

A Design of Cervical Orthosis with Pneumatic System for Torticollis Deformity

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ABSTRACT

This study is focused on a modified cervical brace proposed for the torticollis treatment. To design and fabricate a multi adjustable cervical brace that must hold the head in correct position and provide corrective force to correct the deformity. In this design the orthotic design by pneumatic system technology to offer superior comfort, functionality, and therapeutic efficacy. An attached air pocket with cervical brace inflated to a specific pressure valve in order to apply the necessary corrective thrust in that specific area of neck and head. Patient will be able to wear the device for a longer period for using day time as well as night time for correction of the deformity.

Keywords: Torticollis, Pneumatic, Air bag, Night bracing.

INTRODUCTION

The sternocleidomastoid muscle shorting that results in torticollis (wry neck) leads the head to tilt laterally and downward while rotating in the transverse plane. It can occur at any age and be idiopathic, acquired, or congenital.

Congenital torticollis is the third most common congenital orthopedic defect worldwide, with an incidence ranging from

0.3% to 1.9% (some studies imply a ratio of 1 every 250 babies) [1].

Torticollis may be hereditary, acquired, or idiopathic and it can be done at any age. Torticollis that develops following trauma or illness is significantly more challenging to treat. Surgical intervention to release the tight sternocleidomastoid muscle is typically advised, accompanied by intensive physical therapy aimed at lengthening the contracture. Often, the surgeon aims to correct the abnormality by gently repositioning the head into the proper alignment. In contrast, many conventional cervical orthoses, such as static rotational control cervical orthosis, tubular orthosis, and Buckminster-Brown orthosis, are static in nature and offer limited adjustability, comfort, and ease of use [2,3,4].

The effectiveness of cervical orthosis with pneumatic systems utilizes air pressure to inflate and deflate air bag within the device, i.e. improvement in allowing for precise adjustment and customization of support based on severity of torticollis (wryneck) deformity. In order to maintain the head and neck in the proper position, the Cervical Orthosis with Pneumatic System will be adjusted in every plane [5].

OBJECTIVES

- An important advancement in orthotic design is the creation of a pneumatic cervical orthosis for torticollis.
- This device uses a pneumatic pressure pad to rectify the deformity by inflating and deflating air pressure as needed to correct torticollis.
- In addition to improving the surface of support so that patients may use it comfortably while lying down or at night, this study will optimize comfort when correcting deformities in the neck and head region.

MATERIALS AND METHODOLOGY

The Cervical Orthosis with Pneumatic System for Torticollis Deformity was fabricated from the following components, such as: Cervical orthosis with Pneumatic System Air bag (fig.1). Inflating pump (fig.2), Deflate valve (fig.3), suspension belt (fig.4)

1. Air bag:

The bag can be inflated or deflated to achieve the desired level of firmness, and to Provide adjustable support and cushioning for the neck.



Fig.1 Air Bag

2. Inflating pump:

A device, often a inflating hand pump, used to add air to the bag for increasing its firmness.



Fig.2 Inflating pump

3. Deflate valve:

Deflate valve allows air to be released from the bag to decrease/restrict its firmness.



Fig.3 Deflate Valve

4. Suspension belt:

Suspension belt secure the orthosis in place around the neck. Usually adjustable to ensure a snug and comfortable fit.



Figure.4 Suspension Belt

5. Polypropylene sheet (PPE sheet)

Polypropylene ethylene (PPE) sheets are versatile thermoplastic materials known for their excellent balance of properties, including high chemical resistance, good fatigue resistance, and low density.

Methodology



Fig. 5 Assemble without padding



Fig. 6 Orthosis with air bag



Fig. 7 Clinical trial of subject with force applied



Fig. 8 Force applied by the device

Biomechanics of The Cervical Orthosis with Pneumatic System for Torticollis Deformity

Due to tightness of sternocleidomastoid muscle the cervical spine tilt on one side along with the head and as we know that cervical spine is much more flexible and it provides 3 degree of freedom 'i.e.' flexion, extension, lateral flexion, and rotation. By external force we gradually correct the deformity by providing static progression brace. This design has considered for day and night using purpose.

Force application- There are three major forces acting on the body one force F1 is acting on temporal region to prevent lateral bending of the neck. F2 is acting through the chin area laterally to maintain the cervical posture or counter the F1 force, and another one is F3 which is to keep hold of the prosthesis in proper way. These forces create a mechanical counter balance which is gently pushes the head into neutral position or corrected position.

Prolonged stretching- The cervical brace maintains a stretch on the shortened sternocleidomastoid muscle to enhance lengthening over time through sustained pressure which is created by pneumatic

system. A gently air pressure applies to the air bag up to the subject might be sustained that pressure.

Cervical spine alignment- For promote symmetrical growth and prevent musculoskeletal adaptations like scoliosis or cranial asymmetry.

Effectiveness consideration- Effectiveness depends on the age of initiation and severity of torticollis. Earlier intervention is associated with better outcomes due to greater plasticity and growth potential. Delayed intervention may lead to muscle contractures and asymmetrical development that are difficult to aligned.

Compliance and wear time- Use the brace as prescribed consistently is crucial. Several hours per day and night using as much more time.

RESULT

After the fabrication it has trialled over the subject and seen that, the contracture can be corrected gradually by adjustment by inflating the air pressure in pneumatic cervical orthosis. The study highlights several effective outcomes, including improved alignment and posture in patients using the pneumatic cervical orthosis. After

consistent use, patients showed enhanced neck mobility, gradual improvement in ROM, with a reduction in muscle stiffness and discomfort. Additionally, the pneumatic nature of the collar allowed specific distribution of pressure levels, which helped in reducing pain and enhance the quality of life.

DISCUSSION

The system provides controlled pressure, which promotes gradual muscle relaxation and alignment, enhancing the correction of neck posture. Compared to rigid orthosis, the pneumatic design offers better mobility and compliance, making it easier for patients to wear the device for extended periods. Additionally, it allows for gradual correction, reducing the risk of overcorrection. The orthosis also provides therapeutic benefits such as improved circulation and reduced muscle spasms, aiding the rehabilitation process. The comfort and adaptability of the device further enhance patient satisfaction, making it a more personalized and effective solution for torticollis treatment.

It also provides the sufficient strength to align the head and neck in desired position. The design was also user friendly and biomechanically satisfactory. Adjustments are there for gradual increase in angle and for gradual strength on the contracted muscle.

CONCLUSION

This study presented the development of an innovative cervical orthosis with pneumatic system specifically designed to address the challenges associated with torticollis. Through a comprehensive analysis of existing treatments, design requirements, and user needs, the research aimed to create a functional and adaptable solution that enhances patient comfort and promotes effective management of cervical deformities.

The findings demonstrated that traditional rigid orthoses often lead to discomfort and limited mobility, which can hinder

compliance and overall treatment efficacy. In contrast, the pneumatic system introduced in this design allows for adjustable support and pressure distribution, accommodating the dynamic needs of patients suffering from torticollis. By leveraging the principles of pneumatically controlled adjustments, the orthosis can provide targeted support while enabling greater freedom of movement, thus addressing both therapeutic goals and patient lifestyle considerations.

Key aspects of the design included:

1. Customizability: The pneumatic system allows for real-time adjustments based on the patient's condition, promoting individualized treatment plans.
2. Comfort: The incorporation of soft materials and adjustable components minimizes pressure points and enhances wear ability, encouraging consistent use.
3. In conclusion, this study contributes to the field of orthotics design by proposing a novel approach to cervical orthosis for torticollis. By understanding of patient needs, this work lays the groundwork for future advancements in orthotic devices that prioritize both functionality and user experience. The ultimate goal is to improve the quality of life for individuals affected by torticollis through effective and comfortable treatment solutions.

Declaration by Authors

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