

GAIT STYLE AND ITS RELEVANCE IN THE MANAGEMENT OF CHRONIC LOWER BACK PAIN

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ABSTRACT

Lower back pain is a recurrent problem that may in significant part be related to gait style. Functional limitation of hip extension during gait has been hypothesized as one of the pathologic events that can cause or perpetuate CLBP. Further, functional limitations in hip extension are in large part caused by faulty mechanics of the weight bearing foot in gait. Therefore, using custom foot orthoses (CFO) to change the mechanics of foot function can secondarily improve hip extension and can therefore create prolonged relief of symptoms for CLBP patients.

BACKGROUND

The ability to efficiently stride forward is in part the result of the weight bearing heel lifting from the ground during single support phase and prior to opposite heel contact. This permits stride length to be greater than simply the length of the limbs. For heel lift to occur, the foot uses the pivotal axis available at the metatarsophalangeal (MTP) joints. This ability to advance the top over the bottom permits the center of body mass to advance from behind to ahead of the weight bearing foot during single limb support. Concurrent with this, the hip joint rotates sagittally, permitting the torso to remain erect while the thigh extends out from under the hip. Aside from the rearward thrust created by this action, hip extension also serves to "preload" the limb prior to the initiation of pre-swing and then swing phase. The bearing limb reaches full extension at the conclusion of single support. With opposite heel strike, the trailing limb reverses motion from extension to flexion, accelerating forward just prior to toeoff. At toeoff, the iliopsoas fires to PERPULATE swing phase motion. Keeping in mind that the iliopsoas originates from the vertebrae, disks, and interosseous septa of the lumbar spine, efficiency of this action is paramount to prevent repetitive lumbar stress.

In 1986, Dananberg described the foot pathology known as functional hallux limitus (Fhl)¹. It represents the functional limitation of the 1st MTP joint to dorsiflexion strictly during the single support phase of the step. Normal motion may otherwise be present and it may not exhibit any localized pain to indicate its pathomechanical nature. Since Fhl affects the MTP joint's pivotal axis, it can block timely heel lift and therefore shorten stride length. This results in a reduction in total hip extension available through the conclusion of single support phase (SSP). The more hip extension decreases, the more

difficult is the initiation of the ensuing pre-swing to swing phase motion. In other words, trying to create swing phase without hip extension is like trying to shoot an arrow without pulling back on the bow. Hip extension represents to storage of potential energy that will convert to kinetic energy and can be visualized as pre-swing to swing phase motion.

Without adequate pre-swing acceleration, the iliopsoas must INITIATE rather than simply PERPETUATE hip flexion. This is a far more daunting task. Considering that this is repeated thousands of cycles per day in the average adult, it becomes a repetitive strain injury to the lumbar spine. Since the subtle alterations in foot function that negatively impact swing phase initiation can exist and be locally asymptomatic, they are not generally recognized as a potential etiology of postural symptoms.

MATERIALS & METHODS

Using a single study design, a patient was selected whose lower back pain had successfully resolved following treatment with CFO. The subject walked back and forth on a 30' gait platform for 30 total passes with and without CFO. Before and after videos were recorded. These were then digitized and reviewed. Of the 30 passes, the 5th, 10th, 15th, 20th and 25th were used for graphing. This was reviewed for conditions of with and without CFO. The graphs enclosed detail the differences.

In addition, 20 subjects who were evaluated via in-shoe pressure analysis and side/front video exam and then treated with custom foot orthotics were retrospectively reviewed. The side view was used when the patient was at approximately 90° to the video camera. The frame was stopped and using a goniometer with one arm on the hip and central knee and the other on the hip and shoulder was used to measure total hip extension through the end of single support phase. Patients were measured twice before CFO was instituted and twice after CFO was placed in their shoes.

RESULTS

Single study: On 3/5 steps in the before, there is visible leveling of the extension graphs indicating pauses in hip extension. In the after graph, there is no evidence of hip limitation. (Figures 1/2)

20 patient retrospective review: (Table 1) There was an average increase in total hip extension at the end of single support phase of 4.425°. The largest increase was 7° and the smallest was 0°. Only one subject showed no change. No subjects showed a decrease in hip extension with the use of CFO. Average hip extension prior to CFO was 9.125° and after was 13.55°. (Table 1) In the pre CFO trial, statistical analysis shows P-value < .0005, mean 4.4, confidence interval (3.44, 5.36), with margin of error 0.9641. In the post CFO trial, P-value < .0005, mean 4.4, confidence interval (3.42, 5.38) with margin of error 0.976. Table 2

DISCUSSION

The graph of the gait w/out CFO shows in 3/5 steps in which periods of hip extension show slowing or complete absence of motion. This is precisely the effect that is predicted

by the Fhl model of foot and gait function. Once successfully treated with CFO, far more symmetry is evident with continual and progressive motion of the hip and thigh through the end of single support. Since this study demonstrates 60% failure rate of normal extension, this can represent a 1500/2500 failed step cycles/day. Considering that the trailing limb weighs approximately 15% of body weight, the strain on the iliopsoas and its origin can be enormous. In the 20 patient retrospective review, findings are consistent with the single subject study. An average increase of 4.425° shows almost a 50% gain in ROM of the hip.

The author of this study has previously described gait style as an etiology of CLBP.² The basic model describes LBP as a repetitive strain type injury as described above. In a subsequent prospective outcome study by the same author and published in 1999³, the Quebec Back Pain Disability Scale (QBPDS)⁴ was used to objectively monitor outcomes. This study followed 32 patients considered at or near medical endpoint for CLBP. 53% were male and 47% were female. Average age was 47 years. These patients all exhibited long clinical histories of back pain. Each had failed a multitude of standard lower back treatment modalities, including skilled spinal manipulation, physical therapy, therapeutic injections, and, in some cases, surgery, and were considered to be at or approaching the medical endpoint for their conditions. Treatment consisted of the fabrication of custom foot orthotic devices objectively fabricated through a process using in-shoe pressure analysis and dual direction video systems. Patients were provided the QBPDS test at the following intervals; prior to treatment (time 1), 1-3 months post treatment (time 2), and 6-24 months (average 13.8 months) post treatment (time 3). It is a 20-item self-administered questionnaire that was designed to assess the level of functional disability in patients experiencing back pain. The subjects grade general activities of daily living on a 0-5 scale, with 0 reflecting no difficulty and 5 representing the impossibility of the task. The scores are then converted to a *mean pain score* that represented the sum of all the numerical answers divided by the number of questions answered. Patients in this study were compared to the data from the original QBPDS measurements of 178 CLBP subjects. The QBPDS subjects (time 1) showed a mean pain scale of 2.40 while the subjects of this gait study had mean pain scale of 2.42. At time 2 data collection comparison, standard care reduced the QBPDS subjects score to 2.02. In this gait study group, levels at time 2 showed almost twice the improvement with a score of 1.71. 84% of the subjects reported improvement. 23 out of 32 from the original gait study group were followed through time 3, with an average duration from treatment of 13.8 months. They demonstrated a mean pain score of 1.74. The results were shown to be statistically significant with $p > .0025$ through Time 2 and $p > .01$ through Time 3.

CONCLUSION

Lower back pain exists in three forms; acute, chronic and acute recurrent. Acute pain is known to resolve in 80% of subjects, but 70% of this resolved group can be expected to experience recurrences within 12 months. Finding a cause to the recurrence has been described in a recent "Back Letter" as important to solving this disorder. If the cause of the chronic or acute recurrent form is the result of an otherwise asymptomatic foot problem such as Fhl, then those who treat these patients may never make the connection to

lumbar symptoms. Looking at this disorder as a repetitive strain injury related to gait style, and treating with custom foot orthotics, has been shown to create long-term cures and minimize recurrences. Podiatrist skilled in gait analysis and custom foot orthotic fabrication should be part of the lower back treatment team approach.

Figure 1

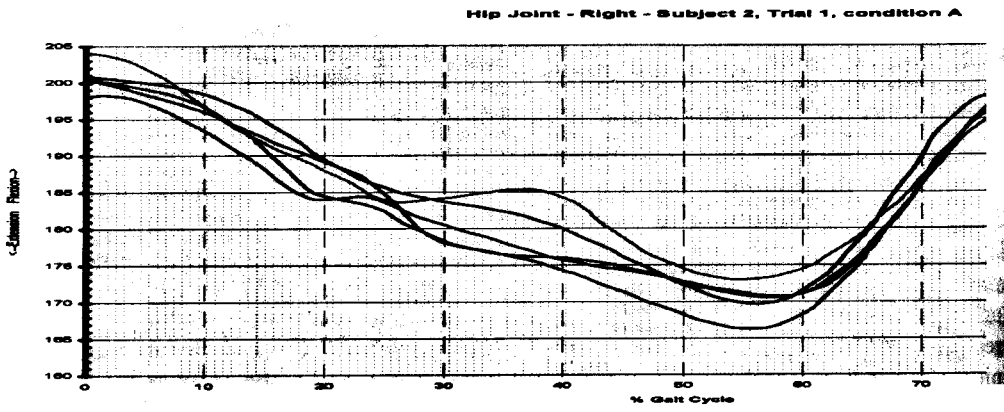


Figure 2

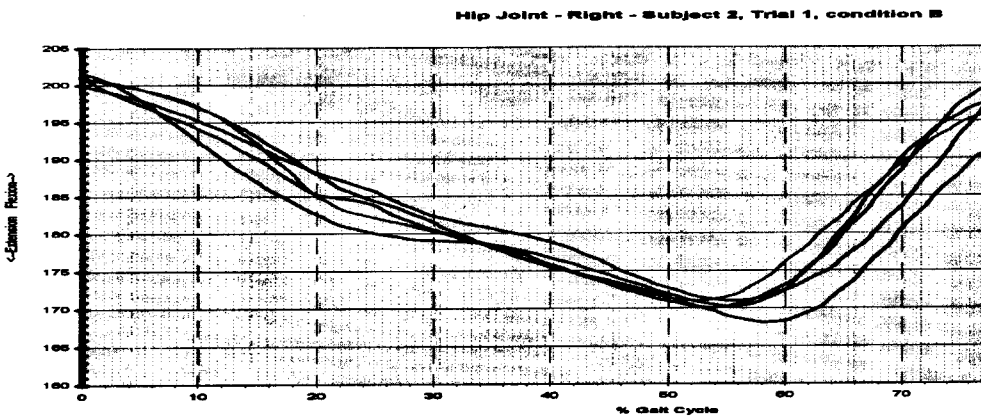


Table 1

Degrees of extension of the hip at the conclusion of single support phase before and after the use of custom foot orthotics.

Before (1)	Before (2)	After (1)	After (2)
8	8	12	14
8	10	14	16
12	10	17	14
5	5	8	6
3	3	10	7
2	2	4	4
3	3	2	3
7	8	10	14
8	10	13	14
10	12	17	15
10	9	15	13
11	11	13	15
12	11	17	19
12	13	18	20
15	15	20	18
12	9	16	15
5	8	13	14
14	13	18	19
10	11	15	17
13	14	16	16

Table 2

	mean	p-value	t	margin of error	confidence in
all	4.4	<.0005	13.51	.658	(3.74,5.06)
(1)	4.4	<.0005	9.55	.9641	(3.44, 5.36)
(2)	4.4	<.0005	9.33	.976	(3.42, 5.38)

REFERENCES

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