A REVIEW OF INNOVATIVE TYPES OF BRACES FOR ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

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INTRODUCTION

What is scoliosis?

- Three-dimensional deformity of the spine and trunk
- 80% of scoliosis cases are idiopathic scoliosis - the cause is unknown
- Adolescent idiopathic scoliosis (AIS) is the most common type of scoliosis - the age of onset is between 10 and 16 years old

A diagnosis of scoliosis is confirmed when the Cobb angle is 10 degrees or greater, which is measured through a standard radiographic examination.

Treatment of scoliosis

- Depends on type of curve, age and severity of spinal curvature
  - Surgery: > 40-50 degrees
  - Brace: Usually between 20 and 30 degrees
  - Observation: < 20 degrees
- Bracing is the most commonly used non-invasive treatment

Introduction

- Bracing is the application of external corrective forces onto the spine and trunk
- It can be rigid or flexible

Example of rigid brace:
Milwaukee brace
Picture from: http://www.scoliosisjournal.com/content/2/1/19/figure/F2

Example of flexible brace:
SpineCor®
Picture from: http://www.spinecor.org/scoliosis-treatment.htm

Problems of conventional rigid braces

- They are made of rigid components such as metals and rigid plastics causing:
  - Heavy, non-breathable and uncomfortable
  - Difficult to move
  - Difficult to wear and take off
  - Bulky and awkward appearances
  - Lower self-esteem, more fatigue and lower compliance

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**INTRODUCTION**

Some existing flexible braces are designed to overcome the limitations of rigid braces

They are made of textiles combined with plastics or metals

SpineCor brace
Picture from: http://www.spinecor.com/ForProfessionals/SpineCorDynamicCorrectiveBrace.aspx

TriaC brace
INTRODUCTION

<table>
<thead>
<tr>
<th>Advantages of existing flexible braces:</th>
<th>Disadvantages of existing flexible braces:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light, breathable and comfortable</td>
<td>Pressure sores</td>
</tr>
<tr>
<td>Greater mobility of the body</td>
<td>Difficulties when going to the toilet</td>
</tr>
<tr>
<td>Thin and more natural appearance</td>
<td>High pain score</td>
</tr>
<tr>
<td>More acceptable for teenagers and higher compliance</td>
<td></td>
</tr>
</tbody>
</table>

Objective:
Review of the design features and materials used for the fabrication of innovative types of braces

appearance

→ More acceptable for teenagers and higher compliance

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METHOD

- Search engines: PubMed, BioMed Central, ResearchGate and SAGE
- Search strings:
  - “innovative brace” + “scoliosis”
  - “smart brace” + “scoliosis”
  - “comfort brace” + “scoliosis”
- Publication date: between 1st January 2005 and 4th December 2015
- Language: English
## RESULTS

<table>
<thead>
<tr>
<th>Search strings</th>
<th>No. of related articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>“innovative brace” + “scoliosis”</td>
<td>4 (3 rigid braces and 1 flexible brace)</td>
</tr>
<tr>
<td>“smart brace” + “scoliosis”</td>
<td>2 (1 rigid brace and 1 flexible brace)</td>
</tr>
<tr>
<td>“comfort brace” + “scoliosis”</td>
<td>6 (4 rigid brace and 2 flexible brace)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

- 5 of them involve the improvement of the comfort and compliance of treatment for AIS
- 3 are rigid braces and 2 are flexible braces
- ScoliOlogiC® Chêneau light™ brace, Gensingen brace™, CMCR brace, Spinealite™ and tailor-made posture correction girdle
ScoliOlogiC® Chêneau light™ brace

Purpose: improve the quality of life of AIS patients
→ lighter, finer and easier to wear

➢ Components: four polyethylene shells, two uprights and straps with attachments
➢ Paddings → increase the wear comfort and increase the area that induces pressure

Advantages:
→ Light brace since fewer materials are used
→ Open spaces are designed for corrective movement
→ Pressure sores caused by compression effects are avoided

The purpose and principle are similar to ScoliOlogiC® Chêneau light™ brace

Differences between them:
→ Gensingen brace™ is based on the precise arrangement of pressure zones and associated open spaces
→ Gensingen brace™ is formed by a single polyethylene shell and the straps with attachments
→ ScoliOlogiC® Chêneau light™ brace is created by using many different parts

**Picture from:** ‘Brace technology’ thematic series-the Gensingen brace™ in the treatment of scoliosis, p.5.

CMCR brace (monoshell carbon brace respecting breathing)

- inspired by wear comfort, lightness in weight, aesthetics and respiratory capacity
- based on the corrective principle of the Lyon brace which consists of brace pads located on humps
- made of polyethylene and carbon with adjustable and mobile supports

Advantages:

→ The mobility provides permanent pressure and more opportunities to orient forces
→ The correction is achieved without blocking chest movement → preserves respiratory capacity
→ An anterior opening allows patients to easily put the brace on

Spinealite™

- **Purpose:** solve the existing problems of soft braces in the market → easier to adjust and use
- mainly consists of elastic ribbon materials
- 3D system consists of pelvic girdle correction, shifting of the shoulder and pelvic girdles against one another, spiral shoulder girdle correction and correction of the sagittal profile

**Advantages:**
→ Simple construction, **easier to wear and adjust**
→ Materials are **durable** → do not lose the tension force after long time wear
→ Corrective forces applied with limited freedom of movement → maximize the corrective effects

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Tailor-made posture correction girdle

- **Purpose:** reduce imbalance of the waist and pelvis with a more natural look and better wear comfort
- mainly made of warp-knitted fabrics (tricot, satinettes and powernet)
- resin bones and EVA foam paddings → supportive and point pressure forces
- elastic shoulder straps and waistband → additional corrective forces

Advantages
- **Natural appearance** (similar to underwear with a vest-like design)
- Breathable and comfortable
- Easy to adjust and wear


Comparison of the innovative types of rigid braces

<table>
<thead>
<tr>
<th></th>
<th>ScoliOlogiC® Chêneau light™ brace</th>
<th>Gensingen brace™</th>
<th>CMCR brace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention period</td>
<td>- Late 2000s</td>
<td>- Late 2000s</td>
<td>- Late 2000s</td>
</tr>
<tr>
<td>Primary materials used</td>
<td>- Four polyethylene shells, two uprights and straps with attachments</td>
<td>- Single polyethylene shell, straps with attachments</td>
<td>- Polyethylene base with carbon blade</td>
</tr>
<tr>
<td>Advantages</td>
<td>- Easier to adjust for all possible curve patterns and trunk sizes of patients</td>
<td>- Easier to adjust for all possible curve patterns and trunk sizes of patients</td>
<td>- Able to provide permanent pressure and orient forces</td>
</tr>
<tr>
<td></td>
<td>- Quicker to produce</td>
<td>- Quicker to produce</td>
<td>- Able to preserve respiratory capacity</td>
</tr>
<tr>
<td></td>
<td>- Lighter, finer and easier to wear</td>
<td>- More comfortable to wear</td>
<td>- Easier to wear</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>- 38° (at the beginning of treatment) reduced to 19° (after 24 months of consistently wearing the brace)</td>
<td>- 43° (at the beginning of treatment) reduced to 23° (after 6 months of consistently wearing the brace)</td>
<td>- 24.1° (at the beginning of treatment) reduced to 20.2° (at the definitive brace removal)</td>
</tr>
</tbody>
</table>
Comparison of the innovative types of flexible braces

<table>
<thead>
<tr>
<th></th>
<th>Spinealite™</th>
<th>Tailor-made posture correction girdle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention period</td>
<td>- 2010s</td>
<td>- 2010s</td>
</tr>
<tr>
<td>Corrective mechanism</td>
<td>- 3D system of postural corrections</td>
<td>- 3-point pressure system</td>
</tr>
<tr>
<td>Primary materials used</td>
<td>- Elastic ribbon materials</td>
<td>- Warp-knitted fabrics, resin bones and EVA foams</td>
</tr>
<tr>
<td>Advantages</td>
<td>- Easier to wear and adjust</td>
<td>- Easier to wear and adjust</td>
</tr>
<tr>
<td></td>
<td>- More durable</td>
<td>- More natural appearance</td>
</tr>
<tr>
<td></td>
<td>- More natural appearance</td>
<td>- More breathable and comfortable</td>
</tr>
</tbody>
</table>
| Effectiveness                | - 27° (at the beginning of treatment) reduced to  - 19° (at the beginning of treatment) reduced to 14° (after 6 months of daytime treatment)
A number of innovative bracing designs have been proposed to increase wear comfort and provide good corrective effects.

- Rigid braces: use materials that are lighter in weight, or reduce the amount of material used → reduce body movement restrictions and weight of the brace.

- Flexible braces: use elastic materials, foams or textiles such as warp knitted fabrics that allows greater body movement, and the more natural appearance can be more acceptable by adolescents.

- Physiological and psychological comforts of patients are important in improving compliance and the corrective effects of bracing treatment.
REFERENCES


REFERENCES

THE END
THANK YOU
Q&A