CHAPTER FOUR

4.1 Introduction

The first part of this chapter deals with the demographic data of all the subjects included in the study. The second part deals with the statistical analysis of the subjective and objective data obtained from the subjects. Included is a discussion of these results.

4.2 Demographic Data

Baseline analysis

Table 1: Continuous demographic data

	N	Mean	SD	Minimum	Median	Maximum	p-value
Age (years)							
Total	60	32.5	6.12	25	31	45	0.1846[1]
Group A	30	31.4	5.59	25	30	43	
Group B	30	33.6	6.50	25	32	45	
Weight (kg)							
Total	60	75.4	16.73	49	74.5	119	0.2001[2]
Group A	30	72.6	16.57	54	70	119	
Group B	30	78.2	16.70	49	79	114	

[1] Wilcoxon Mann-Whitney test for comparison between Group A and Group B
[2] t-test for independent groups for comparison between Group A and Group B

Table 2: Categorical demographic data

		Group A		Group B		Total group		
		N	%	N	%	N	%	p-value
Age	25-29 years	15	50.0	11	36.7	26	43.3	
	30-34 years	7	23.3	6	20.0	13	21.7	
	35-39 years	4	13.3	7	23.3	11	18.3	
	40-45 years	4	13.3	6	20.0	10	16.7	
Race	Black	5	16.7	5	16.7	10	16.7	1.0000[1]
	White	16	53.3	17	56.7	33	55.0	
	Coloured/Indian	9	30.0	8	26.7	17	28.3	
Gender	Male	15	50.0	15	50.0	30	50.0	1.0000[1]
	Female	15	50.0	15	50.0	30	50.0	

Side treated	Left	17	56.7	14	46.7	31	51.7	0.6058[1]
	Right	13	43.3	16	53.3	29	48.3	
Acute/Chronic	Acute	2	6.7	3	10.0	4	8.3	0.1350[1]
	Chronic	17	56.7	23	76.7	40	66.7	
	Acute on chronic	11	36.7	4	13.3	15	25.0	
SI syndrome	Bilateral	15	50.0	15	50.0	30	50.0	1.0000[1]
	Unilateral	15	50.0	15	50.0	30	50.0	

[1] Fisher's exact test for comparison between Group A and Group B

None of the baseline variables showed a significant difference between Group A and Group B. This is important in that Group A and B show a similar representation of the sacroiliac syndrome population. The fact that there were far more chronic than acute cases concurs with Kirkaldy-Willis and Burton (1992: 249) who state that the presentation is rarely acute and nearly always subacute or chronic. An almost equal incidence of side treated, and an equal incidence of bilateral and unilateral sacroiliac syndrome occurred by chance but does indicate something regarding the presentation of sacroiliac syndrome, thus it would be suggested that further research into these demographics be undertaken.

Table 3: Cavitation

Visit		**Group A**		**Group B**	
		N	**%**	**N**	**%**
Manipulation 1	Absent	5	16.7	3	10
	Present	25	83.3	27	90
Manipulation 2	Absent	5	16.7	3	10
	Present	25	83.3	27	90
Manipulation 3	Absent	8	26.7	3	10
	Present	22	73.3	27	90

From the above table it can be seen that for most manipulations a cavitation was present. The slight decrease in cavitations seen for the third manipulation in group A could possibly be due to an already improved mobility as a result of the first two manipulations. Also, some patients had no restrictions at the time of the third manipulation; however, they were still manipulated.

4.3 Follow up over time

For any of the following data that are reported (4.4.1 to 4.5.3), the N for each entry in each table in this section is 60, unless otherwise indicated, and is not included in every table.

Definitions of terms in the tables:

Baseline: Readings at visit 1 for group A and B combined before any treatment has been administered

Immediately pre-manipulation (or Pre-manipulation): Readings at visit 1 for group A and visit 4 for group B combined before first manipulation

Immediately post-manipulation: Readings at visit 1 for group A and visit 4 for group B combined after first manipulation

Visit after manipulation - pre: Readings at visit 2 for group A and visit 5 for group B combined before second manipulation

Visit after manipulation – post: Readings at visit 2 for group A and visit 5 for group B combined after second manipulation

Long after manipulation (or Post-manipulation): Readings at visit 4 for group A and visit 7 for group B combined after three manipulations altogether

Immediately pre-control (or Pre-control): Readings at visit 1 for group B and visit 4 for group A combined before first motion palpation

Immediately post-control: Readings at visit 1 for group B and visit 4 for group A combined after first motion palpation

Visit after control - pre: Readings at visit 2 for group B and visit 5 for group A combined before second motion palpation

Visit after control – post: Readings at visit 2 for group B and visit 5 for group A combined after second motion palpation

Long after control (or Post-control): Readings at visit 4 for group B and visit 7 for group A combined after three motion palpations altogether

4.4 First Objective: Subjective Clinical Findings

4.4.1 Pain (NRS)

Table 4: Pain

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	45.62	10.09	25.00	45.00	75.00
Pre-manipulation	45.58	11.31	15.00	45.00	73.00
Post-manipulation	31.37	17.41	0.00	30.00	63.00
Pre-control	40.62	14.85	0.00	44.00	75.00
Post-control	38.28	18.31	0.00	40.00	75.00

The pain measurements decreased during manipulation from 45.6 to 31.4, and decreased during control from 40.6 to 38.3.

Table 5: Average change from pre- to post pain measurement

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	-14.22	17.78	-55.00	-10.00	20.00
Control (post-pre)	-2.33	14.20	-45.00	0.00	40.00

A large decrease in pain was observed when the manipulation was done and a smaller decrease in pain was observed when the control was done. This is in congruence with the literature (Kirkaldy-Willis and Burton, 1992: 249 and Cassidy and Mierau, 1992: 223) that indicates a decrease in pain is expected post manipulation or after a course of manipulative treatments.

Table 6: Repeated measures ANOVA

Effect	p-value
Period	0.0566
Treatment (group*period)	0.0007
Group (order of treatments)	0.4156

Pain showed a significant treatment effect. The effect of period or group was not significant. We can conclude that the manipulation provided significant pain relief to the patients. The syndrome also improved without manipulation (during motion palpation), but to a lesser extent than during manipulation. This may have been due to the effect of motion palpation, where the patient would have had the

possibility of having the pain reduced by virtue of the cutaneous stimulus from touching the patient and mechanoreceptor stimulus from flexing the hips during motion palpation (Melzack and Wall, 1965). The effect of “Hawthorne” could have contributed to the improvement as shown in the control group, if the patient thought that they were expected to get better or wanted to show improvement to the researcher (Mouton, 1996: 152). Also, at visit 4 the crossover occurred and group A became a control group. As can be seen below, Group A continued to improve whilst they were in the control group as a result of the 3 previous manipulations. This could also have contributed to the slight improvement seen in the control group.

Table 7: Pain measurement at the different visits

Visit	Mean	SD	Minimum	Median	Maximum
Visit 1	45.62	10.09	25.00	45.00	75.00
Visit 4	40.58	15.69	0.00	40.00	73.00
Visit 7	29.07	18.68	0.00	30.00	75.00

The pain measurement decreased over time, with the lowest value recorded after both treatments (manipulation and motion palpation) were given. There is a larger improvement from visit 4 to visit 7 than from visit 1 to visit 4 as a result of a combination of the effects of manipulation on group B and the continued improvement of group A whilst in the control group.

Delayed effect of adjustment in Group A only

Table 8: Readings for Group A only, N = 30, Pain

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	44.83	9.62	30.00	45.00	65.00
Visit 7	30.23	19.54	0.00	29.00	75.00

The readings at Visit 7 were lower than the readings at Visit 1, indicating that the patients continued to improve over time. A possible reason as to why patients in group A continued to improve whilst in the control group is as follows:

During manipulation the neurological effects (e.g. stimulation of mechanoreceptors thus inhibiting the pain (Melzack and Wall, 1965)) are

immediate. The physiological effects (e.g. reduction in muscle hypertonicity (Korr, 1975 as cited in Leach, 1994: 99) and inflammation surrounding the joint) are initiated immediately neurologically but, due to the chronicity of the condition, these effects require time and a number of treatments in order to be effective. According to DeFranca (1996: 401), treatment of chronic joint and muscle conditions takes weeks and even months to restore function satisfactorily. He adds that suspending treatment for 2 to 3 weeks after an unsuccessful initial clinical trial is sometimes followed by signs of improvement. Also, after therapy, when a patient reaches a plateau and appears to be clinically static, suspending therapy often facilitates continued improvement (DeFranca, 1996: 401-402). Therefore, whilst the patient was in the control group, the physiological effects could still have been occurring thus decreasing the pain even further.

Table 9: Repeated measures ANOVA for pain with baseline variables included (immediate effect)

Effect	**p-value**
Period	0.6964
Treatment (group*period)	0.0054
Group (order of treatments)	0.4509
Weight	0.2629
Acute/chronic	0.1601
Bilateral syndrome	0.2650
Side treated	0.3073
Cavitation present	0.0868

None of the baseline variables had a significant effect on the pain outcome. The effect of a cavitation present on the pain outcome is almost significant, however this is inconclusive until one has a larger sample size with a larger number of absent cavitations in order to increase this significance or show that this significance is obsolete.

4.4.2 REVISED OSWESTRY LOW BACK PAIN AND DISABILITY QUESTIONNAIRE

This questionnaire is designed to give one information as to how the patient's back pain has affected their ability to manage everyday life. There are ten sections:

1. Pain Intensity
2. Personal care
3. Lifting
4. Walking
5. Sitting
6. Standing
7. Sleeping
8. Social life
9. Travelling
10. Changing degree of pain

Each section has six statements, and patients were asked to mark in each section only one statement which most closely described their problem at the time. The researcher then allocated marks for each marked statement and calculated the total.

Table 10: Revised Oswestry low back pain and disability questionnaire

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	14.65	6.16	0.00	14.50	31.00
Pre-manipulation	13.95	6.45	0.00	14.00	29.00
Post manipulation	8.55	7.32	0.00	6.50	35.00
Pre-control	12.42	6.85	0.00	12.00	31.00
Post control	11.35	7.54	0.00	11.50	29.00

The measurement decreased a lot during the manipulation from a mean score of 13.95 before the manipulation to a mean score of 8.55 immediately after the manipulation. When the control was given the change in the mean measurements was smaller (12.42 to 11.35).

Table 11: Average change from pre- to post manipulation

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	-5.40	6.49	-24.00	-4.00	10.00
Control (post-pre)	-1.07	4.71	-15.00	-1.00	9.00

There was a larger decrease in the rating when the manipulation was done than when the control was done. This is in congruence with the literature (Kirkaldy-Willis and Burton, 1992: 249 and Cassidy and Mierau, 1992: 223) that indicates a decrease in pain is expected post manipulation or after a course of manipulative treatments.

One cannot really compare the degree of change seen in the Oswestry with that seen in the NRS for the following reasons:

- The NRS reading is a mark out of 100 (Jensen et al., 1986: 118) whereas the Oswestry reading is a mark out of 50. The NRS will obviously show a greater degree of change as it is more sensitive to the permutations that exist in the group under study
- The NRS measures amount of pain (Jensen et al., 1986: 118) exclusively whereas the Oswestry measures a combination of pain and disability (Enebo, 1998: 30). The Oswestry is far more detailed and therefore may be a more accurate representation of the patient's pain and function.

Table 12: Repeated measures ANOVA

Effect	p-value
Period	0.6144
Treatment (group*period)	0.0005
Group (order of treatments)	0.1469

The ratings showed a significant treatment effect. The period and group effects were not statistically significant. We can conclude that the manipulation made a significant change to the rating on the Revised Oswestry low back pain and disability questionnaire. The syndrome also improved during the control

treatment, but to a lesser extent than during the manipulation. As with the NRS, this may have been due to the effect of motion palpation, where the patient would have had the possibility of having the pain reduced by virtue of the cutaneous stimulus from touching the patient and mechanoreceptor stimulus from flexing the hips during motion palpation (Melzack and Wall, 1965). The effect of "Hawthorne" could have contributed to the improvement as shown in the control group, if the patient thought that they were expected to get better or wanted to show improvement to the researcher (Mouton, 1996: 152). Also, at visit 4 the crossover occurred and group A became a control group. As can be seen below, Group A continued to improve whilst they were in the control group as a result of the 3 previous manipulations. This could also have contributed to the slight improvement seen in the control group.

Table 13: Oswestry measurement at the different visits

Visit	Mean	SD	Minimum	Median	Maximum
Visit 1	14.65	6.16	0.00	14.50	31.00
Visit 4	11.72	6.88	0.00	12.00	29.00
Visit 7	8.18	7.79	0.00	7.00	35.00

The Oswestry measurement decreased over time, with the lowest value recorded after both treatments (manipulation and motion palpation) were given.

Delayed effect of adjustment in Group A only

Table 14: Readings for Group A only, N = 30, Pain

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	14.65	6.16	0.00	14.50	31.00
Visit 7	8.18	7.79	0.00	7.00	35.00

The readings at Visit 7 were lower than the readings at Visit 1, indicating that the patients continued to improve over time. A possible reason as to why patients in group A continued to improve whilst in the control group is as a result of the delayed physiological effects of the manipulation (DeFranca, 1996: 401-402)

occurring whilst the patient was in the control group, thus decreasing the pain even further.

Table 15: Repeated measures ANOVA for Oswestry low back pain and disability questionnaire with baseline variables included (immediate effect)

Effect	**p-value**
Period	0.9891
Treatment (group*period)	0.0041
Group (order of treatments)	0.1275
Weight	0.6424
Acute/chronic	0.3365
Bilateral syndrome	0.6263
Side treated	0.5271
Cavitation present	0.5456

None of the baseline variables had a significant effect on functional ability outcome.

4.5 Second Objective: Objective Clinical Findings

4.5.1 Hip Joint Range of Motion

4.5.1.1 FLEXION

Table 16: Flexion (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	96.87	15.23	42.00	101.50	119.00
Immediately pre-manipulation	96.37	15.01	42.00	100.00	119.00
Immediately post-manipulation	100.25	14.20	41.00	102.00	126.00
Visit after manipulation – pre	99.50	13.93	44.00	99.50	132.00
Visit after manipulation – post	102.48	14.16	58.00	101.00	135.00
Long after manipulation*	101.10	14.73	40.00	104.00	135.00
Immediately pre-control	98.82	14.18	40.00	102.00	122.00
Immediately post-control	98.47	14.57	42.00	101.50	130.00
Visit after control – pre	97.72	12.73	43.00	99.00	123.00
Visit after control – post	96.97	12.98	45.00	98.00	125.00
Long after control*	99.73	12.60	63.00	102.00	120.00

* These measurements were taken at the beginning of the following cross-over period.

The normal range of motion is 110º-120º. The average reading at baseline for all participants was 96.9º. This is below the normal range of motion. The reading after three manipulations was 101.1 degrees, which is below normal, but closer to normal than the baseline readings. At the second manipulation the mean was lower than immediately after the first manipulation, but the mean increased after the second manipulation to a value even higher than that immediately after the first manipulation. The second manipulation thus provided additional benefit to the patients. This could be attributed to the concept of “spinal learning” found in the Patterson-Steinmetz model (Patterson and Steinmetz, 1986 as cited in Leach, 1994: 99-101), in that although the influence of the instigating lesion (sacroiliac syndrome) had been removed, the “learned” influence in the spine remained. Thus, in the area of sacroiliac syndrome with accompanying restrictions in sacroiliac motion and muscle spasm, if the syndrome had been there long enough (which was the case as most patients were chronic), there

may still have been segmental facilitation even after sacroiliac manipulation. This is as a result of a “neural scar” of hyperexcitable but subliminally excited neurons which remains and is abnormally responsive to additional stimuli as would occur during manipulation. Manipulation is effective in breaking the cycle; however, alterations in these spinal reflex circuits are not easily removed, and are susceptible to recur. This could explain why at the second manipulation the mean was lower than immediately after the first manipulation, but the mean increased after the second manipulation to a value even higher than that immediately after the first manipulation. “Unlearning” was occurring.

The flexion measurements increased during treatment as shown by the mean immediately pre-manipulation score that increased from 96.4º to 100.3º immediately post-manipulation. This improvement was sustained, since the flexion long after the manipulation was 101.1º, which is higher than the value immediately pre-manipulation. The flexion measurement decreased slightly in the control group. Possible reasons for the increase in hip flexion seen with sacroiliac manipulation are as follows and are supported by Mellin (1988: 669):

- Sacroiliac syndrome may cause a restriction in hip flexion because of a decrease in general physical activity. Thus, with sacroiliac manipulation providing pain relief, the physical activity of the patient may increase thus increasing the mobility of the hip.
- Sacroiliac syndrome, through neurological reflexes, may cause muscle spasm (Harrison et al., 1997: 614 and Hendler et al., 1995: 171). Spasm in the gluteal musculature could restrict hip flexion range of motion. Sacroiliac manipulation elicits reflexes which have the potential to reduce hypertonicity (spasm) in the posterior muscles (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250), thus increasing hip flexion range of motion.

Immediate effect of treatment on flexion

Table 17: Average change from pre- to post-flexion reading (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	3.88	7.82	-12.00	2.50	28.00
Control (post-pre)	-0.35	5.72	-19.00	0.00	14.00

There was an increase in the flexion when the manipulation was done, and a slight decrease when the control was done.

Table 18: Repeated measures ANOVA

Effect	p-value
Period	0.2271
Treatment (group*period)	0.0011
Group (order of treatments)	0.1738

Flexion showed a significant treatment effect and we can conclude that the manipulation made a significant change to the flexion score. There was no effect of the period or group. The carryover effect is the same as the effect for group, thus there was no carryover effect for flexion from the one period to the other.

Delayed effect of treatment on flexion

Table 19: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	4.73	10.88	-19.00	6.00	40.00
Control (post-pre)	0.92	9.40	-21.00	0.00	25.00

There was an increase in the flexion readings in both treatments (manipulation and motion palpation), with a larger increase when the manipulation is done. Possible reasons for the slight increase seen in the control group are:

- Hip flexion during motion palpation could have stretched the gluteal musculature, thus increasing hip flexion range of motion

- At visit 4 group A became a control group, and the physiological effects of the 3 manipulations during the first 3 visits could still have been having an effect whilst in the control group.

Table 20: Repeated measures ANOVA

Effect	p-value
Period	0.2026
Treatment (group*period)	0.0789
Group (order of treatments)	0.4786

Flexion did not show a significant period, treatment or group effect over a longer period.

Delayed effect of manipulation in Group A only

Table 21: Readings for Group A only, N = 30, Flexion (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	94.20	17.52	42.00	98.50	119.00
Visit 7	100.93	13.34	63.00	102.50	120.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402).

Table 22: Repeated measures ANOVA for Flexion with baseline variables included (immediate effect)

Effect	p-value
Period	0.6496
Treatment (group*period)	0.0015
Group (order of treatments)	0.0285
Weight	0.6610
Acute/chronic	0.0078
Bilateral syndrome	0.1793
Side treated	0.0418
Cavitation present	0.0403

The significant baseline variables were side treated, acute vs chronic disease and cavitation present or absent. The change from pre to post measurements is given for side treated.

Table 23: Average change from pre- to post Flexion measurement for side treated

Visit	N	Mean	SD	Minimum	Median	Maximum
Left side						
Manipulation (post-pre)	31	2.03	6.40	-12.00	2.00	16.00
Control (post-pre)	31	-0.87	5.38	-19.00	-1.00	12.00
Right side						
Manipulation (post-pre)	29	5.86	8.79	-8.00	4.00	28.00
Control (post-pre)	29	0.21	6.11	-13.00	0.00	14.00

This indicates that the mean change when the manipulation was done was much higher for the right side than for the left side. The most likely reason for this is as a result of the researcher's limited experience in manipulation, thus possibly having a slightly different technique from side to side which could ultimately affect the effectiveness of the manipulation.

Table 24: Average change from pre- to post Flexion measurement for acute vs chronic

Visit	N	Mean	SD	Minimum	Median	Maximum
Acute						
Manipulation (post-pre)	5	9.00	11.22	-3.00	5.00	27.00
Control (post-pre)	5	-1.40	11.28	-19.00	-1.00	12.00
Chronic						
Manipulation (post-pre)	40	4.70	7.11	-8.00	3.50	28.00
Control (post-pre)	40	0.03	4.99	-13.00	0.00	14.00
Acute on chronic						
Manipulation (post-pre)	15	0.00	7.34	-12.00	1.00	12.00
Control (post-pre)	15	-1.00	5.55	-10.00	1.00	6.00

Due to the small number of patients with acute disease, these results need to be interpreted with some caution. The mean increase was the largest for acute patients, then chronic patients and no benefit was observed for acute on chronic patients. This is inconclusive until one has a larger sample size with a larger

number of acute patients in order to increase this significance or show that this significance is obsolete.

Table 25: Average change from pre- to post Flexion measurement for cavitation present or absent

Visit	N	Mean	SD	Minimum	Median	Maximum
Present						
Manipulation (post-pre)	52	3.71	7.83	-8.00	2.00	28.00
Absent						
Manipulation (post-pre)	8	5.00	8.25	-12.00	6.50	14.00

Due to the small number of patients without cavitation, these results need to be interpreted with some caution. The mean increase was larger for patients without cavitation than for patients with cavitation. This is inconclusive until one has a larger sample size with a larger number of absent cavitations in order to increase this significance or show that this significance is obsolete.

4.5.1.2 EXTENSION

Table 26: Extension (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	23.13	7.57	6.00	24.00	40.00
Immediately pre-manipulation	23.28	7.81	6.00	24.00	40.00
Immediately post-manipulation	26.63	6.57	11.00	27.50	42.00
Visit after manipulation – pre	26.85	9.64	10.00	27.00	80.00
Visit after manipulation – post	28.55	6.75	12.00	29.00	49.00
Long after manipulation*	27.85	7.57	10.00	29.00	42.00
Immediately pre-control	24.52	8.09	10.00	24.00	42.00
Immediately post-control	25.12	7.08	11.00	24.00	40.00
Visit after control – pre	24.20	6.99	10.00	24.00	39.00
Visit after control – post	25.37	6.77	11.00	27.00	40.00
Long after control*	24.13	6.89	7.00	24.00	37.00

* These measurements were taken at the beginning of the following cross-over period.

The normal range of motion is 10º-15º. The average reading at baseline for all participants was 23.1º. This is above the normal range of motion. The reading after three manipulations was 27.9º which is outside the normal range of motion. It is thought by the researcher that this could be due to the measuring technique

of the evaluator. Although the technique was kept standard throughout the research, it may have been better to place a strap around the pelvis to prevent the pelvis coming off the table during extension rather than the evaluator applying a force over the pelvis with his/her hand. Also, due to the pain often associated with lying in the prone position, patients may have had their hips slightly flexed and not in the neutral position when the inclinometer was zeroed. This would have increased the extension range of motion reading.

The extension measurements increased during manipulation as shown by the mean immediately pre-manipulation score that increased from 23.3º to 26.6º immediately post-manipulation. The extension measurement increased slightly during the control treatment, from 24.5º to 25.1º. This improvement was sustained, since the extension long after the manipulation was 27.9º, which is higher than the value immediately pre-manipulation. The second manipulation was also beneficial, since the mean increased from pre- to post the second manipulation.

Immediate effect of treatment on extension

Table 27: Average change from pre- to post extension reading

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	3.35	4.49	-10.00	2.00	13.00
Control (post-pre)	0.60	2.64	-7.00	1.00	8.00

This shows a larger increase in the extension reading when the manipulation is done than when the control is done.

Table 28: Repeated measures ANOVA

Effect	p-value
Period	0.0377
Treatment (group*period)	< 0.0001
Group (order of treatments)	0.4136

Extension showed a significant treatment and period effect. The group effect was not statistically significant. The carryover effect is the same as the effect for

group, thus there was no carryover effect for extension from the one period to the other. We can conclude that the manipulation made a significant change to the extension score. The period effect indicates that there was a change (increase in mean values) over time, regardless of treatment group. This does not influence the comparison of treatments.

Delayed effect of treatment on extension

Table 29: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	4.57	8.28	-22.00	4.00	29.00
Control (post-pre)	-0.38	5.29	-16.00	1.00	9.00

There was an increase in the extension readings during the manipulation, and a small decrease during the control treatment.

Table 30: Repeated measures ANOVA

Effect	p-value
Period	0.4371
Treatment (group*period)	0.0010
Group (order of treatments)	0.0218

Extension showed a significant sustained treatment effect. The group effect was also statistically significant. The carryover effect is the same as the effect for group, thus there was a carryover effect for extension from the one period (manipulation) to the other (control). There was no effect of the period. We can conclude that the manipulation made a significant change over a longer time to the extension score.

The technique used for measuring extension range of motion is very similar to Yeomann's test (Extension test) (Kirkaldy-Willis et al., 1992: 125), which is a pain provocation test for sacroiliac syndrome, in that the patient lies prone and the hip is extended whilst applying a firm pressure over the sacroiliac joint. The difference is that Yeomann's test is passive and extension range of motion is active. Regardless of the difference, it is postulated by the researcher that

extension range of motion was initially restricted as a result of this movement aggravating the pain associated with sacroiliac manipulation and as a result of extension restrictions in the sacroiliac joint limiting hip extension. With sacroiliac manipulation the restrictions were resolved and the pain was reduced thus increasing the extension range of motion.

Also, the hypertonicity of the posterior muscles, like Gluteus maximus, associated with sacroiliac syndrome (Harrison et al., 1997: 614 and Hendler et al., 1995: 171), could limit the contractile ability of these muscles thus limiting extension. Sacroiliac manipulation elicits reflexes which have the potential to reduce hypertonicity (spasm) in the posterior muscles (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250), thus increasing their contractile ability and hip extension range of motion.

Delayed effect of manipulation in Group A only

Table 31: Readings for Group A only, N = 30, Extension (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	23.60	8.57	6.00	24.00	40.00
Visit 7	25.30	6.60	14.00	24.00	36.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402).

Baseline variables

Table 32: Repeated measures ANOVA for Extension with baseline variables included (immediate effect)

Effect	p-value
Period	0.5889
Treatment (group*period)	< 0.0001
Group (order of treatments)	0.6298
Weight	0.9925
Acute/chronic	0.3014

Bilateral syndrome	0.7332
Side treated	0.9784
Cavitation present	0.8942

None of the baseline variables had a significant effect on the extension measurements.

4.5.1.3 ABDUCTION

Table 33: Abduction (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	71.18	13.84	35.00	72.50	93.00
Immediately pre-manipulation	69.37	13.65	30.00	72.00	89.00
Immediately post-manipulation	74.73	12.34	38.00	77.00	97.00
Visit after manipulation – pre	73.03	12.38	38.00	76.00	93.00
Visit after manipulation – post	75.75	12.01	45.00	78.00	102.00
Long after manipulation*	73.72	15.23	17.00	75.50	99.00
Immediately pre-control	72.83	13.24	47.00	75.00	99.00
Immediately post-control	72.33	13.66	46.00	75.00	98.00
Visit after control – pre	71.37	13.13	40.00	71.50	92.00
Visit after control – post	71.38	13.06	36.00	71.00	94.00
Long after control*	71.95	14.67	30.00	73.50	97.00

* These measurements were taken at the beginning of the following cross-over period.

The normal range of motion is 30 to 50º. The average reading at baseline for all participants was 71.2º. This is above the normal range of motion. The reading after three manipulations was 73.7º, which is outside the normal range of motion. It is thought by the researcher that this could be due to the measuring technique of the evaluator. Abduction was measured in the side-lying position. The leg being measured (the top leg) could have been in slight adduction and not in the neutral position when the inclinometer was zeroed. This would have increased the abduction range of motion reading. The technique was however kept standard throughout the research.

The abduction measurements increased during manipulation as shown by the mean immediately pre-manipulation score that increased from 69.4º to 74.7º immediately post-manipulation. This improvement was sustained, since the abduction long after the manipulation was 73.7º, which is higher than the value immediately pre-manipulation. The abduction measurement decreased slightly in

the control group. The second manipulation was also beneficial, since the mean value from pre- to post-second manipulation increased.

There was however a decrease in the reading from immediately post-manipulation (74.73º) to visit after manipulation – pre (73.03º) and again from visit after manipulation – post (75.75º) to long after manipulation (73.72º). This supports the Patterson-Steinmetz theory (Patterson and Steinmetz, 1986 as cited in Leach, 1994: 99-101) as explained for flexion where there is “spinal learning” and an associated “neural scar” which requires a number of manipulations to cause “unlearning” and to break the cycle.

The improvement seen is again most likely to be due to the sacroiliac manipulation relaxing the associated muscle spasm (Korr, 1975 as cited in Leach, 1994: 99), thus improving the contractile ability of the Gluteus medius and minimus and the flexibility of the Adductors. Also, for flexion restrictions in the sacroiliac joint, the side-lying manipulation could to some extent stretch these hypertonic muscles and improve their contractile ability.

With regards to the improvement seen in flexion and extension range of motion, there may be a minimal contribution to this improvement from the restoration of mobility in the sacroiliac joints. According to Cassidy and Mierau (1992: 215) the range of motion in the sacroiliac joints is small and the predominant motion is x-axis rotation coupled with some degree of z-axis translation. Similarly, hip flexion and extension occurs around the x-axis, thus giving rise to the possibility of an increase in x-axis rotation of the sacroiliac joints causing an increase in x-axis rotation of the hip joint. Hip abduction and adduction occurs around the z-axis. The restoration of mobility in the sacroiliac joints would have a minimal effect on hip abduction and adduction as the sacroiliac joints do not work around the z-axis.

Immediate effect of treatment on abduction

Table 34: Average change from pre- to post-abduction reading

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	5.37	7.52	-6.00	4.00	27.00
Control (post-pre)	-0.50	5.14	-11.00	-1.00	14.00

This shows a large increase in the abduction reading when the manipulation is done, and a small decrease when the control is done.

Table 35: Repeated measures ANOVA

Effect	p-value
Period	0.8271
Treatment (group*period)	< 0.0001
Group (order of treatments)	0.8177

Abduction showed a significant treatment effect. There was no effect of the periods or groups. The carryover effect is the same as the effect for group, thus there was no carryover effect for abduction from the one period to the other. We can conclude that the manipulation made a significant change to the abduction score.

Delayed effect of treatment on abduction

Table 36: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	4.35	15.72	-70.00	5.50	36.00
Control (post-pre)	-0.88	10.18	-24.00	0.00	27.00

This shows a large increase in the abduction reading when the manipulation is done, and a small decrease when the control is done.

Table 37: Repeated measures ANOVA

Effect	p-value
Period	0.1716
Treatment (group*period)	0.0615

Group (order of treatments)	0.4025

Abduction did not show a significant period, treatment or group effect over a longer period.

Delayed effect of manipulation in Group A only

Table 38: Readings for Group A only, N = 30, Abduction (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	69.13	15.46	35.00	71.50	89.00
Visit 7	74.30	16.92	42.00	80.50	97.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402), thus causing group A to continue to improve whilst in the control group.

Baseline variables

Table 39: Repeated measures ANOVA for Abduction with baseline variables included (immediate effect)

Effect	p-value
Period	0.5667
Treatment (group*period)	< 0.0001
Group (order of treatments)	0.6186
Weight	0.8528
Acute/chronic	0.0940
Bilateral syndrome	0.6600
Side treated	0.0413
Cavitation present	0.0936

The only baseline variable that had a significant effect on the abduction readings was side treated.

Table 40: Average change from pre- to post Abduction measurement for side treated

Visit	N	Mean	SD	Minimum	Median	Maximum
Left side						
Manipulation (post-pre)	31	4.10	5.92	-6.00	3.00	18.00
Control (post-pre)	31	-1.16	4.54	-11.00	-1.00	10.00

Right side						
Manipulation (post-pre)	29	6.72	8.82	-6.00	6.00	27.00
Control (post-pre)	29	0.21	5.72	-10.00	0.00	14.00

This indicates that the mean change when the manipulation was done was higher for the right side than for the left side. The most likely reason for this is as a result of the researcher's limited experience in manipulation, thus possibly having a slightly different technique from side to side which could ultimately affect the effectiveness of the manipulation.

4.5.1.4 ADDUCTION

Table 41: Adduction (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	9.43	3.90	3.00	9.00	22.00
Immediately pre-manipulation	9.27	3.64	3.00	9.00	22.00
Immediately post-manipulation	10.42	3.53	5.00	10.00	22.00
Visit after manipulation – pre	10.23	3.85	5.00	10.00	22.00
Visit after manipulation – post	11.28	3.72	4.00	11.00	21.00
Long after manipulation*	10.92	3.67	4.00	10.00	22.00
Immediately pre-control	10.00	3.71	4.00	10.00	20.00
Immediately post-control	10.07	3.63	3.00	10.00	18.00
Visit after control – pre	9.72	3.48	4.00	10.00	18.00
Visit after control – post	9.92	3.67	3.00	10.00	18.00
Long after control*	9.85	3.61	4.00	10.00	20.00

* These measurements were taken at the beginning of the following cross-over period.

The normal range of motion is 30º. The average reading at baseline for all participants was 9.4º. This is below the normal range of motion. The reading after three manipulations was 10.9º which is also below normal. It is thought by the researcher that this could be due to the measuring technique of the evaluator. Adduction was measured in the side-lying position. The leg being measured (the top leg) could have already been in slight adduction and not in the neutral position when the inclinometer was zeroed. This would have decreased the adduction range of motion reading. The technique was however kept standard throughout the research.

The adduction measurement increased during manipulation and stayed almost the same during control. The increase was sustained for manipulation. At the second manipulation the mean value pre-manipulation (10.23º) was almost the same as the reading post the first manipulation (10.42º), indicating that the improvement was sustained. The mean value increased from pre to post the second manipulation. There was also a slight decrease in the reading from visit after manipulation – post (11.28º) to long after manipulation (10.92º). As with abduction, this supports the Patterson-Steinmetz theory (Patterson and Steinmetz, 1986 as cited in Leach, 1994: 99-101) where there is "spinal learning" and an associated "neural scar" which requires a number of manipulations to cause "unlearning" and to break the cycle.

Again, the improvement seen is most likely to be due to the sacroiliac manipulation relaxing the associated muscle spasm (Korr, 1975 as cited in Leach, 1994: 99), thus improving the contractile ability of the Adductors and the flexibility of Gluteus medius and minimus. Also, for flexion restrictions in the sacroiliac joint, the side-lying manipulation could to some extent stretch these hypertonic muscles and improve their flexibility.

Immediate effect of treatment on adduction

Table 42: Average change from pre- to post adduction reading

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	1.15	1.80	-6.00	1.00	8.00
Control (post-pre)	0.07	1.15	-4.00	0.00	3.00

This shows an increase in the adduction reading when the manipulation is done, and almost no change when the control is done.

Table 43: Repeated measures ANOVA

Effect	p-value
Period	0.4180
Treatment (group*period)	0.0008
Group (order of treatments)	0.5408

Adduction showed a significant treatment effect. There was no effect of the periods or groups. The carryover effect is the same as the effect for group, thus there was no carryover effect for adduction from the one period to the other. We can conclude that the manipulation made a significant change to the adduction measurement.

Delayed effect of treatment on adduction

Table 44: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	1.65	2.57	-8.00	2.00	7.00
Control (post-pre)	-0.15	3.27	-14.00	0.00	8.00

There was an increase in the adduction readings during manipulation and a decrease during control.

Table 45: Repeated measures ANOVA

Effect	p-value
Period	0.2412
Treatment (group*period)	0.0035
Group (order of treatments)	0.4860

Adduction showed a significant treatment effect, but the period and group effect was not significant over a longer period.

Delayed effect of manipulation in Group A only

Table 46: Readings for Group A only, N = 30, Adduction (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	9.13	3.74	3.00	8.50	22.00
Visit 7	10.30	3.62	4.00	10.50	18.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed

physiological effects of manipulation (DeFranca, 1996: 401-402), thus causing group A to continue to improve whilst in the control group.

Baseline variables

Table 47: Repeated measures ANOVA for Adduction with baseline variables included (immediate effect)

Effect	p-value
Period	0.5699
Treatment (group*period)	0.0014
Group (order of treatments)	0.3392
Weight	0.3320
Acute/chronic	0.5814
Bilateral syndrome	0.9602
Side treated	0.2837
Cavitation present	0.7899

None of the baseline variables had a significant effect on adduction.

4.5.1.5 INTERNAL ROTATION

Table 48: Internal rotation (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	42.88	9.41	27.00	42.00	66.00
Immediately pre-manipulation	41.42	9.88	26.00	38.50	66.00
Immediately post-manipulation	43.88	10.58	23.00	40.50	69.00
Visit after manipulation – pre	43.05	10.72	24.00	40.50	69.00
Visit after manipulation – post	45.60	11.55	23.00	42.50	74.00
Long after manipulation*	45.68	11.22	20.00	45.50	74.00
Immediately pre-control	44.05	10.87	20.00	44.00	74.00
Immediately post-control	44.00	10.54	24.00	43.00	69.00
Visit after control – pre	42.17	10.20	22.00	40.00	65.00
Visit after control – post	42.18	11.27	23.00	40.00	68.00
Long after control*	43.23	10.76	24.00	43.50	70.00

* These measurements were taken at the beginning of the following cross-over period.

The internal rotation measurements increased during treatment as shown by the mean immediately pre-manipulation score that increased from 41.4º to 43.8º immediately post-manipulation. The internal rotation measurement stayed almost the same during the control. The improvement during the manipulation

was sustained, since the internal rotation reading after three manipulations was 45.7º, which is higher than the value immediately pre-manipulation.

The mean value before the second manipulation was almost the same as the value immediately after the first manipulation. The mean after the second manipulation was higher than the mean before the second manipulation, indicating that the second manipulation was also beneficial to the patients.

The Piriformis muscle is an external rotator of the hip (Moore and Dalley, 1999: 551). Most patients with sacroiliac syndrome seem to present with spastic or hyperactive muscles (Harrison et al., 1997: 614 and Hendler et al., 1995: 171). According to Harrison et al. (1997: 616), sacroiliac manipulation seems to be able to elicit reflexes which have the potential to decrease muscle activity and thereby hypertonicity in muscles such as the Piriformis (Kirkaldy-Willis and Burton, 1992: 250). This would increase the flexibility of the Piriformis muscle and allow more internal rotation of the hip, thus giving a possible explanation for the improvement seen above.

Also, for flexion restrictions in the sacroiliac joint, the side-lying manipulation could to some extent stretch Gluteus medius and minimus and even Tensor of fascia lata. This could improve their contractile ability if they were in spasm, thus improving internal rotation range of motion.

Immediate effect of treatment on internal rotation

Table 49: Average change from pre- to post internal reading

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	2.47	6.86	-21.00	2.00	20.00
Control (post-pre)	-0.05	3.52	-14.00	0.00	11.00

This shows an increase in the internal rotation reading when the manipulation is done, and almost no change when the control is done.

Table 50: Repeated measures ANOVA

Effect	p-value
Period	0.0028
Treatment (group*period)	0.0031
Group (order of treatments)	0.0031

Internal rotation had a significant treatment, period and group effect. The statistically significant treatment effect indicates that the manipulation had a larger effect on internal rotation than the control. The carryover effect is the same as the effect for group, thus there was a significant carryover effect for internal rotation from the one period to the other. There also was a significant effect of the period, meaning that the order of the treatments had an effect on the effectiveness of the treatment.

Since the period and the group (order of the treatment) had an effect on the treatment, the analysis was repeated, with only the results of the first period.

Table 51: Results for the first period only, internal rotation, N = 30

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (Group A)					
Pre Visit 1	41.30	10.26	28.00	38.00	66.00
Post Visit 1	40.90	9.44	23.00	38.50	60.00
Pre Visit 4	43.63	13.04	20.00	42.00	74.00
Control (Group B)					
Pre Visit 1	44.47	8.35	27.00	45.00	65.00
Post Visit 1	44.73	8.44	26.00	44.00	62.00
Pre Visit 4	41.53	9.67	26.00	39.50	64.00

The p-value for the comparison of the two groups in Period 1 is 0.6366, this is not significant indicating that no treatment effect was observed during the first treatment period alone.

Delayed effect of treatment on internal rotation

Table 52: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	4.27	8.67	-24.00	5.00	25.00
Control (post-pre)	-0.82	7.94	-21.00	0.00	16.00

This shows an increase in the internal rotation readings when the manipulation is done and a decrease when the control is done. This decrease seen in the control could be as a result of the natural history of sacroiliac syndrome, which could be worsening before it improves (especially since the research sis not note and therefore we don't really know at what stage of the disease the patient is at). Also, cutaneous input from motion palpation is a normal, non-noxious stimulus but could aggravate the condition by virtue of causing facilitated neurons in the neural scar to fire and perpetuate the condition (Patterson and Steinmetz, 1986 as cited in Leach, 1994: 99-101).

Table 53: Repeated measures ANOVA

Effect	p-value
Period	0.0204
Treatment (group*period)	0.0040
Group (order of treatments)	0.8823

Internal rotation showed a significant treatment effect over a longer period, we can therefore assume that the manipulation had a sustained effect over time. The period effect was also significant, but this does not influence the comparison of treatments. There was no effect of the groups. The carryover effect is the same as the effect for group, thus there was no carryover effect for internal rotation from the one period to the other.

Delayed effect of manipulation in Group A only

Table 54: Readings for Group A only, N = 30, Internal rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	41.30	10.26	28.00	38.00	66.00
Visit 7	44.93	11.68	24.00	45.50	70.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402), thus causing group A to continue to improve whilst in the control group.

Baseline variables

Table 55: Repeated measures ANOVA for internal rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.4451
Treatment (group*period)	0.0004
Group (order of treatments)	0.0028
Weight	0.4535
Acute/chronic	0.8713
Bilateral syndrome	0.3010
Side treated	0.9323
Cavitation present	0.6361

None of the baseline variables had a significant effect on the internal rotation measurements.

4.5.1.6 EXTERNAL ROTATION

Table 56: External rotation (degrees)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	43.18	9.21	13.00	44.50	68.00
Immediately pre-manipulation	42.82	9.65	13.00	42.50	68.00
Immediately post-manipulation	45.55	8.90	20.00	46.00	69.00
Visit after manipulation – pre	43.70	9.55	25.00	45.50	68.00
Visit after manipulation – post	46.10	9.31	18.00	48.00	68.00
Long after manipulation*	44.42	9.17	21.00	46.00	68.00
Immediately pre-control	43.27	8.53	21.00	44.50	68.00
Immediately post-control	43.27	8.22	23.00	45.00	65.00
Visit after control – pre	43.98	8.27	24.00	45.50	60.00
Visit after control – post	42.80	8.35	22.00	45.00	59.00
Long after control*	43.32	8.93	20.00	44.00	68.00

* These measurements were taken at the beginning of the following cross-over period.

The external rotation measurements increased during manipulation as shown by the mean immediately pre-manipulation score that increased from 42.8º to 45.6º immediately post-manipulation. This improvement was sustained, since the external rotation reading after three manipulations was 44.4º. The mean external rotation measurement stayed almost the same during control.

At the second manipulation the mean (43.7º) was lower than immediately after the first manipulation (45.6º), but the mean increased after the second manipulation (46.1º) to a value even higher than that immediately after the first manipulation (45.6º). The second manipulation thus provided additional benefit to the patients. The mean after the second control was even lower than before the second control.

The pattern seen above supports the Patterson-Steinmetz “spinal learning” theory (Patterson and Steinmetz, 1986 as cited in Leach, 1994: 99-101). The value before the second manipulation (43.7º) was lower than the value immediately after the first manipulation (45.6º) but higher than the value immediately before the first manipulation (42.8º). Similarly, the value after three manipulations (44.4º) was lower than the value immediately after the second manipulation (46.1º) but higher than the value immediately before the second

manipulation (43.7º). The manipulations were slowly causing “unlearning” and breaking the cycle.

Again, sacroiliac manipulation relieves pain by reducing hypertonicity (spasm) in the posterior muscles (Kirkaldy-Willis and Burton, 1992: 250) like the Piriformis, Gluteus medius and minimus and Tensor of fascia lata. This would increase the contractile ability of the Piriformis muscle and increase the flexibility of Gluteus medius and minimus and Tensor of fascia lata, thus causing and allowing more external rotation of the hip. This could be a possible explanation for the improvement seen above.

Also, for flexion restrictions in the sacroiliac joint, the side-lying manipulation could to some extent stretch Piriformis, Gluteus medius and minimus and even Tensor of fascia lata. This could improve the contractile ability of the Piriformis muscle and the flexibility of Gluteus medius and minimus and Tensor of fascia lata, thus improving external rotation range of motion.

The mean baseline reading for external rotation (43.18º) was slightly more than that of internal rotation (42.88º). In terms of the immediate effect of the first manipulation, external rotation showed an average change of 2.73º whereas internal rotation showed 2.47º. In terms of the delayed effect of manipulation (i.e. after 3 manipulations), external rotation showed an average change of 1.60º whereas internal rotation showed 4.27º, indicating a greater improvement in internal rotation range of motion. This supports the theory mentioned earlier of the Piriformis muscle being in spasm with sacroiliac syndrome, and manipulation causing relaxation of this spasm thus increasing the flexibility of the muscle with subsequent increase in internal rotation range of motion.

Immediate effect of treatment on external rotation

Table 57: Average change from pre- to post external rotation reading

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	2.73	4.21	-6.00	2.00	15.00
Control (post-pre)	0.00	4.52	-14.00	-1.00	16.00

This shows an increase in the external rotation measurement when the manipulation is done, and no change when the control is done.

Table 58: Repeated measures ANOVA

Effect	p-value
Period	0.2442
Treatment (group*period)	0.0021
Group (order of treatments)	0.7893

External rotation showed a significant treatment effect. We can conclude that the manipulation made a significant change to the external rotation score. There was no effect of the periods or groups.

Delayed effect of treatment on external rotation

Table 59: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	1.60	7.42	-22.00	3.00	17.00
Control (post-pre)	0.05	5.35	-13.00	0.00	11.00

This shows an increase in the external rotation measurements when the manipulation is done and no change when the control is done.

Table 60: Repeated measures ANOVA

Effect	p-value
Period	0.1023
Treatment (group*period)	0.2505
Group (order of treatments)	0.5094

External rotation did not show a significant period, treatment or group effect over a longer period.

Delayed effect of manipulation in Group A only

Table 61: Readings for Group A only, N = 30, External rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	42.57	11.19	13.00	42.00	68.00
Visit 7	43.57	9.89	20.00	43.50	68.00

The readings at Visit 7 were higher than at Visit 1, indicating that the patients continued to improve over time.

Baseline variables

Table 62: Repeated measures ANOVA for External rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.3694
Treatment (group*period)	0.0022
Group (order of treatments)	0.8624
Weight	0.7230
Acute/chronic	0.0062
Bilateral syndrome	0.0023
Side treated	0.7136
Cavitation present	0.0007

The following baseline variables had a significant effect on external rotation measurements: acute vs chronic syndrome, bilateral syndrome and presence of cavitation.

Table 63: Average change from pre- to post external rotation measurement for acute vs chronic syndrome

Visit	N	Mean	SD	Minimum	Median	Maximum
Acute						
Manipulation (post-pre)	5	7.00	3.87	2.00	8.00	11.00
Control (post-pre)	5	-2.00	5.61	-8.00	-2.00	5.00
Chronic						
Manipulation (post-pre)	40	1.95	3.23	-2.00	2.00	11.00
Control (post-pre)	40	-0.35	3.34	-14.00	0.00	5.00
Acute on chronic						
Manipulation (post-pre)	15	3.40	5.72	-6.00	3.00	15.00
Control (post-pre)	15	1.60	6.45	-7.00	-1.00	16.00

These results should be interpreted with caution due to the small number of patients who had acute disease. It seems that the manipulation had the largest effect for acute patients, then for acute on chronic patients and a small effect for chronic patients on the external measurement. This is inconclusive until one has a larger sample size with a larger number of acute patients in order to increase this significance or show that this significance is obsolete.

Table 64: Average change from pre- to post external rotation measurement for bilateral syndrome

Visit	N	Mean	SD	Minimum	Median	Maximum
Bilateral						
Manipulation (post-pre)	30	4.80	4.18	-2.00	3.50	15.00
Control (post-pre)	30	-0.23	4.43	-14.00	0.00	10.00
Unilateral						
Manipulation (post-pre)	30	0.67	3.13	-6.00	0.00	11.00
Control (post-pre)	30	0.23	4.67	-8.00	-1.00	16.00

Patients with bilateral disease improved more than patients with unilateral disease when receiving manipulation for external measurements. This can possibly be explained if it is assumed that most sacroiliac restrictions were extension restrictions:

- On the side adjusted, manipulation could stimulate mechanoreceptors causing impulses to travel along medium and large diameter nerve fibers and inhibit pain impulses travelling through smaller fibers from the ipsilateral hypertonic Piriformis muscle (Melzack and Wall, 1965).
- On the side not adjusted but stretched as a result of the side-lying posture, manipulation could stretch the muscles against their muscle spindles leading to a barrage of afferent impulse signals to the central nervous system. This results in reflex inhibition of gamma and alpha motor neurons which may lead to readjustment of muscle tone and relaxation (Korr, 1975 as cited in Leach, 1994: 99) of the opposite Piriformis via a crossed reflex response.

The larger improvement seen in bilateral sacroiliac syndrome could have been as a result of a combination of the effects from both sides.

Table 65: Average change from pre- to post external rotation measurement for presence of cavitation

Visit	N	Mean	SD	Minimum	Median	Maximum
Absent						
Manipulation (post-pre)	8	3.00	5.83	-4.00	2.50	15.00
Present						
Manipulation (post-pre)	52	2.69	3.98	-6.00	2.00	12.00

This should be interpreted with caution due to the small sample sizes. Patients with no cavitation improved slightly more than patients with cavitation. This is inconclusive until one has a larger sample size with a larger number of absent cavitations in order to increase this significance or show that this significance is obsolete.

4.5.2 Hip Joint Position Sense (Proprioception)

4.5.2.1 10º INTERNAL ROTATION

Table 66: 10º internal rotation

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	-1.60	2.01	-7.00	-1.50	2.00
Immediately pre-manipulation	-1.70	2.09	-7.00	-1.00	2.00
Immediately post–manipulation	-1.27	2.15	-6.00	-1.00	5.00
Second manipulation – pre	-1.93	2.45	-8.00	-2.00	2.00
Second manipulation - post	-1.52	1.88	-6.00	-1.00	2.00
Long after manipulation*	-1.75	2.25	-9.00	-2.00	2.00
Immediately pre-control	-1.75	2.43	-9.00	-2.00	2.00
Immediately post control	-1.80	2.21	-8.00	-2.00	2.00
Second control – pre	-1.70	2.42	-8.00	-2.00	5.00
Second control - post	-2.00	2.11	-7.00	-2.00	2.00
Long after control*	-1.60	2.07	-7.00	-1.50	3.00

* These measurements were taken at the beginning of the following cross-over period.

The mean measurement immediately post-manipulation is closer to normal than the mean value immediately pre-manipulation. This improvement is not sustained, since the mean measurement after three manipulations is even further from normal than the value pre-manipulation. Immediately after the control treatment the mean value is further from normal than immediately pre-control.

The second manipulation also seemed to benefit the patients, since their values were closer to normal after the second manipulation than before it.

Due to the facilitation of the neuronal pool at the level of the involved hypertonic muscle associated with sacroiliac syndrome (Korr, 1975 as cited in Leach, 1994: 98-99), proprioceptors could be facilitated erratically thus decreasing hip joint proprioception. However, Bernard and Cassidy (1991: 2126) hypothesize that manipulation forcefully stretches hypertonic muscles against their muscle spindles. Therefore, with sacroiliac manipulation, proprioceptors could be stimulated thus resetting hip joint proprioception resulting in the improvement seen above.

As can be seen from the above, the effect of manipulation on joint position sense, and thus proprioception, is immediate with no sustained effects. This is expected as the effects of manipulation on proprioception are neurological and thus immediate. Therefore, it is suggested by the researcher that proprioceptive activity needs to be facilitated over the long term and between adjustments e.g. using a wobble board.

Proprioception in the control group appears to have deteriorated after motion palpation. This could possibly be due to motion palpation stimulating cutaneous receptors, thus causing further erratic behaviour within the neuronal pool. This could decrease the threshold level for firing the proprioceptive neurons, thus decreasing hip joint proprioception.

Immediate effect of treatment on 10º internal rotation

Table 67: Repeated measures ANOVA

Effect	p-value
Period	0.3780
Treatment (group*period)	0.3439
Group (order of treatments)	0.8271

10º internal rotation did not show a significant treatment, period or group effect.

Delayed effect of treatment on 10º internal rotation

Table 68: Repeated measures ANOVA

Effect	p-value
Period	0.3671
Treatment (group*period)	0.7630
Group (order of treatments)	0.7752

10º internal rotation did not show a significant treatment, period or group effect.

Delayed effect of manipulation in Group A only

Table 69: Readings for Group A only, N = 30, 10º internal rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	-1.43	2.03	-6.00	-1.00	2.00
Visit 7	-1.23	1.96	-6.00	-1.00	3.00

The readings at Visit 7 were closer to normal than the readings at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402). Even though group A became a control group at visit 4, the reduction in muscle hypertonicity induced by the previous three manipulations (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250) could still have been occurring whilst in the control group, hence the continued improvement seen. With muscle relaxation there could be decreased facilitation of the neuronal pool, thus preventing proprioceptors from being facilitated erratically.

Baseline variables

Table 70: Repeated measures ANOVA for 10º internal rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.2177
Treatment (group*period)	0.4918
Group (order of treatments)	0.5375
Weight	0.3659
Acute/chronic	0.7429
Bilateral syndrome	0.6400
Side treated	0.2000
Cavitation present	0.8515

None of the baseline variables had a significant effect on the 10º internal rotation readings.

4.5.2.2 10º EXTERNAL ROTATION

Table 71: 10º external rotation

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	-1.48	2.79	-8.00	-1.50	4.00
Immediately pre-manipulation	-1.90	2.50	-8.00	-2.00	2.00
Immediately post–manipulation	-1.43	2.23	-7.00	-1.00	4.00
Second manipulation – pre	-1.75	2.29	-9.00	-2.00	2.00
Second manipulation - post	-1.87	2.75	-15.00	-1.00	3.00
Long after manipulation*	-1.67	2.36	-8.00	-1.50	4.00
Immediately pre-control	-1.30	2.57	-8.00	-1.00	4.00
Immediately post control	-1.47	2.21	-7.00	-1.00	3.00
Second control – pre	-1.67	2.45	-12.00	-1.00	2.00
Second control - post	-1.87	2.75	-15.00	-1.00	3.00
Long after control*	-1.75	1.99	-7.00	-2.00	2.00

* These measurements were taken at the beginning of the following cross-over period.

The mean 10º external rotation measurement was closer to normal immediately after the manipulation than immediately before the manipulation. This effect was not sustained, since the mean was further from normal after three manipulations. After the control treatment the values were further from normal than before the control treatment.

The second manipulation did not normalise the mean values any further.

These findings are similar to those seen with 10º internal rotation, thus supporting the theories regarding the beneficial effects of manipulation on hip proprioception being immediate and not sustained, and the possible reason for motion palpation having negative effects on hip proprioception.

Immediate effect of treatment on 10º external rotation

Table 72: Repeated measures ANOVA

Effect	p-value
Period	0.4620
Treatment (group*period)	0.1648
Group (order of treatments)	0.7082

10º external rotation did not show a significant treatment, period or group effect.

Delayed effect of treatment on 10º external rotation

Table 73: Repeated measures ANOVA

Effect	p-value
Period	0.7094
Treatment (group*period)	0.3103
Group (order of treatments)	0.2332

10º external rotation did not show a significant treatment, period or group effect.

Delayed effect of manipulation in Group A only

Table 74: Readings for Group A only, N = 30, 10º external rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	-2.03	2.97	-8.00	-2.00	2.00
Visit 7	-1.73	2.05	-7.00	-2.00	2.00

The readings at Visit 7 were closer to normal than the readings at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402). Even though group A became a control group at visit 4, the reduction in muscle hypertonicity induced by the previous three manipulations (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250) could still have been occurring whilst in the control group, hence the continued improvement seen. With muscle relaxation there could be decreased facilitation of the neuronal pool, thus preventing proprioceptors from being facilitated erratically.

Baseline variables

Table 75: Repeated measures ANOVA for 10º external rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.0857
Treatment (group*period)	0.1000
Group (order of treatments)	0.8026
Weight	0.8170
Acute/chronic	0.7979
Bilateral syndrome	0.0748
Side treated	0.7903
Cavitation present	0.2448

None of the baseline variables had a statistically significant influence on the 10º external rotation scores.

4.5.2.3 20º INTERNAL ROTATION

Table 76: 20º Internal rotation

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	-0.78	2.71	-6.00	-1.00	5.00
Immediately pre-manipulation	-1.00	2.52	-6.00	0.00	5.00
Immediately post–manipulation	-0.33	2.90	-7.00	0.00	10.00
Second manipulation – pre	-1.20	2.50	-8.00	-1.00	4.00
Second manipulation - post	-1.02	2.51	-6.00	0.00	5.00
Long after manipulation*	-1.53	3.41	-19.00	-1.00	3.00
Immediately pre-control	-1.10	3.71	-19.00	-0.50	5.00
Immediately post control	-1.37	2.60	-8.00	0.00	3.00
Second control – pre	-1.30	2.53	-8.00	-1.00	8.00
Second control - post	-1.25	2.21	-8.00	-1.50	4.00
Long after control*	-0.53	2.25	-5.00	0.00	3.00

* These measurements were taken at the beginning of the following cross-over period.

The mean 20º internal rotation measurement was closer to normal immediately after the manipulation than immediately before the manipulation. This improvement was not sustained over time. The mean measurement was further from normal after the control than before the control.

The mean immediately before the second manipulation was further from normal than the mean after the first manipulation. The mean after the second manipulation was again slightly closer to normal.

These findings are similar to those seen with 10º internal rotation, thus supporting the theories regarding the beneficial effects of manipulation on hip proprioception being immediate and not sustained, and the possible reason for motion palpation having negative effects on hip proprioception.

Immediate effect of treatment on 20º internal rotation

Table 77: Repeated measures ANOVA

Effect	p-value
Period	0.4035
Treatment (group*period)	0.1217
Group (order of treatments)	0.1111

20º internal rotation did not show a significant treatment, period or group effect.

Delayed effect of treatment on 20º internal rotation

Table 78: Repeated measures ANOVA

Effect	p-value
Period	0.2669
Treatment (group*period)	0.2669
Group (order of treatments)	0.0286

20º internal rotation did not show a significant treatment or period effect. The group effect was significant. The carryover effect is the same as the effect for group, thus there was a carryover effect for 20º internal rotation from the one period to the other. This implies that the delayed effect of treatment should be evaluated for the first period only.

Since the period and the group (order of the treatment) had an effect on the treatment, the analysis was repeated, with only the results of the first period.

Table 79: Results for the first period only, 20º internal rotation, N = 30

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (Group A)					
Pre Visit 1	-1.83	4.48	-19.00	-1.00	3.00
Post Visit 1	-1.87	2.79	-8.00	-1.00	3.00
Visit 2	-1.97	2.06	-6.00	-2.00	2.00
Pre Visit 4	-0.27	2.23	-5.00	0.00	3.00
Control (Group B)					
Pre Visit 1	-0.80	2.28	-5.00	0.00	3.00
Post Visit 1	-0.87	2.39	-5.00	0.00	4.00
Visit 2	-1.60	2.33	-6.00	-2.00	4.00
Pre Visit 4	-1.23	1.83	-5.00	-1.00	2.00

The p-value for the comparison of the two groups in Period 1 is 0.8544, this is not significant indicating that no treatment effect was observed during the first treatment period alone.

Delayed effect of manipulation in Group A only

Table 80: Readings for Group A only, N = 30, 20º internal rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	-1.20	2.77	-6.00	-1.50	5.00
Visit 7	-0.27	2.23	-5.00	0.00	3.00

The readings at Visit 7 were closer to normal than the readings at Visit 1, indicating that the patients continued to improve over time. As for 10º internal and external rotation, this could be explained by the delayed physiological effects of manipulation (DeFranca, 1996: 401-402) causing muscle relaxation (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250). This could result in decreased facilitation of the neuronal pool, thus preventing proprioceptors from being facilitated erratically.

Baseline variables

Table 81: Repeated measures ANOVA for 20º internal rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.1484
Treatment (group*period)	0.2039
Group (order of treatments)	0.1910
Weight	0.8316
Acute/chronic	0.5620
Bilateral syndrome	0.4465
Side treated	0.0076
Cavitation present	0.2795

The only baseline variable that had a statistical significant influence on the 20º internal rotation measurement was side treated. There was a larger improvement for people being treated on the left side. The most likely reason for this is as a result of the researcher's limited experience in manipulation, thus possibly having a slightly different technique from side to side which could ultimately affect the effectiveness of the manipulation.

4.5.2.4 20º EXTERNAL ROTATION

Table 82: 20º external rotation

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	-0.73	3.04	-9.00	0.00	5.00
Immediately pre-manipulation	-0.92	2.58	-9.00	0.00	4.00
Immediately post–manipulation	-0.53	2.15	-7.00	0.00	6.00
Second manipulation – pre	-0.83	2.95	-13.00	0.00	4.00
Second manipulation - post	-1.12	2.99	-10.00	0.00	4.00
Long after manipulation*	-0.72	2.69	-15.00	0.00	4.00
Immediately pre-control	-0.65	3.12	-15.00	0.00	5.00
Immediately post control	-0.90	2.69	-8.00	0.00	4.00
Second control – pre	-1.15	2.97	-12.00	0.00	4.00
Second control - post	-1.15	2.63	-8.00	0.00	4.00
Long after control*	-0.85	1.90	-7.00	0.00	3.00

* These measurements were taken at the beginning of the following cross-over period.

The measurements showed a small mean change during both treatments (manipulation and motion palpation). The second manipulation did not have any benefit.

These findings are similar to those seen with 10º internal rotation, thus supporting the theories regarding the beneficial effects of manipulation on hip proprioception being immediate and not sustained, and the possible reason for motion palpation having negative effects on hip proprioception.

Immediate effect of treatment on 20º external rotation

Table 83: Repeated measures ANOVA

Effect	p-value
Period	0.3824
Treatment (group*period)	0.2695
Group (order of treatments)	0.5803

20º external rotation did not show a significant treatment, period or group effect.

Delayed effect of treatment on 20º external rotation

Table 84: Repeated measures ANOVA

Effect	p-value
Period	0.7887
Treatment (group*period)	0.5923
Group (order of treatments)	0.7553

20º external rotation did not show a significant treatment, period or group effect.

Delayed effect of manipulation in Group A only

Table 85: Readings for Group A only, N = 30, 20º external rotation (degrees)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	-0.93	3.24	-9.00	0.00	4.00
Visit 7	-0.80	2.07	-5.00	0.00	3.00

The readings at Visit 7 were closer to normal than the readings at Visit 1, indicating that the patients continued to improve over time. As for 10º internal and external rotation, this could be explained by the delayed physiological effects of manipulation (DeFranca, 1996: 401-402) causing muscle relaxation (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250). This could result in decreased facilitation of the neuronal pool, thus preventing proprioceptors from being facilitated erratically.

Baseline variables

Table 86: Repeated measures ANOVA for 20º external rotation with baseline variables included (immediate effect)

Effect	p-value
Period	0.0135
Treatment (group*period)	0.0765
Group (order of treatments)	0.7629
Weight	0.4439
Acute/chronic	0.6806
Bilateral syndrome	0.0455
Side treated	0.8416
Cavitation present	0.2021

The only baseline variable that had a statistical significant influence on the 20º internal rotation measurement was bilateral disease. There was a larger improvement for people with unilateral disease.

It is postulated that this could be due to patients with bilateral sacroiliac syndrome having more muscle spasm than patients with unilateral sacroiliac syndrome. This could result in greater facilitation of the neuronal pool and proprioceptors being facilitated even more erratically, thus decreasing hip joint proprioception even further. The possible larger amount of muscle spasm associated with bilateral sacroiliac syndrome would also take longer to resolve with manipulation, the effects of which may not be seen after only 3 manipulations.

4.5.3 Pressure Threshold of the Piriformis Muscle

Table 87: Algometer readings (kg/cm^2)

Visit	Mean	SD	Minimum	Median	Maximum
Baseline	6.16	2.69	1.50	5.80	10.00
Immediately pre-manipulation	6.50	2.64	2.40	5.80	10.00
Immediately post –manipulation	6.67	2.59	2.40	6.20	10.00
Second manipulation - pre	6.69	2.69	2.80	6.55	10.00
Second manipulation - post	6.77	2.73	2.70	6.50	10.00
Long after manipulation*	7.11	2.72	2.50	6.50	10.00
Immediately pre-control	6.37	2.83	1.50	6.00	10.00
Immediately post control	6.38	2.86	1.30	5.75	10.00
Second control – pre	6.43	2.73	1.40	5.55	10.00
Second control – post	6.40	2.75	1.40	5.50	10.00
Long after control*	7.02	2.62	3.10	7.40	10.00

* These measurements were taken at the beginning of the following cross-over period.

The mean algometer readings did not show a large change during either treatment. For both treatments (manipulation and motion palpation) the sustained effect was larger than the effect immediately after the treatment. The second manipulation did not seem to have any influence either.

As mentioned in chapter two, sacroiliac manipulation seems to be able to elicit reflexes which have the potential to reduce hypertonicity (spasm) in the surrounding muscles (Korr, 1975 as cited in Leach, 1994: 99 and Kirkaldy-Willis and Burton, 1992: 250), thus possibly increasing the pressure threshold of those muscles. The reflex would be an immediate neurological effect; however, the decrease in muscle spasm is more likely a physiological effect which may take time to occur, especially in cases of chronic sacroiliac syndrome as was the case in the majority of patients in this study. This could be the reason why the sustained effect was larger than the effect immediately after treatment

Immediate effect of treatment on algometer readings

Table 88: Average change from pre- to post algometer readings (kg/cm^2)

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	0.17	0.90	-1.60	0.00	4.70
Control (post-pre)	0.01	0.43	-0.70	0.00	2.30

The mean algometer readings showed almost no change during either treatment.

Table 89: Repeated measures ANOVA

Effect	p-value
Period	0.0274
Treatment (group*period)	0.2125
Group (order of treatments)	0.1623

The algometer readings did not show a significant treatment or group effect. The period effect indicates that there was a change over time, regardless of treatment administered. This does not influence the comparison of treatments.

Delayed effect of treatment on algometer readings

Table 90: Average change from immediately pre-manipulation/control to the reading at the long after manipulation/control visit (kg/cm^2)

Visit	Mean	SD	Minimum	Median	Maximum
Manipulation (post-pre)	0.60	1.91	-5.10	0.35	5.10
Control (post-pre)	0.65	1.48	-2.60	0.25	6.00

This shows an increase in the algometer readings over a longer time in both treatments (manipulation and motion palpation). A possible reason for the increase seen in the control group as well is as a result of the "gate control theory" (Melzack and Wall, 1965). During motion palpation, cutaneous stimulation, as well as mechanoreceptor stimulation as a result of hip flexion, could cause impulses to travel along medium and large diameter nerve fibers and thus inhibit pain impulses travelling through smaller fibers. This could increase the pressure threshold. Also, during motion palpation, hip flexion may stretch the Piriformis muscle to some extent, thus reducing hypertonicity and spasm and increasing the pressure threshold.

Table 91: Repeated measures ANOVA

Effect	p-value
Period	0.7282
Treatment (group*period)	0.9092
Group (order of treatments)	0.4112

The algometer readings did not show a significant treatment, period or group effect.

Delayed effect of manipulation in Group A only

Table 92: Readings for Group A only, N = 30, (kg/cm^2)

	Mean	SD	Minimum	Median	Maximum
Visit 1 (pre-adjustment)	6.14	2.74	2.40	5.80	10.00
Visit 7	7.17	2.76	3.10	8.00	10.00

The readings at Visit 7 were higher than the readings at Visit 1, indicating that the patients continued to improve over time. This supports the theory mentioned in the discussion of the numerical pain rating scale (NRS) regarding the delayed physiological effects of manipulation (DeFranca, 1996: 401-402).

Baseline variables

Table 93: Repeated measures ANOVA for algometer with baseline variables included (immediate effect)

Effect	p-value
Period	0.4380
Treatment (group*period)	0.1521
Group (order of treatments)	0.0782
Weight	0.1529
Acute/chronic	0.1012
Bilateral syndrome	0.2333
Side treated	0.8839
Cavitation present	0.1403

None of the baseline variables had a significant effect on the algometer readings. It was assumed by the researcher that with hypertonicity of a muscle like Piriformis associated with sacroiliac syndrome, there would be a decrease in pressure threshold of that muscle. This could possibly not be the case as there

was not a significant increase in pressure threshold of the Piriformis muscle with sacroiliac manipulation. This could be due to:

- Hypertonicity of the Piriformis muscle not being completely resolved after three manipulations (delayed physiological effects), especially in cases of chronic sacroiliac syndrome. Sometimes daily manipulation for 10 days is required (Kirkaldy-Willis and Burton, 1992: 249).
- An algometer measuring pressure threshold over the Piriformis muscle being the wrong tool to measure tonicity.

It is therefore necessary that further research in this regard is conducted.