for symptomatic participants, and comparable for asymptomatic participants. Some of the differences in results between the 2 studies may be attributable to and explained by one or more of the following factors:

- Differences in spinal anatomy<sup>28</sup> in terms of access to facet joints
- Differences in biomechanical function allowing for different movement patterns in the 2 regions resulting from dissimilar facet joint orientation<sup>28,29</sup> and sequelae related to open kinematic chains as compared to closed kinematic chains<sup>24,25</sup>

- Differences inherent in outcomes and the methodologies applied in reliability studies (ie, participant population, sampling error, and different examiners).<sup>30,31</sup>

A possible explanation for the perceived improvement in the end-feel of the motion segment in the asymptomatic population, regardless of whether they received SMT or placebo, could be that the fixations found before treatment may have been classified as a minor or muscular-type of fixations (as described in Schafer and Faye<sup>25</sup>), and therefore, these muscular fixations might have been difficult to palpate both pre-and postintervention. This suggestion was supported in this study, where it appeared that the fixations might have been more difficult to identify with motion palpation in the asymptomatic population. This would have compounded the motion palpation reassessment for any change in the quality of a fixation that was difficult to palpate at the outset. Another possibility is that the restrictions in symptomatic participants were more obvious and therefore may have led to enhanced performance in both identifying the restriction, as well as in identifying restriction changes. Therefore, it might be of benefit to develop a grading system to assess fixations before and after treatment. However, the practical problem with this is that it might be difficult to teach, as every examiner's interpretation of the grade of the fixation might be different. A positive point about developing this grading system is the development of subtlety of perception of motion restriction and its improvement. For the purpose of improving methods to monitor patient progress in one's practice, the skill of assessing change in the motion segment needs to be mastered.

It was reported by DeBoer et al<sup>14</sup> that in some instances, consecutive vigorous motion palpation on subjects by the 3 examiners in their study sometimes resulted in cavitations occurring within the joints and therefore reported the possibility that the fixations that were previously present within those joints might have been removed at some point during data collection. This is in accordance with the findings of Carmichael<sup>15</sup> on the sacroiliac joints. They suggested that if the testing procedure was performed repeatedly, mobility within the joint might change. If this was the case, then some in the control group were not genuine unchanged persons, causing underestimation of specificity and the etiologic fraction. If motion restriction was more minor in asymptomatic participants, unanticipated motion restoration could have a greater effect on specificity and etiologic fraction for asymptomatic participants.

Another scenario is that SMT may not have led to true EFI after SMT in all cases, resulting in either an overestimation or underestimation of the EFI. Therefore, 3 variables are needed to be considered in affecting the EFI and therefore altering sensitivity and etiologic fraction. The first is cavitation, which is believed to increase motion,<sup>32</sup> but it often occurs at vertebral motion segments other than the target segment.<sup>33</sup> Second, treatment may

also simply fail. Third, cavitation may not be required to engender patient change<sup>34</sup> so the impact of cavitation may not be important.

This study attempted to meet the challenge made by Haas et al<sup>9</sup> to increase the generalizability of the responsiveness of spinal end-play assessment by investigating a different region of the spine and including a walk-in clinical population rather than students exclusively. Yet, we must acknowledge the limitations of this study. The sample size was too small to make precise estimates of responsiveness indices and to compare results for symptomatic and asymptomatic subgroups. In addition, only one examiner, the blinded end-feel examiner, conducted all palpation examinations, and as has been previously noted, examiner performance can be heterogeneous.<sup>9</sup>

This study excluded the use of subjective outcome measures of pain and functional disability. It might be of interest to include these in future studies of the same nature to assess the relationship between symptomatic improvement and EFI. This might allow a comparison between the subjective response of the patient and the response as determined by the clinician.

## CONCLUSION

It is important for any health profession to develop effective measures of patient improvement. Motion palpation, which is a tool used to assess the biomechanics of the joints, must be accurate and sensitive to change to benefit the patient. The results of this pilot study suggest that motion palpation of end-feel assessment appears to be a responsive postadjustive assessment tool in the cervical spine for determining whether perceived motion restriction found before treatment improves after SMT. This result might be limited to symptomatic participants.

### Practical Applications

- Cervical motion palpation of EFI appears to be a responsive postmanipulation assessment tool for determining whether perceived motion restriction found before treatment improves after SMT.
- This observation may be limited to symptomatic participants, as in many asymptomatic participants, the EFI occurred despite the type of treatment received.

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