4.3 ROM means and p-value

The mean quantity of ROM for each movement direction, the differences among means and the standard deviation (Appendix 4) were calculated and reported in Table 4. Values in degrees.

Table 4

<table>
<thead>
<tr>
<th>ROM (Degrees) + SD</th>
<th>Traction (Straight Pull)</th>
<th>AP Glide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Flexion</td>
<td>53.736 (±13.304)</td>
<td>54.936 (±11.330)</td>
</tr>
<tr>
<td>Extension</td>
<td>53.688 (±14.791)</td>
<td>56.01 (±15.080)</td>
</tr>
<tr>
<td>Right Rotation</td>
<td>69.126 (±11.085)</td>
<td>73.866 (±12.59)</td>
</tr>
<tr>
<td>Left Rotation</td>
<td>69.481 (±11.010)</td>
<td>72.688 (±10.130)</td>
</tr>
<tr>
<td>Right Side Bending</td>
<td>35.303 (±8.540)</td>
<td>37.87 (±8.440)</td>
</tr>
<tr>
<td>Left Side Bending</td>
<td>35.633 (±8.740)</td>
<td>37.149 (±8.320)</td>
</tr>
</tbody>
</table>

The data are visualised by the graphs here below.
Mean C.R.O.M. Pre - Post in degrees

<table>
<thead>
<tr>
<th>Flexion</th>
<th>Extension</th>
<th>Right Rotation</th>
<th>Left Rotation</th>
<th>Right Side Bending</th>
<th>Left Side Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
</tbody>
</table>

Flexion | Extension | Right Rotation | Left Rotation | Right Side Bending | Left Side Bending |

Differences among pre-post means

<table>
<thead>
<tr>
<th>Flexion</th>
<th>Extension</th>
<th>Right Rotation</th>
<th>Left Rotation</th>
<th>Right Side Bending</th>
<th>Left Side Bending</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traction</td>
<td>AP Glide</td>
<td>Traction</td>
<td>AP Glide</td>
<td>Traction</td>
<td>AP Glide</td>
</tr>
</tbody>
</table>
Figure 13 shows the box and whisker plots where the distribution of ROM for the six movements (right and left rotation, flexion, extension, right and left lateral bending) before and after the two mobilisation techniques is presented. A very small number of outliers are present; the vast majority of ROMs are included among the whiskers that represent a range of 25 degrees, and the boxes are very small, with two small median quartiles gathering 50% of the ROMs. The standard deviation values are substantially overlapping with the intrarater reliability study where the same cervical active movements were used (Fletcher 2008). This confirms that the data distribution is normal and that inclusion criteria could select a group of participants with appropriate characteristics.
The researcher used the Paired samples t-test to compare the effects of two different techniques measured in ROM on a sample. The statistical calculations were generated by the SPSS software and the report is on Appendix 4. The author followed the steps for statistical testing of differences listed by Carter (2016 p.271) and trained to use the software package with the tutorial at https://statistics.laerd.com/premium.
The p-values showing the α value for the pre and post difference for each movement direction and each technique are in Table 5:

Table 5

<table>
<thead>
<tr>
<th></th>
<th>Traction p-value</th>
<th>AP glide p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Rotation</td>
<td>0.036</td>
<td>0.009</td>
</tr>
<tr>
<td>Left Rotation</td>
<td>0.004</td>
<td>0.045</td>
</tr>
<tr>
<td>Flexion</td>
<td>0.333</td>
<td>0.348</td>
</tr>
<tr>
<td>Extension</td>
<td>0.400</td>
<td>0.000356</td>
</tr>
<tr>
<td>Right Side bending</td>
<td>0.030</td>
<td>0.058</td>
</tr>
<tr>
<td>Left Side bending</td>
<td>0.204</td>
<td>0.341</td>
</tr>
</tbody>
</table>

5. Discussion

5.1 Confirmation/rejection of the hypotheses

The experiment had two null hypotheses:

- The two selected spinal mobilisations do not immediately increase the active ROM of the cervical spine.
- The comparison of the variations of the ROM between the manual traction and AP glide under traction will result in no difference.

The first null hypothesis was rejected as all of the means of the measured CROM showed an immediate increase after each mobilisation technique, even if the entity of the increase was small (Table 4).
Furthermore, the p-values obtained were as follows:

All of the rotations showed a statistically significant increase in ROM: right rotation and left rotation after traction were 0.036 and 0.004, respectively, and right rotation and left rotation after AP glide were 0.009 and 0.045, respectively.

For flexion, both techniques showed no change in ROM (p=0.333, p=0.348 for traction and AP glide, respectively). The AP glide showed a highly significant increase in ROM (p=0.000356) for the extension, but no effect was found for traction (p=0.400).

For the lateral bending, right lateral bending after traction had a significant change (p=0.030), while the other ROMs could not show a similar improvement; in left lateral bending (p=0.204 and p=0.342 for traction and AP glide, respectively) and left lateral bending (p=0.058) after AP Glide.

The same six CROMs that showed a statistically significant difference had a difference in amplitude larger than the measure error, which is 2.5° (Koerhuis et al., 2003; Pearcy & Hindle, 1991).

For the second null hypothesis, the comparison of the two techniques, the results were:

The p values for the T-Test technique versus technique post treatment Traction and AP glide were: in right rotation: p=0.02, in left rotation: p=0.135, in flexion: p=0.296, in extension: p=0.023, in right lateral bending: p=0.411, and in left lateral bending: p=0.061.

This result cannot allow the second null hypothesis to be rejected.

5.2 Clinical considerations

Statistically significant differences do not mean that the satisfaction of patients after a clinical treatment is high. The minimum clinically important difference (MCID) represents the smallest improvement considered worthwhile by a patient. For a few years (Copay 2007), MCID as a concept has been offered as a new standard for determining the effectiveness of a certain treatment and can describe the patient satisfaction in reference to that given treatment.

MCIDs are established by expert consensus and are related to patients’ self-reported treatment outcomes. The present experiment outcome is CROM recorded by an
electromagnetic device, thus it is not possible to find a MCID for cervical pain related to CROM. This means that the author could not use any MCID for the clinical considerations section.

Table 4 shows that all of the active movement directions demonstrated a positive difference between the ROMs recorded before and after the mobilisations, even if only some directions showed significant differences.

Thus, after rejection of one of the two null hypotheses, it is possible to say that the experiment results support the description and advocated clinical application of the two techniques tested:

- Manual traction (Cyriax, 1984; Atkins, 2016). The aim of this technique is to increase the ROM of the cervical spine: “It often achieves an increase in range and decrease in pain.” (Atkins, 2016 p. 249).
- AP glide under traction (Cyriax, 1984; Cyriax & Cyriax, 1993; Atkins, 2016): “This technique is applied if the symptoms have centralised and the range of movement has increased, but extension remains slightly limited” (Atkins, 2016 p.254).

All of the measured CROMs showed an increase after the mobilisation techniques, and the extension after the AP glide showed the larger increase and a significant difference between the measurements before and after the technique was performed.

AP glide is a technique including articular movement aimed at stretching the zygapophyseal joints, while manual traction is mainly aimed at reducing the pressure on the intervertebral disc. It seems logical to have a larger ROM increase after AP glide than after the manual traction. The clinical meaning of the two techniques is different. Manual traction is used to reduce pain by decreasing the disc compression, whereas AP glide aims to increase the cervical extension when the pain has decreased but the ROM, mainly in extension, is still limited. The present study supports the descriptions and aims of the techniques.

The researcher has been successfully applying both techniques in a clinical setting for 18 years for many patients affected by neck pain. The fact that only six out of 12 ROMs showed a significant increase was surprising.
Three possible explanations for that finding were:

- The study enrolled healthy pain-free volunteers. It is possible that some of the participants did not show a significant increase in the ROM after the mobilisation because his/her cervical spine was already at the end of the possible ROM and further increase was not possible without creating damage to the cervical spine of the volunteers.

- It has been shown that manipulations and mobilisations can immediately reduce pain in the vertebral column (Fernández-De-Las-Peñas, 2007; Fernández-De-Las-Peñas, 2008) and spinal manipulations can increase the quantity of endorphins in the blood stream (Degenhardt, 2007) and reduce the quantity of inflammatory cytokines (Teodorczyk-Injeyan, 2006). Those two techniques are normally successfully applied to produce an analgesic effect. A patient in pain normally increases his/her ROM mainly as a result of the analgesia. This effect was missing in the present experiment that was performed on painfree subjects.

- Six repetitions of the mobilisations were performed for each session. The volunteers showed no unwanted effects, and none complained of post treatment soreness. This is very positive, but it is also possible that some CROMs did not show a significant change because the number of repetitions was too small for that group of asymptomatic individuals. The author chose to be very cautious when preparing the study protocol, but it is possible that a larger number of repetitions could show a larger ROM increase.

5.3 The strengths of the study are as follows:

The randomisation of the volunteers to one technique for the first session, and subsequently the other technique for the second, and the randomisation of the active cervical movements.

The study is easily reproducible, as it has been described in full detail and iconographic documentation has been attached to the Appendix 1.

The generalisability of the results is supported by the comparison between the pre-mobilisation mean ROM of the study’s population with the latest CROM normative study (Swinkels, 2014), showing a substantial overlap of the results.
The literature review could not find any publications measuring CROM variation after musculoskeletal medicine vertebral mobilisation techniques. For the first time, the author of the current dissertation had the possibility to measure the CROM with high quality electromagnetic equipment.

5.4 The limitations of the study are as follows:

The researcher had a time limit of 6 months to run the experimental procedure after study approval of the Comitato Etico Cantonale Ticino. The experiment was part of his Master of Science in Musculoskeletal Medicine and the current dissertation, which contains the experimental procedure and the data obtained, was submitted 8 months after the Comitato Etico Cantonale Ticino study approval. This implies that a limited number of subjects could be enrolled for this study.

The choice to recruit healthy volunteers implied limitations for the generalisability to a clinical population. Asymptomatic subjects do not allow for the prediction of the result with symptomatic patients.

A single researcher applied the experimental procedure, which is a threat to the external validity of the results.

The choice of the author was to place more emphasis on internal validity, accepting to reduce the external validity.

A study applying manual therapy techniques on patients affected by knee arthritis had a washout period of 48 hours (Moss, 2007). Longer periods were used for studies on neurological patient rehabilitation (Wiles, 2001). The author made the assumption that a washout period of two weeks between the two sessions should reset the condition of the asymptomatic volunteers. Nevertheless, some physical carryover could have been present when the second technique was applied.

A limited age group was selected, which implies a limited applicability to the general population.

P<0.05 is an arbitrary decision.

The experience of the researcher in applying the techniques reduces the generalisability of the results.
False-positive results may also have occurred because all of the volunteers knew they were part of the interventional group and may have expected to move more and better after the technique.

The availability of the Fastrak Polhemus allows for study replication only in well-equipped research laboratories.

5.4 Study results summary

- The mean of all of the 12 pre-post treatment CROMs differences showed an increase when measured after the cervical mobilisation technique
- The increases in six active CROMs out of 12 were significant
- The active CROM that showed the largest increase is extension after AP glide
- It was not possible to demonstrate that one technique increases the CROMs after treatment more than the other
- The results supported the clinical application of the two techniques and the description of the desired effects of the AP glide.

6. Conclusion

This study tested two musculoskeletal medicine mobilisation techniques for the cervical spine. Thirty-six healthy volunteers were enrolled and received the two mobilisation techniques in two different sessions. Six CROMs were measured before and after the two mobilisations. Six CROMs out of 12 showed significant increases after the mobilisations, and the volunteers did not report any unwanted side effects such as post-treatment soreness, vertigo, or nausea. It was not possible to demonstrate that one technique is more effective than the other.

The study results support the use of the two selected mobilisation techniques to increase the CROM. The experimental procedure was prepared to maximise the internal validity, and the high definition of the data produced by the electromagnetic sensors system allowed careful measurement of the active ROM of the cervical spine before and after the mobilisation techniques. Extension after the AP glide was the CROM that showed the highest difference after treatment (p=0.000356). In the clinical setting, the aim of AP glide
is to increase the ROM restriction in extension (Atkins, 2016 p.254); the clinical application of the technique was confirmed by the present study. External validity is limited by the selection of healthy volunteers and by the small sample size. Future experiments enrolling patients affected by cervicalgia and with a larger number of participants could give more robust support to the clinical application of the two musculoskeletal medicine mobilisation techniques for the cervical spine.
References


Bohannon, R. W., et al. (2009). Reliability and validity of pendulum test measures of spasticity obtained with the Polhemus tracking system from patients with chronic stroke. Journal of Neuroengineering and Rehabilitation, 6, 30


Comitato Etico Cantonale Ticino Switzerland


Heinemann Oxford p. 30-32


Declaration of Helsinki http://www.wma.net/fr/30publications/10policies/b3/index.html


Framework for Research Ethics 2012 [http://www.esrc.ac.uk/_images/framework-for-research-ethics-09-12_tcm8-4586.pdf](http://www.esrc.ac.uk/_images/framework-for-research-ethics-09-12_tcm8-4586.pdf)


magnetic tracking device compared to inclinometer. *European Spine Journal, 18*(2), 276-281.


Normativa cantonale generale

Normativa federale


pain threshold levels following a cervical myofascial induction technique in pain-free healthy subjects. *Journal of Manipulative and Physiological Therapeutics, 32*(5), 352-357.


Websites

One sample Kolmogorov Smirnov Test
https://en.wikipedia.org/wiki/Kolmogorov%E2%80%93Smirnov_test

Paired samples T-test
https://en.wikipedia.org/wiki/Student%27s_t-test

Laerd statistics tutorial

Kofam
https://www.kofam.ch/en/home/

Comitato Etico Ticino
https://www4.ti.ch/dss/dsp/us/ce/comitato/