The use of motion analysis to assess a patient pre and post a clinical massage treatment

Reflective markers are placed onto a person or object that is to be tracked. For objects these are placed wherever is convenient. For people and animals they are placed in order to capture the position of joint centres and capture the movement of body parts.


LED lamps illuminate the markers. The lamps are placed as close as possible to the cameras to maximise the amount of light reflected straight back.

This may be simply represented as below.
The amount of light received by the cameras is a function of the lamp brightness, the marker size and inversely proportional to the square of twice the distance from camera to marker.
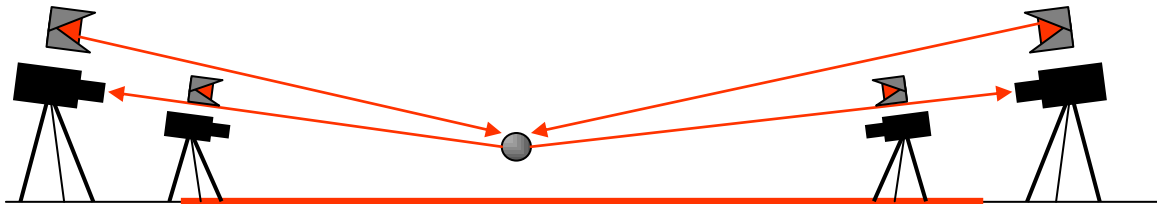
Provided that enough cameras can detect the markers the system software determines their location. This alone will allow simple viewing of their position in 3D and calculation of the properties of the bodies they are attached to.

However to aid visualisation and for coaching and animation purposes,
the markers may be used to locate graphics
and animations in 3D space.
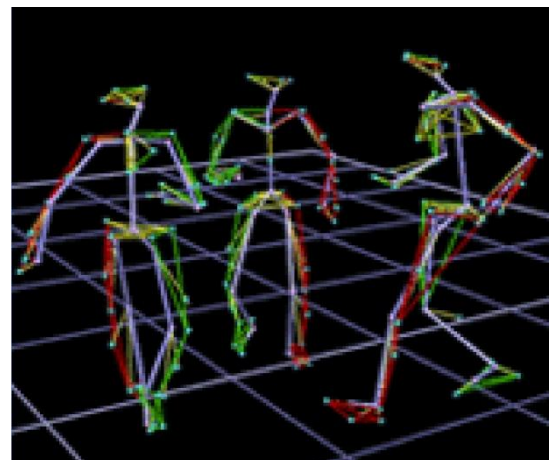
Research Day ▪ August 2005

In August 2005 I measured the changes on patient pre and post a clinical massage treatment.

For the first hour a variety of "markers" were placed on my patient's body and specific joints to measure the following:

Standard gait report pre and post treatment

- Joint kinematics
- Joint kinetics
- Gait parameters

With **extra features** looking closer at joint kinematics on

- Pelvis tilt, obliquity, rotation,
- Hip flexion/extension, ab/adduction, rotation
- Knee flexion/extension, ab/adduction, rotation
- Ankle plantar/dorsi flexion, varus/valgus
- Foot progression (view from below)
- The comparison of pre and post massage walking speeds
- Pelvis position and height and horizontal position
- Views of right hand side, left hand side, front, rear, above and below

The range of motion pre and post treatment

- Shoulder rotation
- Arms reach across body
- Length of arms by side
- Flexion of upper arm
- Frontal movement of left and right leg

Once all the above had been measured the "markers" were removed and I treated my patient.

The "markers" were then replaced on my patient's body and the research was completed.

Examples of some of the Results

Graph traces

The graph traces in this report are coloured according to the following convention:
red   Patient's left hand side
green Patient's right hand side
grey   Average and standard deviation of normal dataset

Normal dataset

The normal dataset used in this report represents 9 adults, 6 females and 3 male and contains only kinematic data.
It was collected and processed by Dr. Richard Baker of Musgrave Park Hospital, Belfast

In order to appreciate the full effects of this research, using motion analysis technology, you have to see the comparisons of the moving 3D "skeleton" animations, 3D views, and graphs as well as interactively move the animations to see the full effect a clinical massage treatment had on the patient.
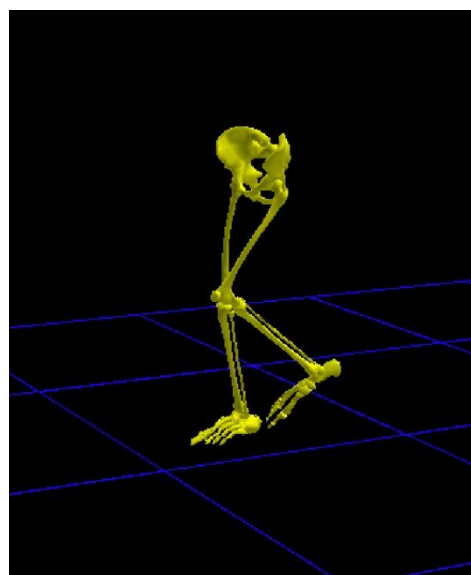
A still capture taken from a motion analysis animation does not have the same impact as a moving one. However, I hope that the following examples will give you an idea of the benefits that the Clinical massage treatment had.

View from left hand side
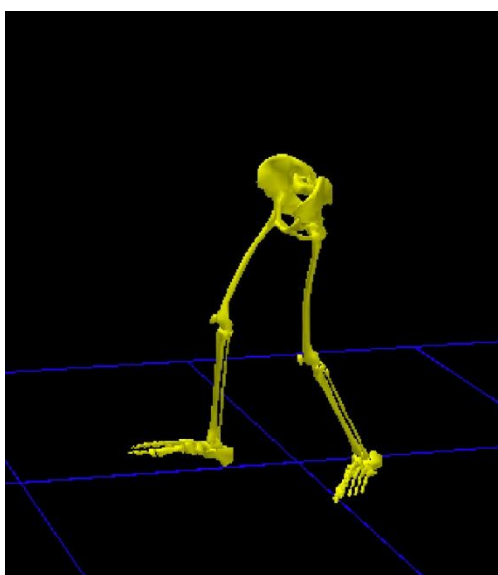
**Pre**   **Post**

Gait Parameters

pre

	Left	Right
Cadence (average)	92.3 steps/min	
Cadence	nim/spets 92.3	92.3 steps/min
Double Support	0.39 s	0.39 s
Foot Off	53.2 %	76.9 %
Limp Index	0.69	1.45
Opposite Foot Contact	39.7 %	60.3 %
Opposite Foot Off	16.7 %	13.5 %
Single Support	0.30 s	0.61 s
Step Length	0.39 m	0.41 m
Step Time	0.78 s	0.52 s
Step Width	0.39 m	0.39 m
Stride Length	m 0.36	0.81 m
Stride Time	1.30 s	1.30 s
Walking Speed	0.28 m/s	0.62 m/s
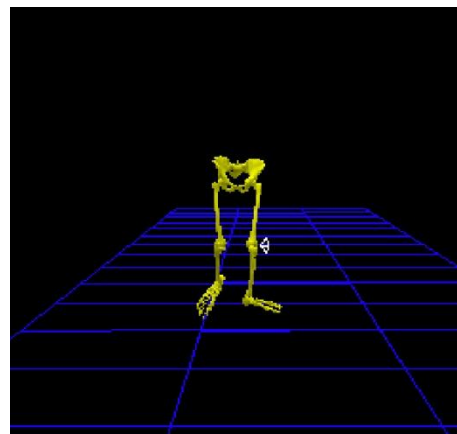
post

	Left	Right
Cadence (average)	87.9 steps/min	
Cadence	93.5 steps/min	82.3 steps/min
Double Support	0.44 s	0.62 s
Foot Off	66.2 %	72.0 %
Limp Index	0.97	1.02
Opposite Foot Contact	39.0 %	65.7 %
Opposite Foot Off	7.14 %	36.0 %
Single Support	0.41 s	0.43 s
Step Length	0.57 m	
Step Time	0.78 s	0.50 s
Step Width	0.31 m	
Stride Length	1.06 m	
Stride Time	1.28 s	1.46 s
Walking Speed	0.82 m/s	

Average values from Normal dataset:

	Avg
Cadence	1.00 ± 0.098 1/s
Foot Off	60.2 ± 2.42 %
Opposite Foot Contact	49.9 ± 1.88 %
Step Length	719 ± 57.5 mm
Step Time	50.1 ± 1.88 s
Stride Length	1441 ± 113 mm
Stride Time	0.99 ± 0.084 s
Walking Speed	1453 ± 223 mm/s

Comments:
The system has been unable to provide actual values for the step length, step width, stride length and walking speed from the right leg, post-massage. However using the cadence and the limp index some conclusions about the effect of the massage on the gait can be drawn:
1. The limp index (calculated based on the length for each step) has tended towards a value of 1 (normal) after massage. This means that that the software, despite being unable to categorical identify the step length has determined that after the massage the length of each step is approximately equal. This can be clearly seen in the animation alongside.
2. The cadence values have changed from the pre-massage values, and have actually separated. The conclusion is that the movement has changed from a slow long step, followed by a short quick step, two steps of equal length similar to the long step previously. This has the effect of actually slowing the walk, but maintaining an equaling walking pattern.

The normative values are taken from a study by Baker, from Queen Mary's College Belfast.

Comparison of pre and post walking speeds
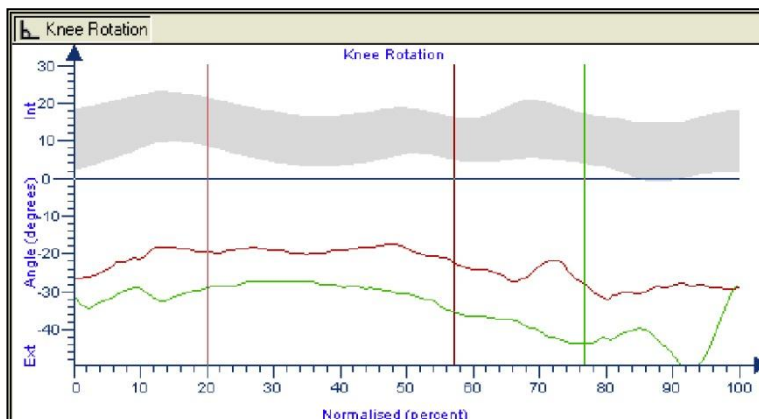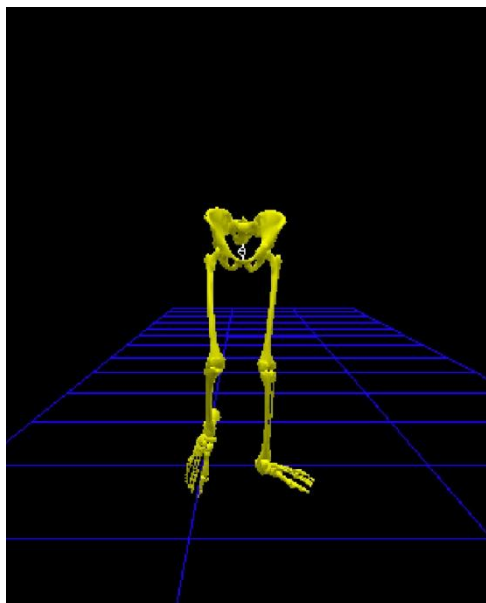
Comments:
The difference between the pre- (green) and post-massage (yellow) gait and walking speeds is clearly visible when viewed together. The treatment has increased the speed of gait, the fluidity of gait, and when viewed from above, has improved the movement in terms of reducing likely causes of future injury. It will be critical in deterring the success of the treatment to assess the long term impacts of the treatment and how long each treatment effect lasts.
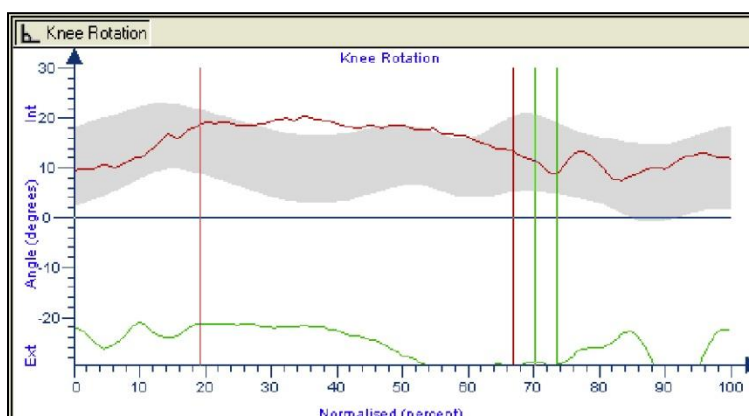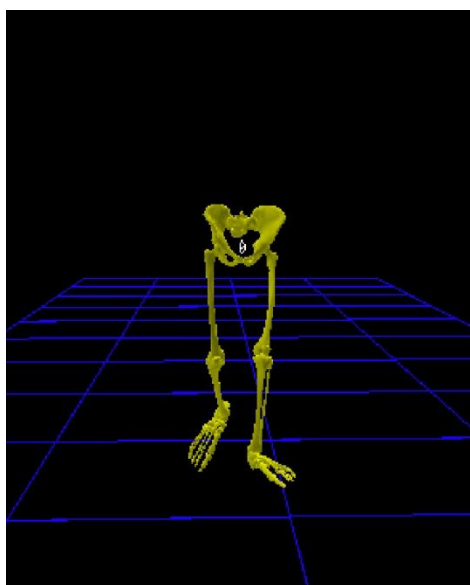
Pre
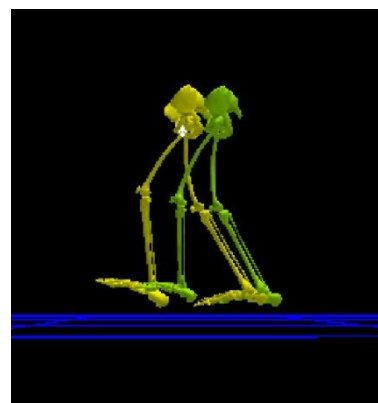
Post

Comments:
The treatment has a number of effects on the knee joint, the most pronounced being that irrespective of any other effect the knee joint motion becomes smoother and less erratic. This can be easily seen on all the graphs as the number of small spikes and blips in the trace is reduced.

The impact of the massage on the flexion / extension of the knee during locomotion is limited - the movement is clearly still restrained in some manner, and although the smoothness of the movement is increased the range and type of movement is generally unaffected.

The ad/adduction and rotation of the knee combine with the effects on the hip to bring the foot progression angle of the left foot in line with the right. The benefits of this is that the reduction of pressure on the knee due to the decreased rotation of the knee and hip. The consequences of this on the reduction of potential future injury are very important. The amount of rotation at the knee in the pre-treatment gait is likely to result in problems in later life.

Pre
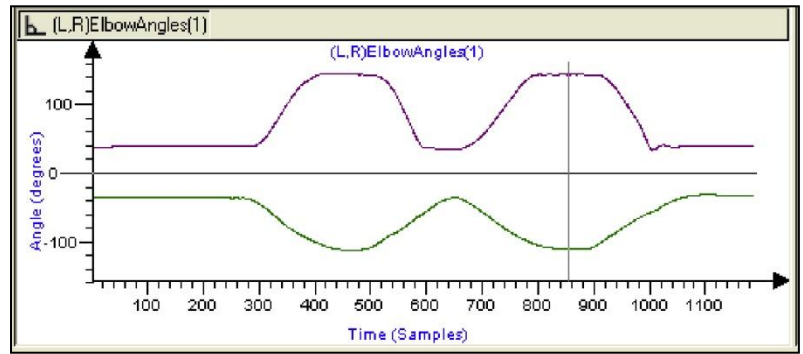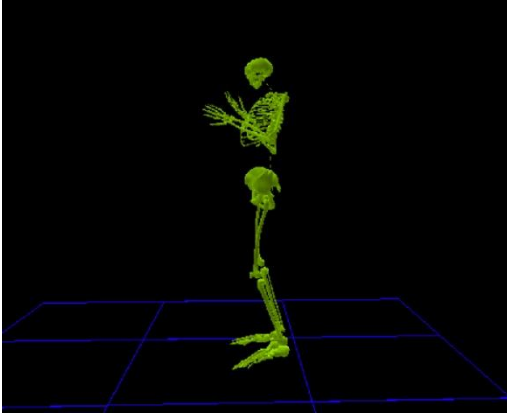
Post
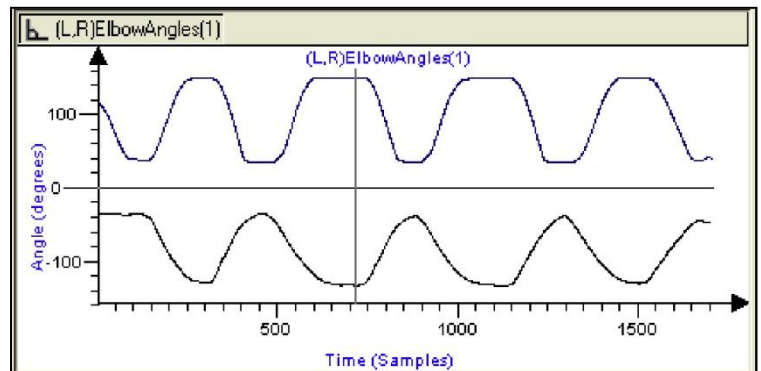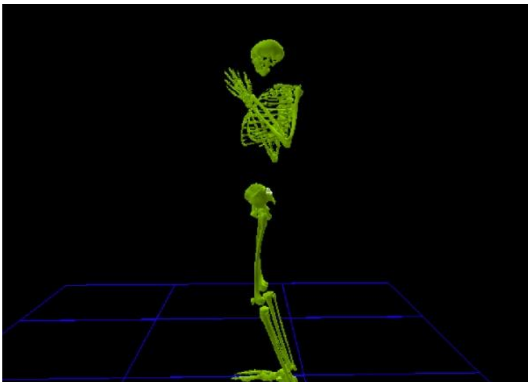
> *Comments:*
> *The effect of the massage is again to aid the movement rather than have a large effect on the range of movements. However in this exercise Mark is clearly able to extend his elbows to a greater degree than previously. The left arm is still hindered in its ability to move at the same rate as the right hand, although this has improved after treatment. The slope of the graphs for the left hand is indicative of this.*

Conclusions

The Clinical massage treatment has a clear effect on the patient and is identifiable through the variety of data collected.

However there are a number of key issues apparent in the data.

1. The patient often compensates for limited movement by introducing movement elsewhere in the system to allow motion to remain close to expected levels. This is often difficult to detect either in real life, on video or in the animations.

2. The range of movement is often increased after treatment. Where there is no change it is suspected that there is another limiting factor that prevents any increase in range of movement.

3. Whether the range of motion has been affected, the ease of the movement normally has been. The smoothness of the graphs and slope of the graph (indicating speed of movement) have been altered by the treatment.

4. A prominent aspect to the patient's gait has been the reduction in the left foot progression angle. Caused by a combination of changes to the hip and knee movement after treatment this clearly improves the ease, effectiveness and efficiency of the patient's gait.

5. The reduction in spinal lean to the right after treatment improves the patient's posture. The consequential impact on a number of other actions and movements demonstrates the importance of this change.

Having had the opportunity to do this piece of research and seen the quantitative data about how clinical massage has an effect on the patient it would interesting to do a larger funded research project looking into the benefits of clinical massage therapy using motion analysis technology.

Something for the future perhaps?

Finally, does clinical massage therapy work? I think we all know the answer to be YES.