

# The Influence of the Protonics® Knee Brace on Pelvic Position

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**Background and Purpose:** Excessive anterior pelvic position is known to promote the malalignment of the lower extremity and contribute to patellofemoral pain syndrome (PFPS). The purpose of our study was to determine if the use of a Protonics® knee brace, a system designed by the Inverse Corporation, would have an effect on pelvic alignment of individuals with PFPS. **Subjects:** Ten individuals, who presented with PFPS and a unilateral pelvic tilt of 5° or greater, participated in this study. **Methods:** Measurements were taken before and after one application and treatment protocol using the Protonics® brace to determine if there was a reduction in anterior pelvic tilt. **Results:** Three subjects showed no change in anterior pelvic tilt, two showed an increase in anterior pelvic tilt, and five showed a decrease in anterior pelvic tilt. Overall, a significant decrease was noted between the pre and post-pelvic tilt measurements ( $p=0.04$ ). **Conclusion and Discussion:** While only 50% of the subjects demonstrated a reduction in anterior pelvic tilt, our research indicated that pelvic position can in fact be altered by use of this brace.

**Key Words:** *Inclinometer, Pelvic tilt, Patellofemoral pain syndrome, Protonics® knee brace*

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Despite the vast number of persons affected by patellofemoral pain syndrome (PFPS), the treatment of this dysfunction continues to be a challenge. The *Inverse Corporation* claims to provide a unique treatment method for persons suffering from PFPS through the use of the Protonics® knee brace. This brace is thought to neutralize muscle imbalances, thereby correcting malalignment of the pelvis and lower extremities. This study was conducted to determine if the Protonics® knee brace would affect pelvic position in subjects with patellofemoral pain. Specifically, our purpose was to assess whether a significant reduction of anterior pelvic tilt occurs after one standard treatment protocol using the Protonics® knee brace in subjects with patellofemoral pain syndrome. If pelvic position is returned to neutral through the use of this system, physical therapists will have an improved scientific understanding of the brace and an additional viable treatment option for patients with PFPS.

## Literature Review

Patellofemoral pain syndrome (PFPS) is a common orthopedic disorder resulting in diffuse anterior knee pain.<sup>1,2</sup> PFPS is the number one cause of knee pain in the United States. As high as one in four individuals in the general population suffer from PFPS.<sup>1</sup> Persons between 10 and 35 years of age are more commonly affected by PFPS with the prevalence being higher in females.<sup>1,3,4</sup>

Patients with PFPS typically complain of persistent pain in the retropatellar region during prolonged knee flexion positions such as sitting, stair climbing, and squatting.<sup>1,4</sup> Common complaints of PFPS include patellar crepitus upon active knee motion; mild swelling, buckling, or instability of the knee joint; and/or locking of the patella.<sup>1,4,5</sup> Patellofemoral pain syndrome may originate from a variety of sources and is generally considered to result from a combination of the following factors: lower extreme malalignment, increased hip internal rotation, genu recurvatum, quadriceps dysplasia,

muscular imbalance, patella alta, lateral retinacular tightness, and excessive foot pronation.<sup>1,5-7</sup>

In 1996, *Inverse Corporation* manufactured a knee brace, named Protonics<sup>®</sup>, that was developed as a rehabilitation system for the knee (Figure 1). Protonics<sup>®</sup> is a knee orthosis that provides programmable resistance to the hamstrings during activity. This resistance causes a reflex reciprocal inhibition of the overactive quadriceps to allow for a balanced co-contraction of the muscles surrounding the knee. With increased knee stability, proprioceptors are activated to allow for proper knee joint alignment.<sup>8</sup> *Inverse Corporation* claims that the Protonics<sup>®</sup> knee brace reduces patellofemoral dysfunction by improving knee alignment through restoration of muscle balance and alignment of the lower extremity, beginning at the pelvis. An anteriorly rotated pelvis causes increased internal rotation of the femur resulting in the lateral thigh muscles which create friction between the lateral femoral condyle and the patella.<sup>2,9</sup> It is this excessive articular contact which often causes symptoms common to PFPS.

The focus of this study was to link Protonics<sup>®</sup> resistance of the hamstrings with changes in pelvic position. To date, no experimental data has been found to establish that the Protonics<sup>®</sup> knee brace does in fact affect an anteriorly tilted pelvis. The work of Kendall and McCreary<sup>10</sup> and Link et al.<sup>11</sup> demonstrated that increased lumbar lordosis, weak abdominals, tight hip flexors, and lengthened hamstrings are all factors which can lead to an anteriorly tilted pelvis. *Inverse Corporation* claims that<sup>11</sup> the Protonics<sup>®</sup> knee brace will cause an anterior tilted pelvis to be placed in a more neutral position as a result of the resistance given to the hamstrings. This neutral position will place the femur in its correct anatomical position, therefore decreasing the compressive forces at the knee joint.<sup>11</sup>

Walker et al.<sup>13</sup> and Loebel<sup>14</sup> found a high degree of reliability when measuring pelvic tilt with an inclinometer. It should be noted that there are several other methods for measuring pelvic tilt including the electric tilt detection device<sup>15</sup>, fluoroscopy<sup>16</sup>, and a television computer system using a 3-dimensional coordinate system.<sup>17</sup> The inclinometer was chosen for this study due to its reliability in the measurement of pelvic angle, low cost, easy accessibility, and simplicity of use.<sup>14, 15</sup>

## **Methods**

### **Subjects**

Subjects were recruited by the directors of three local outpatient physical therapy clinics. All subjects signed an informed consent before being screened for the presence of both PFPS and unilateral anterior pelvic tilt. The screen for PFPS followed the criteria of Laprade et al.<sup>1</sup>: 1) no neurological disorder, 2) no history of recurrent patellar subluxation, 3) no current or symptomatic meniscal or ligamentous involvement at the knee, 4) no gross knee effusion, and 5) positive responses in at least two of the following clinical tests: Clarke's sign, Patellar Grind Test, and tenderness with palpation of the patellar surfaces. Subjective reports of diffuse retropatellar pain due to prolonged sitting, ascending/descending stairs, deep knee bends, and/or athletic activities were taken and recorded.

Subjects were required to demonstrate a unilateral anterior pelvic tilt with a difference of 5° or greater to participate in the study. A unilateral anterior pelvic tilt was determined by

bilateral pelvic angle measurement. Each subject's pelvic angle was measured bilaterally in the standing position. Measurements were performed using an inclinometer to determine the angle formed between a line connecting the anterior superior iliac spine and the horizon. The Measurement taken to determine anterior pelvic tilt was used as the pre-treatment measurement. All screening and measurements for PFPS and pelvic tilt were performed by one research clinician to eliminate inter-rater error.

### **Procedures**

The Protonics<sup>®</sup> brace was fitted by a research clinician according to the application guidelines specified by the Inverse Corporation. The brace was placed on the lower extremity which demonstrated the anterior pelvic tilt.

Each subject performed the warm-up exercise protocol as set forth by the Inverse Corporation.<sup>18</sup> These warm up exercises included seated, supine, prone, and standing hamstring curls designed to reposition the pelvis into neutral. A resistance level of eight was chosen to standardize the treatment protocol for all subjects. The subjects performed 10 repetitions of each exercise listed in the warm up exercise protocol.

Once the subject had completed the treatment protocol, he/she was re-measured for pelvic tilt employing the identical method used during the pre-measurement process. The data was recorded for analysis of any change in the position of the pelvis.

### **Data Analysis**

A one-tailed paired t-test was used to compare the pelvic tilt measurement taken before and after one treatment of the Protonics<sup>®</sup> protocol ( $\alpha=0.05$ ). The data used was a mean of three measurements of the pelvic angle. A positive difference would indicate an improvement of the pelvis to a more neutral position after one treatment of using the Protonics<sup>®</sup> protocol. A negative value would indicate acceptance of the null hypothesis of no difference in pelvic tilt.

### **Results**

Ten subjects demonstrated a unilateral pelvic tilt greater than 5°. There were 8 females and 2 males, with ages ranging from 13 to 45 years. The sample included individuals that varied in activity level from highly athletic to sedentary

The mean anterior pelvic tilt prior to application of the Protonics<sup>®</sup> knee brace was 19.9° (SD = 6.9°). The mean post-application measurement following completion of the Protonics<sup>®</sup> warm-up exercise protocol was 16.7° (SD=3.7°). There was a mean decrease in interim pelvic tilt of 3.2° (SD=53°). A one-tailed piqued t-test showed there was a significant difference between pre and post measurements ( $p=0.04$ ). Three subjects had no change in unilateral pelvic tilt, two showed an increase in anterior pelvic tilt, and five showed a decrease in anterior pelvic tilt (Appendix A).

### **Discussion**

The results of our study showed a significant decrease in pelvic angle measurement taken before and after one application and treatment with the Protonics<sup>®</sup> knee brace. While a significant mean decrease was found, it should be noted that only 50% of the

subjects did in fact show a reduction in pelvic tilt. Three subjects showed no change in pelvic alignment, and two subjects actually allowed an increase in anterior pelvic tilt. Overall, because a significant decrease was found, these results support the claims of the *Inverse Corporation* that the Protonics® knee brace will reduce an anterior pelvic position in subjects with patellofemoral pain,

The findings suggested that by repositioning a unilateral pelvic tilt on individuals with patellofemoral pain syndrome, biomechanical changes occur to improve knee alignment. Neutral pelvic position may improve alignment of an internally rotated femur, decrease recruitment of lateral thigh muscles, and neutralize the position of the patella to promote better tracing. A balanced pelvis would also help restore normal length and recruitment of the hip flexors, lateral thigh muscles, and hamstrings. These changes could potentially improve co-contraction of the muscles surrounding the knee and pelvis. This information is beneficial to clinicians treating individuals with patellofemoral pain as it may indicate that patellofemoral pain is not only due to influences occurring at the knee, but could potentially be the result of a problem occurring further up the biomechanical chain. This gives the clinicians other options to consider in the treatment of patients with patellofemoral pain

Upon review, our study exhibited several limitations including small sample size, resistance level of the knee brace, and measurement error. The Protonics® knee brace was standardized to a resistance level of eight, irrespective of the patient's strength or activity level. Several subjects were high-level athletes and did not show a change in pelvic alignment. One possible explanation may be that the resistance level was not sufficient to recruit the hamstrings with the amount of force required to affect pelvic alignment

Further research is needed to determine how long the change in pelvic position is maintained and to validate the Protonics® treatment protocol established to provide a permanent change in pelvic alignment. Additionally, it would be useful to determine if other treatment strategies such as muscle energy techniques, which follow the same concepts as the Protonics® system, can affect pelvic alignment and therefore be a treatment option for clinicians treating patients with patellofemoral syndrome.

## ***Conclusion***

While the Protonics® knee brace did not result in an anterior pelvic tilt reduction in all subjects, the results of our research suggested that pelvic position is in fact altered by the use of this brace. Further research is necessary to determine the longevity of pelvic angle reduction following removal of the Protonics® brace.

## ***Acknowledgements***

A special thanks to those who contributed to our research project. We would like to acknowledge *Inverse Corporation*, Lincoln Nebraska, for supplying the Protonics® knee braces used in our study; Athletic Rehabilitation Center, Diamond Bar, CA; Peach wood Physical Therapy, Glendora, CA; Professional Physical Therapy, Whitter, CA; for helping with recruitment of subjects; and the supportive staff at Loma Linda University.

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## Appendix A

*Comparison of anterior pelvic tilt between uninvolved and involved innominants and pre and post application of Protonics® brace.*

Subject	Uninvolved Mean	Involved Mean	Pre-Application Mean	Post-Application Mean
1	9.3	14.0	14.0	18.7
2	26.0	32.3	32.3	23.3
3	13.7	25.3	25.3	14.3
4	10.3	16.7	16.7	11.3
5	13.3	20.0	20.0	20.0
6	23.3	28.3	28.3	19.3
7	4.3	12.0	12.0	13.7
8	11.0	16.3	16.3	16.3
9	16.3	21.0	21.0	16.7
10	7.0	13.0	13.0	13.0