Shaun Dixon competes as an elite long distance track, road and cross country runner for Highgate Harriers and England. He is also a coach, specialising in helping runners run and train more efficiently.

His running history includes:

- Part of the silver medal winning GB in the European Mountain Running Championships in 2014
- Current UK Fell Running Champion
- 4th in the National Cross Country Championships in 2013
- Represented England twice over cross country, and once as a trail runner
- Ran for England in a prestigious race in Spain last year
- Compete on the road, track, country, and trails/ mountains
- PB's
    - 30.16 10k
    - 66.42 ½ Marathon

As a serious runner, Shaun is naturally keen to minimise injury and optimise performance. As part of this process, Shaun attended for a 3D gait analysis for a comprehensive assessment of his running profile.

In terms of injury history, Shaun has been fortunate with no significant injuries but does have a tendency to left hamstring tightness.

Clinical assessment

A standard clinic assessment revealed the key points to be:

- An external hip position (more rotation outwards than inwards)
- A small reduction in left hip motion
- Hamstring and calf muscle tightness
- His feet were mildly pronated but within the normal range for static standing.
- Equal leg length

So, essentially, he has a fairly symmetrical structure other than slightly less left hip motion.

3D gait analysis

The 3D gait analysis compares Shaun's data to the world's largest database of runners. The information is plotted as Left (blue circle) and right (red diamond) and statistically calculates whether his values are within an ideal, excessive or reduced range. Generally, excessive motion is due to poor control / muscle strength whereas reduced motion is due to muscle tightness / joint restriction.

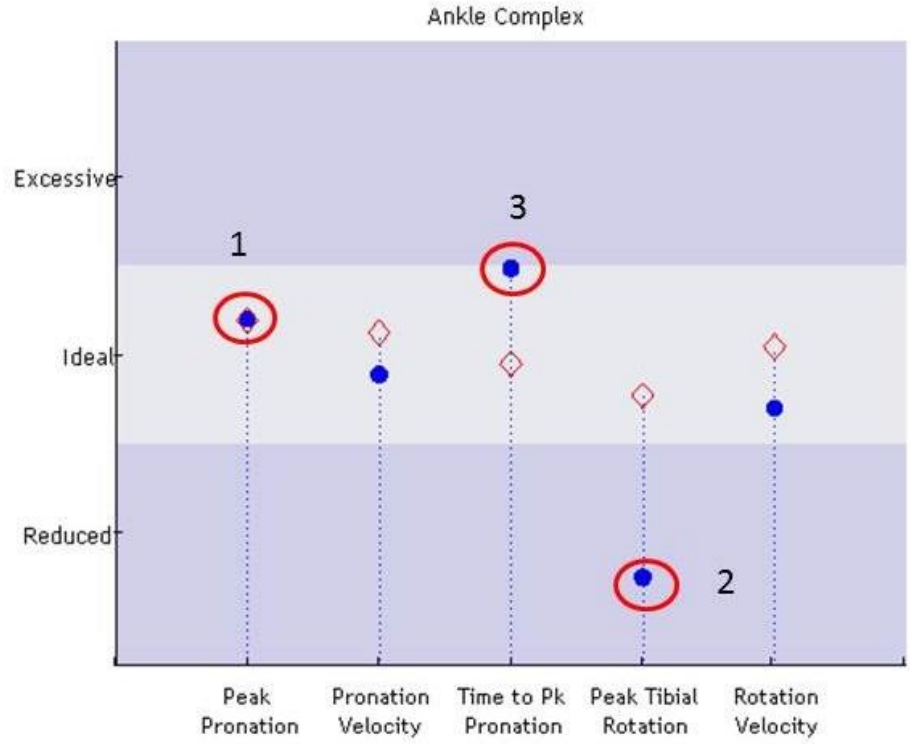

Figure 1: Running analysis ankle

His running assessment (Figure 1) confirms that he pronates within a normal range (1) but the left tibia (lower leg) does not internally rotate as much as it should (2) and therefore the peak pronation occurs slightly later in the step (3)

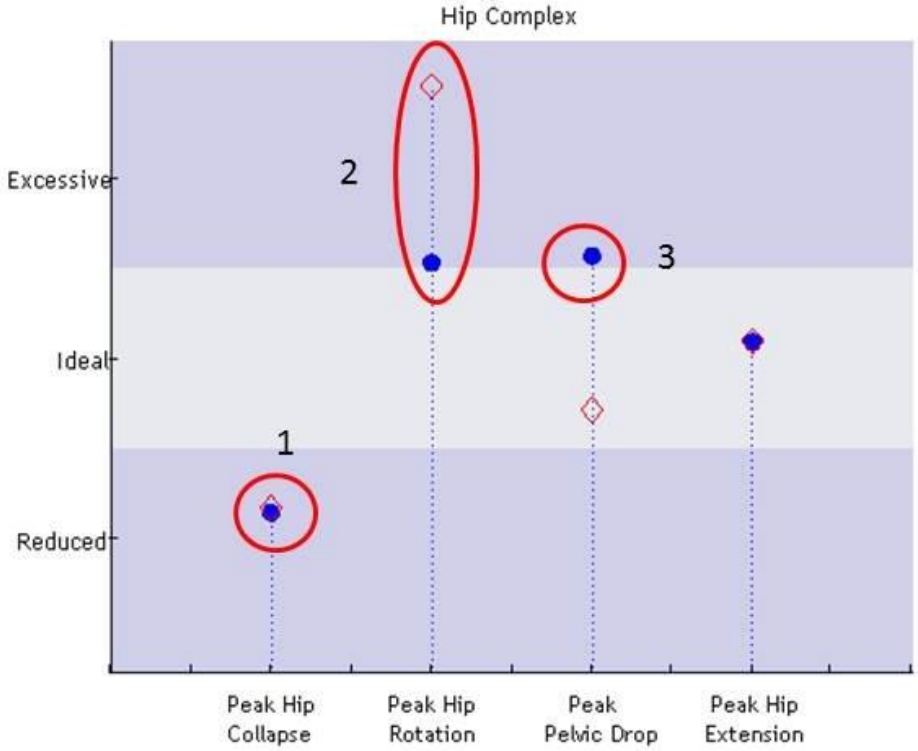

Figure 2: Walking analysis hip

His hip results are more revealing. When we analysed his walking values (Figure 2), there is some reduced motion for hip collapse (1).

However, he has excessive hip rotation which is much worse on the right (2) and excessive pelvic drop on the left (3) indicating poor control at the hips / pelvis. The difference in the hip rotation between the left and right sides may be due to the slightly reduced motion at the left hip.

We commonly see that where motion is reduced in one direction (i.e. hip collapse) it is increased in another direction (i.e. hip rotation).

Shaun's values on running (Figure 3) demonstrate an interesting and important point. You will see that generally, the values observed are lower for running than they are for walking. It is commonly believed that the increased force of running would make function worse. However, the opposite is often true and is supported in the scientific literature[1] because the muscles work harder and therefore reduce the overall relative movement. Of course, if there is an underlying problem (evident in Shaun's case on walking), this may become a problem later in training / a race as the muscles fatigue and are less able to control movement. This is a factor commonly missed.

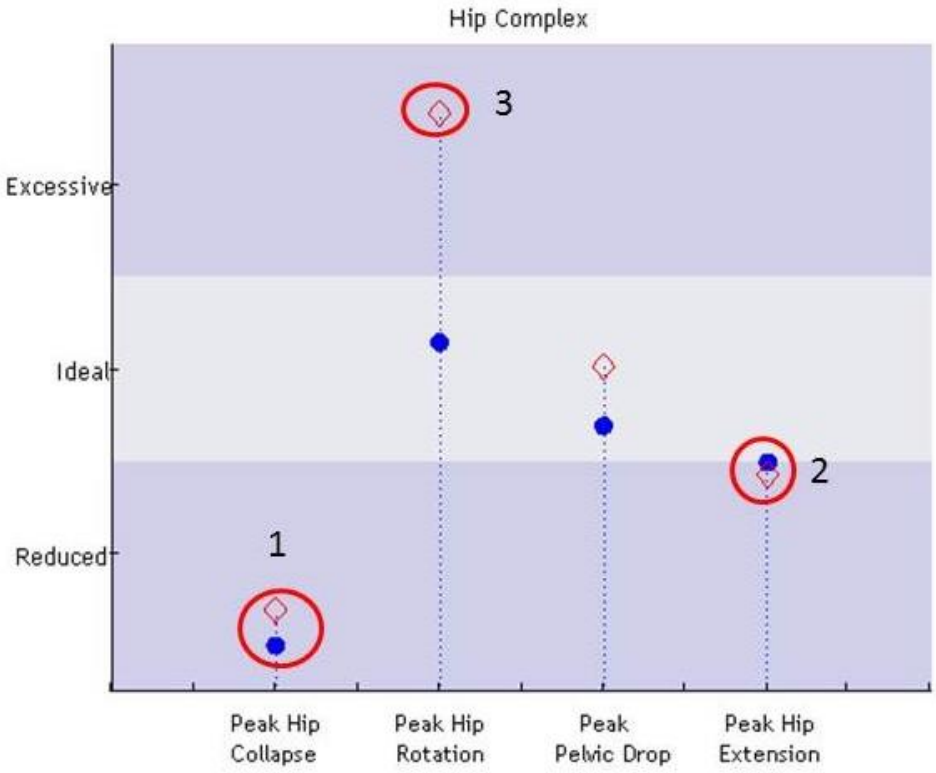

Figure 3: Running analysis hip

In Shaun's case, hip collapse remains restricted (1) and there is some reduction in hip extension (2). Whilst left hip rotation and pelvic drop are now within the normal range, right hip rotation remains excessive (3). Once again, some of the difference between the left and right hip may be due to the slightly reduced left hip motion.

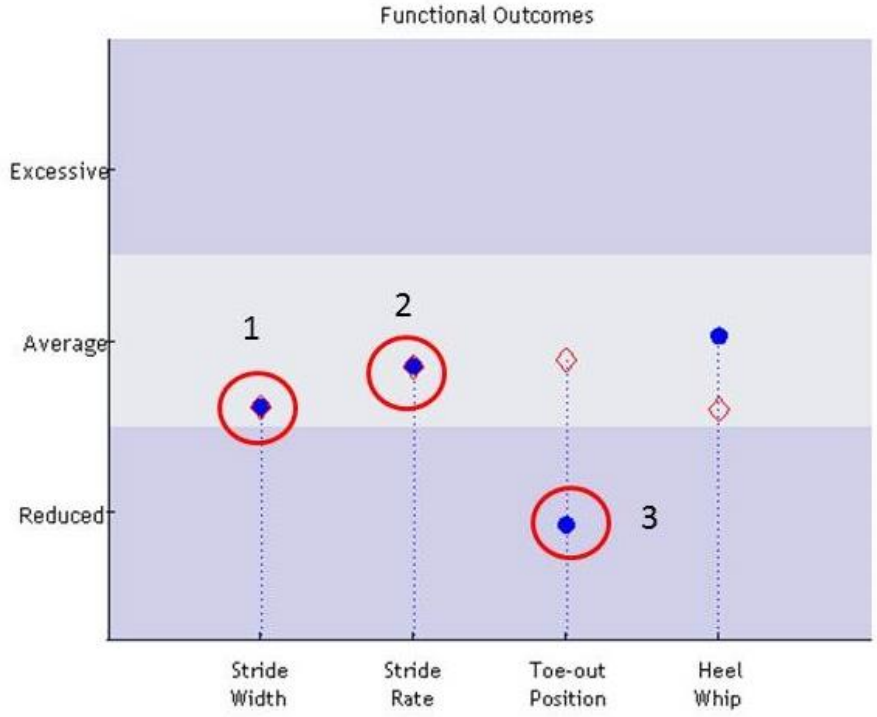

Figure 4: Functional outcomes running

The final aspect that we can look at to inform potential areas for improvement is his running style. In this graph, you will note that his stride width (1) and stride rate (2) are on the low side of normal. Whilst these are within the normal range, there is some evidence that the narrower the stride width, the greater the force on the lower leg (tibia)[2] and the greater the effect on the various angular measures throughout the limb. A slower stride rate can be indicative of a longer step length which, combined with reduced hip extension may indicate a less than optimum pattern.

As a result, further analysis of his running style is required although he may need to improve his flexibility and control for this to be achieved without injury. The last point to note is the low toe out position of the left foot (3). This suggests that his foot points slightly more inwards than would be expected and compared to his right foot. This almost certainly is reflective of the lower hip motion on the left.

So what are our recommendations for Shaun?

He has relatively symmetrical structure other than reduced left hip motion which is reflected by some asymmetrical function on gait analysis. He does have evidence of poor control bilaterally. Whilst this appears better on the left on running, this is most probably due to the restricted hip motion, which in turn, reduces the ability to compensate for the hamstring tightness. This reduces the rotation in the lower leg (tibia) and delays the time to peak pronation. This dysfunction would reasonably explain his symptoms of left hamstring tightness.

Our recommendations would be:

Footwear:	A neutral shoe is sufficient.
Orthoses (shoe inserts):	These are not indicated
Flexibility:	He has known hamstring and calf inflexibility. However, reviewing ITB and the hip flexors would help to optimise hip function. It may not be possible to improve the left hip range of motion but optimising the range available would be of benefit.

Control:	There is evidence of poor control at both hips and he requires a programme to optimise stability / control and then target a strength and conditioning programme appropriate for his level of competition.
Running style:	This requires further analysis as his overall function improves with the above plan, in particular evaluating stride width, stride rate and hip extension.

It should be noted that there is controversy regarding the optimum running style. Current thinking suggests that it is unlikely that anyone has optimum biomechanical function and there simply is not enough evidence to suggest that one style fits all. It is likely that the style adopted is based around an individual's biomechanical function.

Modifying certain aspects of gait (stride width, stride rate) may help to reduce stress. However, when changing style and reducing load to certain tissues / structures, there is a risk of increased load to others. Thus, it is preferable to improve overall function with an appropriate rehab programme to reduce this risk and then the desired gait alterations may be more achievable. In Shaun's case, his background as a coach will allow him to use this information as he evaluates his own performance.

The aim of this case study is to provide an insight as to how gait analysis can be used to guide our assessment and management of athletes.

Nester CJ, Lessons from dynamic cadaver and invasive bone pin studies: do we know how the foot really moves during gait? JFAR 2009, 2:18 doi:10.1186/1757-1146-2-18

Meardon SA, Derrick TR, Effect of step width manipulation on tibial stress during running, J Biomechanics, http://dx.doi.org/10.1016/j.biomech.2014.04.047