Spinal bracing for the child with neurological dysfunction: is the future rigid?

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Introduction
Provision of rigid orthoses has been provided since the pre-Columbian Indian population used cork bark to stabilise the spine around 900AD. Although the materials have improved greatly over the years, the guiding principles are still the same, requiring rigidity to prevent spinal malalignment initiated by varying factors ranging from neuropathic muscle imbalance to trauma. Blue printing of radiographs have provided the orthotists with the knowledge to enable translational and torsional components to be incorporated in the brace to counter the classic scoliosis presentations. However as feedback from patients suggests that rigid braces are not the most comfortable, it is worth reconsidering the principles of bracing.

Discussion
Spinal bracing for children with early onset neuropathic originating scoliosis has taken the form of rigid plastic moulds formed around corrective plaster casts, often taken under analgesia using casting frames to enable clinicians to gain posturally corrected positions. This is fine in the context of spinal symmetry; however we may be overlooking vital factors that become apparent as natural maturation occurs.

Clinically over years, clinicians note that however good the casting outcomes are, the scoliosis continues to develop and continues to the point that surgery is required to stabilise the child hip or sitting position. The main discussion therefore must be why this is occurring. And what can be done to reduce or overcome this progression. The understanding of neurological development is at last providing an opportunity to develop different orthotic treatment and therapy strategies that appear to require further investigation.

In children with cerebral palsy, the brain infarct often causes a lack of body self-awareness, particularly noticeable in diplegic and quadriplegic presentations. It is now understood that the early years of development provide the brain with spatial awareness of body position which is a learned pattern\(^1,2\). The motor patterns are learnt using repetitive movements requiring multiple feedback and feed forward of external and internal stimuli, coupled with processing in pattern generators within the central nervous system. These children habitually do not understand where centre is, however if provided with an external stimuli they can adjust...
ly clinical experience is suggesting that longer term positional change, therefore re-programming the brain to the new learnt position. Ear-to-sway in a figure of eight pattern in order to provide continual stimula
tions to enable the brain to absorb where they are in space, using both efferent and afferent neural pathways.

Scoliosis in children with cerebral palsy is often due to the imbalance of spinal muscles, initiating the typical “C” shaped curve commonly described. In the early presentations this often manifests as off centre sitting as seen previously. At this stage this is a postural curve and can be easily adjusted by external stimulae. If left untreated the postural component will develop into a structural presentation as the internal integrity of the vertebral support structure become deformed due to imbalanced internal modelling. This is the point at which most orthopaedic surgeons come in to contact with the patient and where rigid bracing is prescribed in order to “buy” time prior to the inevitable surgical intervention. However there is alternate view, that the rigid brace, however, can make the prognosis worse as with full support the spinal support muscles are not required to stabilise the spine and can lose tone in just three days. The result is that the spinal orthosis has now become the scaffold that the patient requires going forward. Special seating has a similar effect as a good number of these children will use any support mechanism, however provided to stabilise themselves.

The child presented in Figure 1 & 2 shows clearly the effect of an external stimulae can have- the dynamic elastomeric fabric orthosis (DEFO) provides a low level compressive total body force with resistance to stretch panels inbuilt to support the weaker muscle structures associated with cerebral palsy. The advantage this type of dynamic orthosis has is that it is worn next to the skin is totally breathable, washable and cosmetic. Compliance is improved as the orthosis is hidden and being non rigid is not felt at extremes of movement. It utilises long term low level pressure to guide rather than force correction, therefore re-programming the brain to the new learnt position. Early clinical experience is suggesting that longer term positional change can become apparent after a period of few years. The practice has been to provide DEFO suits with-in the first few years of diagnosis of cerebral palsy for children with athetoid and hypotonic presentations, whilst under the care of the paediatric physiotherapy service, to improve sitting ability and resultant distal functional gains.

More recent development have incorporated de-rotational and translator resistance within the construct of the suits to counter the typical scoliosis curve presentations.

In the first case study, a five year old female patient presented with a cystic tumour in her thoracic spine and a three-week history of intermittent backache, which woke her at night. Examination indicated a left convex postural scoliosis without any rib hump, with deficient neurological signs from the greater trochanter down. She required a shoe raise to counter the left leg length discrepancy. Detailed MRI scans reported a thoracic cord neurocytoma and syrinx above which was excised. Development of scoliosis after this type of surgery is not uncommon.

At the age of seven years a recurrence was observed. As all neurological signs were intact, spinal corrective brace treatment should be the preferred treatment, however, the use of a rigid bracing was not an option due to her previous experiences and the scoliosis design dynamic Lycra® orthosis was prescribed. X-rays of the patient wearing the orthosis have indicated a halving of the Cobb angle from 33° to 15°. The patient also wore a small heel raise of 18 mm in the second X-ray. The raise reduced the pelvic tilt but not the scoliosis as the vertebral angle initiates at the L5 level. Subsequent X-rays have indicated that the curve has been held for 30 months at 20°. Unlike rigid bracing this angle has been held, even when not wearing the suit, suggesting that the patient has developed the muscle control to counter the natural curve progression. Initially the patient felt off-balance but quickly adapted to the new position.

A second case study demonstrates how the same pressure system can alter even larger magnitude curves. A five year old male, who presented with myotonic dystrophy and pectus carinatum, was off balance with difficulty in standing up and was unable to walk without great deal of assistance. Due to environmental issues, poor compliance was cited as a reason for not rigidly bracing the child. He presented with a left sided thoracic T8 apex curve of 70° and a vertebral rib angle over 20°. One year later, at the age of six years the x-rays showed curve reduction of the 35°, a vertebral rib angle closer to 20° difference, with the symmetry line closer to mid line and a reduced pectus carinatum protrusion. The child was also able to stand unaided and able to walk with greater reduced support and was compliance in wearing the suit during daytime only.

Discussion
The use of dynamic control orthoses has been used regularly in the treat-
Challenges and limitations in early intervention.


2 Eyre J. If hemiplegia is amblyopia of the corticospinal system can we develop a “patch”? Australasian Developmental Medicine and Child Neurology Conference 2010 8/02/2010; Christchurch New Zealand: DMCM; 2010. p. 1.


6 Matthews M, Crawford R. The use of dynamic Lycra orthosis in the treatment of idiopathic scoliosis using elastic bands linked to pelvis and thoracic fixation mechanisms. The elastic bands provide a force to initiate corrective change on the spine through differing designs of compression and migration of the spine. This relies on a good understanding of positioning and tensioning of the orthoses. In children with cerebral palsy there is requirement for total body neurophysiological sensory input that is not possible for this type of orthosis.

Therapists are able to initiate corrective procedures using their hands to provide compressive and functional positioning on the child to correct and encourage spinal symmetry. Therefore an orthosis should be capable of mimicking this concept. Lycra based orthoses has been recognised as a means of reducing muscle tone and to improve function due to increased proprioceptive input. The orthosis improves the feedback to the brain via the somatosensory system and resultant improved motor control.

There is no reason why somatosensory input should not be used in the treatment of idiopathic scoliosis, particularly in the earlier stages where the Cobb angle is less than 25 degrees – the level at which orthopaedic orthotic treatment is initiated. There is an argument for waiting for the wedging of the vertebral bodies to be evident; however there is also a good counter argument to use this non-invasive orthosis before that with the expectation to reduce the progression of the curve. There is also the possibility of improving compliance to the orthotic intervention – a factor identified as factor for reduced efficacy in spinal bracing.

**Conclusion**

The use of dynamic elastomeric fabric orthoses therefore can provide a viable opportunity to manage scoliosis management, by providing an improved cosmetic, improved compliance and a truly dynamic option to the rigid bracing used for the last 30 years since the introduction of the modular scoliosis brace.

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