Review

INNOVATION OF THE PELVIS TILT FUNCTIONAL DIAGNOSTICS IN CHILDREN

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ABSTRACT

THE AIM of the research is to make literature review and to study the possibilities for implementation of Digital Pelvic Inclinator in functional diagnostic of the pelvis inclination during the prevention of the postural disorders in children. METHOD: The Digital Pelvic Inclinator (DPI) developed by Sub-4 Technologies, is a precision measuring device used to quantify innominate bone inclination. Using the described technique, the DPI can be used to assess pelvic behavior by using the specialize protocols. DPI uses a digital display. This display allows the physiotherapist to see the output of the device while performing the measurement procedure. RESULTS: Twenty-five children were assessed by the DPI. The results show that the pelvic inclination in children were average for left 10.78° and for right 10.28°. Torsion was the difference between left and right inclination of innominate bones. Mean value of torsion is 2.108° this indicate potential for developing progression lordosis in children from 1 to 3 class. CONCLUSION This new and innovative methodology allows asymmetry, dysfunction and adaption to be quantified, allowing instant evidence based diagnosis and treatment. The DPI subsequently allows the physiotherapist to record normative values after treatment interventions have been implemented.

Key words: Digital Pelvic Inclinator, pelvic tilt, physiotherapy.

INTRODUCTION

Traditionally, pelvic tilt has often been measured in clinical practice to identify the presence of abnormal postures that may cause dysfunction and lead to chronic musculoskeletal pain conditions, such as low back pain (1).

The postural disorders in children are a wide-spread problem. To precise the functional diagnostic in children is the most important part of the prevention. The key point in this aspect is the utilization of the devices. Unfortunately, the literature and the results on the problem are very scant.

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implementation of Digital Pelvic Inclinator in functional diagnostic of the pelvis inclination during the prevention of the postural disorders in children.

METHODS

Different models of caliper - based inclinometer have been investigated in the literature. The Palpation Meter (PALM, Performance Attainment Associates, St. Paul, MN, USA) is the caliper-based inclinometer that has been extensively explored (1, 3-5, 7-9). Other models that have been investigated include those developed and modified by Walker (1987) and Crowell (1994) (2, 11). The included a spirit level to permit readings relative to the ground, finger-tip rings to allow superior palpation of the bony prominences, and a digital read-out for ease and speed of reading the output (2). The Digital Pelvic Inclinator (DPI, Sub-4 Limited, UK) is a new, commercially-available, caliper -based inclinometer that is very similar to the model

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developed by Crowell (1994). Like this model the DPI uses a digital display (2). This display allows the physiotherapist to see the output of the device while performing the measurement procedure. In addition, the DPI also has recessed calliper ends, which allow simultaneous palpation of the bony prominences with the hands and the calliper arms. Finally, the DPI also contains a spirit level to facilitate measurements of pelvic angles relative to the ground as well as relative to the other side of the pelvis.

THE DEVICE

Figure 1. Digital Pelvic Inclinator

Data is captured by the DPI via a tiny three-axis accelerometer attached to a small electronics board. The accelerometer measures the static acceleration of gravity in the three directions. The electronics use this data to calculate the angle of tilt. This data is then shown in numerical form on the LCD.

The DPI is only as accurate as its user and has high inter/intra physiotherapists reliability if used in the correct manner, following the guidelines below. The anterior superior iliac spine (ASIS) and pubic symphysis are aligned vertically. In this position the pelvis is in 'neutral' and is described by Kendall (2005) "as an ideal position for the pelvis" (6). Kendall also describes the normal sagittal plane inclination between the posterior superior iliac spine (PSIS) and ASIS as being approximately 5° +ve (Innominate inclination is considered +ve when the PSIS is higher than the ASIS, and -ve when the PSIS is lower than the ASIS). Others have described average inclination at around 11.3° +ve and 8.8° +ve $3,5.2^{\circ}$ (6).

However, variations as much as twelve degrees have been found in cadaver studies. This author describes the normal inclination of the

The Digital Pelvic Inclinator (DPI) developed by Sub-4 Technologies, is a precision measuring device used to quantify innominate bone inclination. Using the described technique, the DPI can be used to assess pelvic behavior by using the specialized protocols. The Digital Pelvic Inclinator (DPI) allows the physiotherapists to understand and measure the role of the pelvis in development of repetitive injury including lower back (**Figure 1**).

average adult innominate to be around 8 to 10° +ve, based on clinical experience.

- The DPI is an easy to use hand-held instrument designed to allow the physiotherapists to measure innominate inclination and establish pelvic torsion.
- The two moveable arms with sensory finger grips increase proprioception and therefore accurate measuring.
- The precision arms pivot about a main body, which houses a digital inclinometer and a spirit level. The spirit level allows the main body to be kept level during measurement.
- The DPI allows the physiotherapists to record quantitative data both before and after treatment (6).

THE PROTOCOLS

1. Basic Pelvic Torsion Measurement Start on one side of your patient and take an innominate bone inclination. Record this data.

Then repeat the innominate bone inclination measurement, but this time on the contralateral side. Any difference in the values between each side is described as a pelvic torsion, which may require corrective treatment (**Table 1**).

Table 1. An example of a basic pelvic torsion measurement

Right Innominate Inclination	15 ⁰
Left innominate Inclination	8 ⁰
Pelvic Torsion	7 ⁰

2. The Pelvic Equilibrium Theory

The Pelvic Equilibrium Theory' is an exciting new explanation of pelvic adaption in the presence of leg length inequality (LLI). Discovered by specialist podiatrist Clifton Bradeley this new theory is fast becoming the most popular MSK assessment protocol used in clinical biomechanics across the world (Figure 2).

The form is titled "Pelvic Equilibrium Theory Assessment Form" and includes a logo for "Sub-4 Health". It contains several sections for patient information, a central diagram of a human figure from a posterior view, and various assessment tables.

Patient Information:

Patient Name: _____

Height (cm): _____ Date: _____

Weight (kg): _____ Age: _____

Right Heel Lift (%): _____ DOB: _____

Left Heel Lift (%): _____ B.M.I: _____

Shoe Size: _____

Central Diagram: A posterior view of a human figure with "Left" and "Right" labels on the sides. Above the figure is "P.A View".

Assessment Tables:

Left Innominate Inclination on Arrival = P.I ilium ☐ A.S ilium ☐	Right Innominate Inclination on Arrival = P.I ilium ☐ A.S ilium ☐
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Pelvic Torsion = _____

Static Functional Trial (using 8mm EVA board)	Under Right Foot	Left =	Right =	Therefore Pelvic Torsion =
	Under Left Foot	Left =	Right =	Therefore Pelvic Torsion =

Dynamic Functional Trial (using 8mm in shoe raise) <small>(ie: 8mm at heel, 3mm at forefoot)</small>	In Right Shoe	Left =	Right =	Therefore Pelvic Torsion =
	In Left Shoe	Left =	Right =	Therefore Pelvic Torsion =

What is the Innominate Range from all 5 pairs of numbers collected? Left = _____ Right = _____

To establish the Pelvic adaptation present follow these instructions using 8⁰-10⁰+ve as normative values:
 Have you recorded any inclination > 10⁰+ve in the shaded areas? If so how many degrees greater = _____
 Have you recorded any inclination < 8⁰+ve in the shaded areas? If so how many degrees less = _____
 The Pelvic Adaptation therefore = _____

← P.I ilium (Posterior inferior) → Normal Range ← A.S ilium (Anterior superior) →

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Figure 2. Pelvic Equilibrium Theory Assessment form

SUBJECT

In our preliminary research we applied the DPI in 25 children from the beginning classes (from I to III classes) in the school "Jordan Iovkov" – Sofia during the period April - May 2016. The average age was 8.6 years (from 7 to 9). Was measured left and right pelvic inclination and therefore - torsion.

RESULTS

Twenty-five children were assessed by the DPI. The results are presented in Table 2.

Table 2. Results from inclination measurement

Average- left side	10.78 ⁰
Average- right side	10.28 ⁰
Average of Torsion	2.108 ⁰

The results show that the pelvic inclination in children are average for left 10.78° and for right 10.28°. Torsion is the difference between left and right inclination of innominate bones. Mean value of torsion is 2.108° this indicate potential for developing progression Lordosis in children it 1 to 3 class.

DISCUSSION

During normal standing the head is upright and facing forwards, the neck is slightly extended, the upper back is in slight flexion, and the lower back is in slight extension. The slightly extended inward curve of the neck (cervical spine) and lower back (lumbar spine) is referred to as lordosis. There are several researches about lordosis and the concomitant dysfunctions. The screening examination involved 83 children with the average age from II and III classes at the School at Sofia in October - November 2012 shows result from hamstring length test (10). In 25,30% (21 children) of the group was indicated lordosis. The hamstring was shortened in 20 (95%) of them with average 61, 1° (minimal value 45° to maximal 75°). Only 20 children were free of spinal deformities. Their average hip flexion was 75° (minimal value 60° to maximal 90°).

The rate for adults is 8+ve +10⁰+ve. In the same time there are no standards for children about measuring of the pelvis inclination by DPI (6).

Our results show averages slightly above normal for pelvic inclination (Left 10.78, right 10.28).

A basic pelvic torsion measurement will clearly identify whether there is a twist (torsion) between each innominate bone, which can be quantified and recorded prior to intervention. If a pelvic torsion is identified and the physiotherapists implements their preferred treatment program to reduce the torsion, the DPI can then be used again after treatment to quantify the improvement / correction.

The functional diagnostic of the postural disorders in children plays the important role regarding the prevention of the structural spine deformities and chronic muscle skeletal problems.

CONCLUSION

This new and innovative methodology allows asymmetry, dysfunction and adaption to be quantified, allowing instant evidence based diagnosis and treatment. The DPI subsequently

allows the physiotherapist to record normative values after treatment interventions have been implemented. In short this means that:

- Dysfunction can be quantified.
- Treatment becomes more directive and accurate.
- Improvement can be quantified.
- The effects of orthotics, heel-raises and other treatments can be quantified.

All these indices lead to more precise physiotherapy for prevention and correction.

Abbreviations:

DPI – Digital Pelvic Inclinator

ASIS – anterior superior iliac spine

PSIS - posterior superior iliac spine

LLA - leg length inequality

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