Clinical results of the new cervico-thoracic orthosis ‘Neck-Chest brace’

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ABSTRACT
The efficacy of a new cervico-thoracic Neck-Chest brace (N-C brace) prepared for post-operative patients of cervical canal expansive laminoplasty was assessed. The orthosis is light in weight (300 g) and easy to fit. The effect of the orthosis to restrict the neck motion was studied in 10 normal young males by using lateral view radiographs in extension and flexion positions. The average range of the neck motion for the N-C brace was 24.4% of the values obtained without the orthosis. The restriction of the motion was significantly better than that without orthosis. Then, the clinical efficacy of the N-C brace was assessed in 40 patients of cervical spondylotic myelopathy who underwent expansive laminoplasty. Alignment changes of the postoperative cervical spine was found only in 10% of the patients who had a straight and kyphotic curvature pattern in the cervical spine before operation. The cervical alignments in the other 90% of patients were not changed post-operatively. These data clearly demonstrated that the N-C brace effectively controls the neck motion and is recommended for patients who have a lordotic curvature pattern in the cervical spine to prevent the post-surgical changes in the alignment after expansive laminoplasty.

Key words: cervico-thoracic brace, cervical canal expansive laminoplasty, limitation of neck motion, post-operative neck support

INTRODUCTION
Many types of cervical orthoses have been used in the treatment of various diseases and injuries of the neck. Two different purposes are included in the application of the cervical orthosis: one is to provide comfortable support to the neck and the other to give stability by limiting the range of motion in a potentially unstable spine. Many types of cervicothoracic braces, e.g. the four-poster brace and the SOMI brace, have been used. In choosing the appropriate cervical orthoses for post-surgical patients, we should consider these two rather conflicting requirements: comfortable support and restriction of movement, depending on the type of surgery.

Myelopathy due to developmental stenosis of the
canal is one of the common disorders in the cervical spine, and several types of decompressive laminoplasties have been performed. While these laminoplasties were elaborated to prevent post-surgical deformity of the cervical spine, the patients still often show post-surgical changes in the alignment of the cervical spine. To prevent progression in the cervical deformity, we have used our original cervical orthosis named ‘Neck-Chest (N-C) brace’ for patients who underwent cervical laminoplasty since 1993. The purpose of this study is to compare the effectiveness of the N-C brace with the Philadelphia collar in limiting the motion of the neck and to assess the effects of the N-C brace on the alignment of the cervical spine in patients who were post-operatively fitted with the brace.

MATERIALS AND METHODS

The neck portion of the brace is made of PE light, contoured for mandibular and occipital support with adjusting screws attached to their anterior and posterior sides. The thoracic frame is made of suborthoren, directly connected to the neck portion. Since the brace has no posterior pillar, patients are able to lie down directly in a supine position. The weight of the brace is approximately 300 g and the neck portion is used as a neck collar when detached from the thoracic frame (Fig. 1a, b, c).

ASSESSMENT

Limitation on the motion of the neck

Ten young adult men from 20 to 26 years old served as subjects. None complained of neck pain or cervical root pain, without any history of trauma in the cervical region. Radiographs confirmed normal cervical spines of the subjects. In all subjects, lateral view radiographs of the cervical spine in the neutral, flexion and extension positions were initially taken. Then, after fitting the N-C brace, lateral view radiographs were taken in the flexion and extension positions. Orthotic devices were fitted to each subject by a certified orthotist. On the radiographs, basal lines were drawn through the inferior lips of C3 and C7 vertebral bodies, and angles formed by the lines perpendicular to these base lines were measured. The angle of the flexion radiograph was measured and named a, and the angle of the extension radiograph was measured and named b. The value of a + b was also obtained for the angle of total neck motion (Fig. 2). To obtain the degree of neck motion with the orthoses, the values of a + b were respectively compared to the values on the films taken without the orthoses, and the degree of motion was presented by the percent value.

Figures 1  The Neck-Chest brace (a) anterior view, (b) lateral view showing adjusting screws at anterior and posterior sides and (c) posterior view.
Patients and surgery

Forty patients with cervical myelopathy who underwent cervical canal expansive laminoplasty of the midsagittal splitting type (Kurokawa et al., 1984) were recruited for the study. 40 patients including 29 males and 11 females with an average age of 63.6 years had suffered from cervical myelopathy. During surgery, the spinous processes of the cervical spine were cut at their center by using an air drill, and gutters were prepared by the drill in the bilateral sides of the C3–C7 laminae. Then, the spinal canal was expanded by opening the center of the spinous process. Hydroxyapatites blocks were inserted as spacers between the divided spinous processes (Fig. 3a, b, c). Cervical alignment changes were measured at the point of one year to 8 years and 3.2 years on average after the operations.

Figure 2  The methods of measurement of the neck motion. ‘a’ is flexion angle and ‘b’ is extension angle. Total neck motion is determined by ‘a + b’.

Figure 3 (a) Postoperative lateral rentgenogram of the cervical canal enlargement (b) Postoperative computed tomogram at cervical spine. (c) Hydroxyapatite spacer between the divided spinous process.
Post-surgical changes in the alignment

The N-C brace was put on the patients in the second postoperative week, when ambulation was started. The patients used the brace until the sixth week. Then, the cervical alignment was assessed by semiquantitative evaluation of the radiographs. On the lateral radiograph of the neutral position, the postero-caudal ends of C2 and C6 bodies were connected to the base line (A). The perpendicular distances from postero-caudal ends of the C3–C5 bodies to the base line were measured and the sum of the respective values for C3–C6 (a) was obtained. The value D or a/Ax100 was used as the index for the alignment of the cervical spine. The alignment was classified into 5 categories and defined according to the value of the parameter D: D ≥ 25, hyperlordosis 25 > D ≥ 5, lordosis 5 > D ≥ 0, straight; and 0 > D, kyphosis. The validity of this categorization was based on data reported (Ishihara 1968). The S-shape pattern of the cervical spinal curvature was also noted from radiographs (Fig. 4).

\[ D = a_1 + a_2 + a_3/A \times 100 \]

Hyperlordosis: D ≥ 25
Lordosis: 25 > D ≥ 5
Straight: 5 > D ≥ 0
Kyphosis: D < 0

RESULTS

Neck motions with orthosis

The average percent value of the degree for flexion-extension with N-C brace was 24.4 and 7.6% compared to the value obtained on the radiographs without orthosis. The range of neck motion with the N-C brace was significantly smaller when compared to the values without the orthoses (P 0.001, paired t-test) (Fig. 5).

Postoperative changes in the cervical alignment with N-C brace

In 40 cases of cervical spondylotic myelopathy, the parameter D values in 2 cases indicating hyperlordotic deformity of the cervical spine, the values in 22 cases indicating lordosis, those in 7 cases belonging to the straight group and 6 cases having kyphosis. There were no S-shape cases before the operations. After the operations, 3 cases out of 40 cervical spondylotic myelopathy patients, who had a straight neck defined from the parameter D before surgery, radiographically showed a development of S-Shape in 2 cases and development to kyphosis in one case. One kyphosis case showed a distinct development of kyphosis after surgery. These 4 cases that developed post-surgical changes in the cervical alignment belonged to the straight or kyphotic groups before surgery.

![Figure 5](image)

The significance of limitation of motion in normal range verses N-C brace by paired t-test.

![Figure 6](image)

Cervical alignment before and after the operation.

DISCUSSION

This study demonstrated that our new N-C brace had a good restriction of the cervical motion. The average value of the allowed motion for flexion-extension, 24.4% to the normal motion, indicates that the degree of the restriction is equivalent to the values reported
for other cervico-thoracic orthoses such as SOMI brace, four-poster brace and rigid cervico-thoracic brace. Since the weight of the N-C brace is as light as 300 g, easy handling is an additional advantage of the N-C brace.

There are 2 main indications for the application of cervical orthoses. One is the conservative treatment for trauma of the spine. The other indication is post-operative neck support after various types of surgery. When using the cervical orthosis for potentially unstable types of fractures and/or dislocations, a high degree of restriction of cervical motion and a stable fixation of the head on the neck are required. On the other hand, since expansive laminoplasty does not seem to cause severe instability of the spine, rigid restriction of movement is not usually required for post-operative orthoses. However, in our experience, post-operative use of the conventional cervical brace was not able to prevent cervico-thoracic kyphotic change after laminoplasty. The SOMI brace was easy to fit, but some patients were not able to keep the lordotic position of the neck because of incomplete fitting of the anterior part of the brace. The inconveniences of conventional types of orthoses caused us to develop the N-C brace, giving reasonable restriction to the neck motion with easy handling for post-surgical use.

In this study 4 cases out of 40 (10%) developed changes in the alignment after the operation. Since the restriction of neck movement by the N-C brace was found to be equivalent to other conventional cervico-thoracic braces, the development of post-surgical alignment changes in these 4 cases would not be due to the less effectiveness of the N-C brace for support. While expansive laminoplasties have often been used in the treatment of cervical myelopathy, such as hemilateral open-door type and bilateral open-door type, there have been no detailed reports concerning post-operative application of the cervical orthosis and the changes in the neck alignment after surgery. However, we think it important that the postoperative alignment changes occurred only in patients who had a straight or kyphotic curvature pattern before surgery, and the other 90% of patients, most of whom had a lordotic curvature pattern before surgery, maintained the curvature with N-C brace. Since deterioration in post-operative kyphosis in patients who have a straight or kyphotic cervical spine before surgery may not be prevented by the use of an orthotic brace only, careful observation of the cervical alignment would be necessary in these cases.

In conclusion, we have reported the clinical results of the N-C brace made of orthoren and PE light. While the weight of the brace is as light as 300 g, the brace was found to effectively restrict neck motion. The use of the N-C brace prevented changes in cervical alignment in 90% of the patients who had expansive laminoplasty in the neck. The N-C brace is well recommended for patients who have a lordotic curvature pattern in the cervical spine to prevent post-surgical changes in alignment after expansive laminoplasty.

REFERENCES