

Orthoses for Neck Control

Introduction

Cervical collars are used widely to immobilise the neck following injury in the prehospital stabilization of trauma patients and as part of definitive treatment of vertebral column injuries either on its own or for post operative immobilisation. Cervical collars are also useful in certain neurological conditions such as motor neuron disease where by providing support to easily fatigued neck muscles they enhance the person's functional capacity in areas such as eating and reading. A large number of different designs are available and they all help by reducing motion variably at the joints in the cervical spine and at the occipitocervical junction and in so stabilising the spine, reduces pain and discomfort and protects the spine from secondary injury.

Classification and biomechanics

Different and rather nondescriptive eponyms are frequently employed for orthotic devices. Confusion can be avoided by using a descriptive nomenclature for orthosis based on the body segments they immobilise. Thus spinal orthoses can be broadly divided into cervical orthoses (CO), head cervical orthoses (HCO), cervico thoracic orthoses (CTO), thoraco lumbosacral orthoses (TLSO), lumbosacral orthoses (LSO) and cervicothoracolumbosacral orthoses (CTLSO). The remainder of this article looks at the former three in some detail.

The capacity of an orthosis to immobilise the spine is a primary measure of its effectiveness. A clear recognition and understanding of the differences in function between the various orthoses available is required of the clinician so that informed decisions can be made regarding the choice of orthosis and appropriateness of the orthosis for a particular clinical condition. Orthoses vary in how much they can restrict movement in the neck and stability they can provide. The movements possible in the neck are forward flexion, extension, rotation and lateral flexion. For an orthoses to be effective, it must be able to prevent or limit all these movements. The presence of a myriad of designs is a reflection of the attempts that have been made to reach this ideal and also a testament to the limitations of the existing designs. A number of studies have attempted to compare the effectiveness of the more popular designs available using radiographic techniques. The limitation of

many of these is that effectiveness has been addressed in terms of the total range of motion allowed in the cervical spine. This approach is unsatisfactory because it disregards the fact that the cervical spine is segmental and that it is segmental motion that needs to be controlled rather than that of the cervical spine as a whole. Some devices are better at controlling movements at particular segmental levels and efficacy of motion restriction by level is the key characteristic to address. The concept of total range of motion also ignores the possibility of paradoxical movement between motion segments, a phenomenon known as snaking which has been reported by several authors and can be troublesome even in constructs like the halo jacket.¹

All orthoses work by a combination of sensory feedback and physical restriction. It is likely that in addition to the physical restriction, an orthosis works by reminding the user to not turn his / her head too far or too quickly, by a decrease in the load on injured muscles and ligaments caused by the added support that the collar provides to the head, and psychological support among others. Many of these factors rely on compliance and an understanding on the part of the user. Where such compliance is not forthcoming as in patients who are unconscious or psychologically disturbed, the clinician should consider carefully the use of additional measures to provide stability to the neck.

Cervical orthoses

Cervical orthoses such as soft collars which are used following mild injuries to the neck such as whiplash injuries use only sensory feedback and have no ability to restrict movement. They remind the user to limit movement, which in turn provides good pain relief. They are made of dense foam with a stockinette cover and fasten at the back with a Velcro strip. The drawbacks in using them for long periods are that patients can become dependent on them and they can lead to wasting of the neck muscles from lack of use.

Head cervical orthoses

Head cervical orthoses are generally more rigid collars made of various plastic materials in different designs to provide greater support and restriction. Most of the commonly used ones such as the Aspen collar (Figure 1), Philadelphia collar (Figure 2) and the Miami collar are prefabricated.



Pradeep Thumbikat is a Specialist Registrar in Spinal Injuries Rehabilitation at the Princess Royal Spinal Injuries Centre, Northern General Hospital, Sheffield with special interests that include spinal biomechanics and spasticity management.



Clara Bailey is a Senior Orthotist at the Northern General Hospital, Sheffield working mainly in general orthotics with a specialised interest in footwear and neck bracing for MND patients.



Dipak Datta is a Consultant & Hon Senior Clinical Lecturer in Rehabilitation Medicine at the Specialised Rehabilitation Services, Northern General Hospital, Sheffield Teaching Hospitals Foundation NHS Trust, Sheffield. His special interests include orthotics and prosthetics and he was the Chairman of the BSRM working party report on Orthotics, From Surgical Appliances to Orthotics: Towards an Effective Service, 1999.



Figure 1: Aspen Collar – Note the central opening for a tracheostomy tube.



Figure 2: Philadelphia Collar, which is one of the most widely used head cervical orthoses.

Correspondence to:
 Mr Pradeep Thumbikat,
 Specialist Registrar in
 Spinal Injuries,
 Princess Royal
 Spinal Injuries Centre,
 Northern General Hospital,
 Herries Road, Sheffield S57AU.
 Tel: 01142715646, 07916166421,
 Fax: 01142715649,
 Email: pradeep.thumbikat@
 gmail.com or
 pradeep.thumbikat@sth.nhs.uk

Askins and Eismont analysed the collars that accounted for 80% of the cervical orthosis market in the United States in 1995 and found that Philadelphia and Aspen collars when properly applied still allowed for 53% and 62% of normal neck rotatory motion respectively. 66% and 69% of normal lateral flexion was allowed by Philadelphia and Aspen collars respectively.² They found that NecLoc orthosis provided greater restriction of neck motion in all planes and was more effective than the Philadelphia and Aspen collars in reducing intervertebral motion. It is important to bear in mind that despite the use of collars, considerable movement is still possible in the cervical spine and additional measures should be taken to protect the spine where required. Both the Philadelphia and the Aspen are two piece collars with lateral fastenings. The Philadelphia collar is made of Plastizote and can accommodate a tracheostomy opening where as the Aspen collar is a polythene shell with cotton lined foam padding. Both of these are available off the shelf in various sizes, ensuring easy availability. The sizing and fitting of an orthosis is important to get the most benefit from any orthosis and should be carried out by a person accustomed to the use of the particular orthotic design. A poorly fitting device adversely affects the biomechanical properties of the device and its ability to immobilise and support the neck. The relatively minor advantages demonstrated or claimed by some devices need to be balanced against cost and patient comfort, the data on which unfortunately is not available for most if not all devices. Head cervical orthoses are useful for immobilization, but do not stabilise the spine. They are usually used for stable mid cervical injuries or post operatively when rigid control is no longer required.

Cervico thoracic orthoses

Cervico thoracic orthoses provide greater restriction of neck motion than the above mentioned collars. They are best exemplified by posterior cervical appliances with chin and occipital pieces which are connected to sternal and back plates with four metal uprights. The common ones in use include the Sternal Occipital Mandibular Immobiliser (SOMI), Philadelphia collar with extension, Aspen 2 post and Aspen 4 post cervical collars.³ The SOMI is a light weight appliance which can be easily fitted and provides considerable restriction of movement in the mid to lower cervical region. SOMI has no posterior rods making it easier to use in those who are on bed rest. Sandler et al analysed the efficacy of different collars varying in restrictive range from a soft collar to a SOMI and found that although there was a decrease in the motion permitted by the more restrictive devices, the differences were not large.⁴

Head cervico thoracic orthoses

An HCTO provides maximum immobilisation of the cervical spine. Examples of this include the Minerva orthosis and the rigid halo. The former is a total contact appliance made of plastic materials over a positive body cast.⁵ It encloses the upper trunk, neck and back of the head and has a band around the forehead. It is very effective in preventing lateral and rotational neck motions,



Figure 3: A halo jacket being used as the definitive treatment for a C2 fracture. A good fit is necessary for maintenance of reduction and for the avoidance of complications.

being as effective as the halo in controlling injuries below C2. The halo is superior in restricting motion at the occiput, C1 and C2 levels.

A halo orthosis (Figure 3) provides the maximum restriction of flexion and extension of the potentially unstable cervical spine and is frequently used for immobilisation of the neck after a period of cervical traction or spinal fusion. The halo consists of a halo ring, a vest and upright posts. Most modern halo rings are made of lightweight MRI compatible materials and accepts 4 pins. The ring used should be large enough to allow for a 1cm clearance around the head the pins attach the ring to the forehead, two anterolaterally and two posteriorly. The pin sites are cleaned routinely with normal saline to prevent infection. The tension in the pins should be monitored regularly and if there is evidence of loosening, they should either be tightened or replaced. The halo vest which the ring connects to through four upright posts is made of prefabricated plastic material lined with sheepskin or a soft fabric. The vest should fit snugly to prevent pressure sores and loss of reduction. Once securely



Figure 4: A prefabricated MND collar. The padded spring supports the head while allowing forward flexion of the neck.

applied, patients can be mobilised in a halo and can participate in physical activities. Complications of the halo are numerous and include pin loosening, infection, ring migration, pressure sores, nerve injury, dysphagia, skull perforation and brain abscess. Other problems that the halo has also been associated with include an increased incidence of non union of some fractures and inability of the patients to tolerate the device.

Complications with collars and bracing in general include pressure sores, muscle atrophy, allergic reactions and skin maceration. Monitoring the condition of the skin under the brace and skin hygiene is paramount when it comes to reducing complications. Further, brace treatment should be closely followed with regular clinical examinations and radiographs as appropriate.

Cervical orthoses in neurological conditions

In non traumatic conditions such as weakness in neck muscles due to a neurological condition, the expectations of an orthosis are very different to that of an orthosis used in an unstable spine. They may be required only at certain times in the day, should not compromise residual function and should be able to restrict only certain movements while providing support to the neck. The MND collar (Figure 4) is a good example of a collar designed to help improve the quality of life of patients suffering from motor neuron disease. It is made from padded spring steel; the design ensuring that only flexion of the neck is restricted while supporting the head on the shoulders. It is meant to be used when the patient is tired for activities that require an extended position of the neck such as watching television.

When muscle weakness is severe, the use of collars in isolation may not be appropriate as it can lead to the head falling forwards onto the collar resulting in excessive pressures on the chin and jaw leading to skin necrosis. In such situations the use of a collar should be resorted to only after correction of the sitting position to ensure the patient does not assume a slumped position. Many patients find it either difficult to tolerate the device or conversely find that it provides inadequate support. Where a prefabricated orthosis is not adequate, consideration should be given to the use of a custom made orthosis, which is the preferred choice of many departments in the country.

References

1. Hughes SJ. *How effective is the Newport/Aspen collar? A prospective radiographic evaluation in healthy adult volunteers.* J Trauma 1998;45(2):374-78.
2. Askins V, Eismont FJ. *Efficacy of five cervical orthoses in restricting cervical motion: A comparison study.* Spine 1997;22:1193-8.
3. Gavin MT et al. *Biomechanical analysis of cervical orthoses in flexion and extension: a comparison of cervical collars and cervico thoracic orthoses.* J Rehabil R D 2003;40:527-38.
4. Sandler AJ, Dvorak J, Humke T, Grob D, Daniels W. *The effectiveness of various cervical orthoses. An in vivo comparison of the mechanical stability provided by several widely used models.* Spine. 1996;15;21(14):1624-29.
5. Sharpe KP, Rao S, Ziogas A. *Evaluation of the effectiveness of the Minerva cervicothoracic orthosis.* Spine 1995;20(13):1475-79.