Omnidirectional retractor-supporting ring as a new device for carotid endarterectomy

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In carotid endarterectomy (CEA), the traditional retractors are often difficult to use because they tend to obstruct surgical manipulations, especially in the deep operative field on the rostral side. The authors have invented a new omnidirectional retractor-supporting ring (OD ring) to solve the problems of traditional retractors. The OD ring has an ellipsoid-shaped frame (major axis: 275 mm, minor axis: 192 mm) with 22 equally spaced outward protrusions. Rubber bands from which blunt mini-hooks are hung are twisted around the protrusions. The OD ring was placed on the operative area, and the skin edges were retracted by mini-hooks placed symmetrically. The hooks were moved gradually from the shallow to the deep operative field as surgical dissection continued to expose the carotid bifurcation and distal internal carotid artery (ICA). The OD ring was used in 158 consecutive CEAs in the authors' institute between July 2010 and October 2013. The OD ring provided a flatter surgical field and was less obstructive than traditional retractors, thereby facilitating surgical manipulation in the deep operative field such as at the distal ICA. Furthermore, because of its simpler shape, angiorrhaphy could be conducted more smoothly, with less tangled thread during closure of the arteriotomy. There were no technical complications related to the OD ring. As a new retractor system for CEA, the OD ring is less obstructive and provides a flatter surgical field than traditional retractors, thereby facilitating surgical manipulations in the deep operative field around the distal ICA.

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KEY WORDS carotid endarterectomy; device; omnidirectional; retractor; surgical technique

THE effectiveness of carotid endarterectomy (CEA) for advanced carotid stenosis has been established in many large studies. Various surgical instruments for CEA are being used, including standard retractors.^{3,6} In a conventional CEA, after skin incision a Weitlaner retractor is applied to hold the skin edges. The retractor is placed progressively deeper into the operative field as neck dissection continues, especially on the lateral side. A second retractor, such as a hinged Richards device, together with hooks, are sometimes placed deeply to retain the jugular vein laterally and to expose the distal internal carotid artery (ICA). However, the traditional retractors are often difficult to use because they tend to obstruct surgical manipulations, especially in the deep operative field on the rostral side. We have invented a new omnidirectional retractor-supporting ring (OD ring) to solve the problems of traditional retractors.

Methods

The OD ring is made of stainless steel. It has an ellipse-like shape (major axis: 275 mm, minor axis: 192 mm) and can be bent to fit the contour of the operative site in the cervical region (Fig. 1A and B). Twenty-two outward protrusions 12 mm in length are welded to the outside of the ring at an equal distance apart (Fig. 1C). Disposable rubber bands are twisted around the protrusions, from which blunt mini-hooks are hung (Fig. 2).

We received approval for this study from the ethics committee at Tokyo Women's Medical University. Carotid endarterectomy was performed as described in our previous reports.^{1,2,4,5} Surgery was conducted under general anesthesia that was induced using propofol, with somatosensory and motor evoked potential monitoring in all patients. The patient was placed supine with the head

ABBREVIATIONS CEA = carotid endarterectomy; ICA = internal carotid artery; OD = omnidirectional.

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FIG. 1. Photographs showing the structure of the novel retractor system. **A:** An overview of the OD ring. The ring is ellipsoid-shaped, with a major axis of 275 mm and a minor axis of 192 mm. **B:** The OD ring can be bent to fit the contour of the operative site in the cervical region. **C:** Twenty-two outward protrusions are welded at equal intervals to the outside of the ring. The blunt protrusion is 12 mm in length.

vertex pointing slightly downward and the head rotated to the contralateral side. An incision was made along the anterior sternocleidomastoid border. A T-shaped silicone shunt system was used routinely in all patients.^{1,2,4,5} Then the OD ring fitted with rubber bands was placed, and the skin edges were retracted by blunt mini-hooks attached to the rubber bands. Mini-hooks were placed symmetrically around the skin edges and were moved gradually from the shallow to the deep operative field as surgical dissection progressed, to expose the carotid bifurcation and the distal ICA (Fig. 3). The mini-hooks could be moved easily and simply to expose the target structures.

After the microsurgical procedures, the OD ring with blunt mini-hooks could be removed quickly from the surgical field.

Results

The OD ring was routinely used in 158 consecutive CEAs in our institution between July 2010 and October 2013. The blunt mini-hooks could be placed easily and quickly to obtain OD retraction of the operative site (Fig. 3). Furthermore, larger hooks also could be applied to the OD ring. Use of more hooks provided greater stability to

FIG. 2. Preparation of the novel retractor system for CEA. **A:** A disposable rubber band to be used with the new retractor system. **B:** The rubber bands are twisted around the protrusions welded to the ring. **C:** Hooks with 2 blunt prongs for retraction. **D:** An overview of the prepared OD ring with rubber bands.

FIG. 3. Operative view. **Left:** The OD ring and blunt mini-hooks provide omnidirectional retraction. The operative wound is retracted by many hooks hung from rubber bands attached to the OD ring circumferentially. **Right:** An enlarged view of the operative wound showing that omnidirectional retraction of the skin edges is achieved by the hooks.

the OD ring. The ring and blunt mini-hooks were used repeatedly after washing and sterilization. The rubber bands were disposable.

The OD ring provided a flatter surgical field than the traditional retractors did (Fig. 4). Furthermore, distal ICA was also easily exposed with mild retraction by using the OD ring. Therefore, the OD ring was less obstructive compared with traditional retractors, thereby facilitating surgical manipulation in deep operative fields—such as exposure of the distal ICA (Fig. 5). Furthermore, the simple shape allowed angiorrhaphy to be conducted more smoothly with less tangled thread during closure of the arteriotomy. We experienced no complications related to the OD ring system.

Discussion

The OD ring was invented as a novel retractor system for CEA. This device has been commercially available from Fujita Medical Instruments Co., Ltd, Tokyo, Japan, since January 2011. Currently, the OD ring has been approved only in Japan. Because of the less obstructive structure and composition compared with conventional retractors, the OD ring allows smoother and easier manipulations, especially in the deep operative field around the distal ICA, and facilitates exposure of the distal ICA.

Traditional retractors such as the blunt Weitlaner retractor and hinged Richards retractor are generally used in CEA. These retractors are moved progressively as neck dissection continues to expose the carotid bifurcation and the distal ICA.^{3,6} The retractors are held to expose the plane of carotid bifurcation from the proximal to distal site during surgery, over or through which surgeons manipulate microsurgically in the operative field. If the retractors and additional hooks are used proficiently, the operative field is widened and the distal ICA is more adequately exposed. Although the traditional retractors are useful in CEA, some problems exist regarding exposure of the distal ICA in the deep operative field, surgical manipulation, and angiorrhaphy. The traditional retractors often obstruct the surgeon's hands when manipulating in the deeper operative field. It is particularly difficult to dissect the distal ICA in a patient with a high bifurcation, because of the deep working plane. Another problem occurs during suturing. The sutures often became entwined with parts of the traditional retractors. Placement of a shunt system, which is routinely used in our procedures,^{1,2,4,5} is sometimes restricted by the traditional retractors.

The present novel retractor system, the OD ring, may solve these problems, including obstruction by the handles of the traditional retractors. The innovative aspects of the new retractor system include having fewer parts

FIG. 4. Comparison between the novel retractor system (**A and B**) and traditional retractors (**C and D**). Panels **A** and **C** show overviews of the 2 systems, and panels **B** and **D** show side views of the 2 systems. The right side of the views is the caudal and the left side is the rostral side of the operative field. The new retractor system has a bendable ring to fit the contour of the operative site (**B**). The new retractor system has fewer protruding parts (**B**) than the traditional retractors (**D**).

FIG. 5. Comparison of surgical manipulations between the novel retractor system (**left**) and the traditional retractors (**right**). The right side of the views is the caudal and the left side is the rostral side of the operative field. The protruding parts of traditional retractors restrict the surgeon's hand movements more seriously than those of the new system. Therefore, the new retractor system facilitates manipulations of the vessels and surrounding structures in a deep operative site.

protruding upward from the operative wound compared with the traditional retractors, and providing a flatter surgical field. Furthermore, this system retracts the surgical wound omnidirectionally in a symmetrical manner, facilitating smooth surgical procedures. Various blunt mini-hooks used with the present retractor system may further improve the surgical procedures.

Conclusions

We invented the OD ring as a novel retractor system for CEA. Compared with traditional retractors, the system provides a less obstructive and flatter surgical field, thereby facilitating surgical manipulations in the deep operative field around the distal ICA. The distal ICA is more adequately exposed. The system has a simple structure and is reusable after sterilization, except the rubber bands. The OD ring is more useful in CEA than traditional retractors.

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Conception and design: Yoneyama, Okada. Acquisition of data: Yamaguchi. Analysis and interpretation of data: Tanaka. Drafting the article: Yoneyama. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Kawamata. Administrative/technical/material support: Okada. Study supervision: Okada.

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