Modified Wound Dissection Preserving the Greater Occipital Nerve in Foramen Magnum Decompression: A Technique to Reduce Postoperative Pain

Satoru Shimizu¹ Tomoya Yamazaki¹ Koji Kondo¹ Satoshi Utsuki² Hidehiro Oka²
Kenji Nakayama¹ Isao Yamamoto¹ Kiyotaka Fujii²

¹ Department of Neurosurgery, Yokohama Stroke and Brain Center, Yokohama, Kanagawa, Japan

² Department of Neurosurgery, Kitasato University School of Medicine, Sagami-hara, Kanagawa, Japan

Address for correspondence and reprint requests Satoru Shimizu, M.D., Department of Neurosurgery, Yokohama Stroke and Brain Center, 1-2-1 Takigashira, Isogo-ku, Yokohama, Kanagawa 235-0012, Japan (e-mail: Satoru4756@aol.com).

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Abstract

Patients undergoing foramen magnum decompression for Chiari malformation may experience severe postoperative pain in the area innervated by the greater occipital nerve (GON). We developed a modified dissection to lessen this pain. A midline skin incision was extended 2 cm in a cephalad direction to theinion and the skin was minimally retracted. After exposing the occipital bone, the semispinalis capitis and the trapezius muscles were detached subperiosteally in a caudal-to-cephalad direction. Consequently, the muscles and skin containing the GON were retracted in a single layer. We retrospectively compared the intensity of postoperative pain recorded on the visual analogue scale (VAS) by patients who underwent decompression using our (group A, $n = 5$) and the conventional layer-by-layer dissection technique (group B, $n = 5$). The VAS scores were not different on the day of surgery, but subsequently they fell faster in group A. Group A patients received a mild analgesic for a short period. Group B patients required a stronger analgesic for prolonged periods. Postoperative GON numbness/tenderness was observed only in group B. With respect to most evaluation criteria, the difference between the two groups was significant. Our anatomically rational dissection that protects the GON results in less postoperative pain.

Keywords

- foramen magnum decompression
- greater occipital nerve
- postoperative pain

Introduction

Patients undergoing foramen magnum decompression (FMD) for Chiari malformation often experience severe postoperative occipital pain. Damage to the greater occipital nerve (GON) is one of several possible contributing factors. Patients with severe pain require treatment with strong analgesics and their hospitalization may be prolonged.

We developed a modified wound dissection technique for FMD; as it reduces damage to the GON based on the surgical

anatomy,^{1–3} it lessens the degree of postoperative occipital pain.

Materials and Methods

We used our technique in five adults who underwent FMD for Chiari malformation since 2008.

Under general anesthesia, the patient is placed in the prone position and the neck is fixed in slight flexion using a Mayfield head clamp. A midline skin incision is made from a

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point ~2 cm above the inion down to the nuchal hair line (→Fig. 1A). Minimal dissection between the subcutaneous layer and the fascia of the trapezius muscle is performed as medially as possible. The fascia of the trapezius and the galea cephalad to the fascia are incised in the midline, and the occipital bone is exposed through the trapezius and the semispinalis capitis muscles. Then, starting at the midline, the semispinalis capitis and the trapezius muscles at the nuchal line are gently detached to a point 3 cm off the midline. Care is taken to detach the muscles in the caudal-to-cephalad direction (→Fig. 2A), consequently, the scalp and nuchal muscles are dissected from the bone as a single layer without shearing. The skin edge and the dissected muscles are retracted with blunt-pronged self-retaining retractors (→Fig. 2B), and standard decompression comprising craniectomy of the foramen magnum, laminectomy of C1, and duraplasty using a dural substitute (expanded polytetrafluoroethylene; Preclude® Dura Substitute; WL Gore & Associates, Flagstaff, AZ, USA) is performed in the usual fashion. At

Figure 1 Diagrams showing the relationship between the course of the greater occipital nerve (GON) and midline skin incisions in the modified single-layer (A) and conventional layer-by-layer dissection (B) techniques applied for foramen magnum decompression. The GON pierces the trapezius muscle 1.5 to 3.5 cm (mean 2.4 cm) lateral and 0 to 3 cm (mean 1.2 cm) caudal to the inion, and the semispinalis capitis muscle 0.5 to 2.5 cm (mean 1.6 cm) lateral and 1 to 5 cm (mean 3.7 cm) caudal to the inion.² In the modified dissection technique (A), the incision is extended 2 cm in a cephalad direction to the inion. This relaxes the retracted tissue containing the GON. GON, greater occipital nerve.

Figure 2 Diagrams showing the relationship between the greater occipital nerve (GON) and nuchal muscles when the modified (A and B) and conventional dissection techniques (C and D) are used. With the modified single-layer dissection technique, the semispinalis capitis and trapezius muscles at the nuchal line are dissected subperiosteally in a caudal-to-cephalad direction (arrow) with minimal retraction of the scalp (A). The arrowheads indicate the sites at which the GON pierces the muscles. The GON in the semispinalis capitis muscle is closest to the midline. P1, P2, and P3 show the portions, and A1 and A2 the angles of the GON, respectively. Sufficient muscle detachment reduces the pressure exerted at muscle retraction, thereby minimizing iatrogenic injury to the GON and to muscles containing the nerve. Cranial extension of the incision exposes the galea aponeurotica at retraction (B). In the conventional layer-by-layer dissection method with a small incision (C), excessive retraction of the wound edge is required for detachment of the trapezius muscle. This results in stretching of the GON (bidirectional arrow) where it pierces the muscle just beside the midline, raising the risk of its direct transection (dashed arrow). At wound closure, the GON may be constricted by wide stitches (asterisk). Furthermore, upon retraction of insufficiently detached nuchal muscles, excessive retraction pressure damages the muscles and the GON which is stretched (bidirectional arrows) and compressed (arrows) (D).

Table 1 Criteria to Assess Postoperative Pain

	Group A	Group B	p Value
VAS on the day of surgery (% [mean])	40–90 (60)	80–100 (90)	0.0547 ^a
Days required to obtain 50% of VAS recorded on the day of surgery (mean)	2–4 (2.6)	4–9 (6.2)	0.0138 ^a
Analgesics			
Type (dose in mg/day)	Acetaminophen (600)	Indometacin (150)	
Days administered (mean)	3–8 (4.4)	5–9 (6.8)	0.0445 ^a
Creatinine kinase on the first postoperative day (U/L [mean])	149–383 (294)	303–2254 (1098)	0.0472 ^a
Number of patients reporting GON numbness/tenderness	0	3	0.0384 ^b

Note: Group A ($n = 5$) was treated with our modified dissection method, and group B ($n = 5$) by the conventional dissection technique.

^aMann–Whitney U test.

^bChi-square test.

GON, greater occipital nerve; VAS, visual analogue scale.

closure, the nuchal muscles are stitched only to the fascia to avoid constricting the GON coursing of the muscle in the body.

We retrospectively assessed the outcomes in 10 consecutive patients who were operated since 2004 when we began to collect visual analogue scale (VAS) data routinely for the evaluation of postoperative pain. Group A ($n = 5$, treated since 2008) was operated using our method. Group B ($n = 5$, treated between 2004 and 2007) had undergone conventional layer-by-layer dissection comprised a midline skin incision between theinion and nuchal hair line (►Fig. 1B) and subperiosteal dissection of the trapezius and semispinalis capitis muscles as lateral as possible. In detaching the muscles at the nuchal line, the skin edge was retracted in the lateral direction to allow visualization of the whole width of the detachment. After muscle dissection, the wound was retracted with self-retaining retractors, the usual decompression procedure was performed, and closure that included stitching in the muscle bodies was performed. All operations were performed by the first author (S.S.).

The five criteria used to evaluate postoperative pain were (1) the VAS score (%) on the day of the operation, (2) the time required to obtain a 50% decrease in pain as recorded on the VAS on the day of surgery, (3) the type of analgesics used and the length of their required administration, (4) the level of serum creatinine kinase on the first postoperative day, and (5) postoperative numbness and tenderness of the GON. All patients recorded their pain level on the VAS by placing a cursor on a scale that recorded the pain level in increments of 10; 0 indicated no pain and 100 unbearable pain. The analgesics were acetaminophen (600 mg/day), classified as a class 1 drug by the World Health Organization and indometacin (150 mg/day), a class 2 drug.³ If acetaminophen failed to produce adequate pain relief we administered indometacin. No other pain treatments were delivered. GON tenderness was assessed at the nuchal line next to the incision. To detect significant differences between the two groups, criteria 1 to 4 were analyzed by the Mann–Whitney U test. Criterion 5 was assessed with the chi-square test.

Results

A summary of our findings is presented in ►Table 1. All 10 patients reported postoperative nuchal and/or occipital pain whose characteristics differed from their preoperative pain. In group A, the mean VAS on the day of surgery was lower; the difference between the two groups was not statistically significant. On the other hand, the time to obtaining a 50% decrease in the VAS recorded on the day of surgery and the period for which pain medication (acetaminophen) was necessary was significantly shorter in group A and their serum creatinine kinase level was also significantly lower. Postoperative GON numbness/tenderness was reported only by group B patients (right, $n = 1$; left, $n = 1$; bilateral, $n = 1$). Their numbness involved broad areas of the occipital scalp. We encountered no complications or difficulties with respect to wound retraction among group A patients.

Discussion

Many of our patients who had undergone FMD or the midline suboccipital procedure using a small incision reported postoperative jabbing pain or numbness in the areas innervated by the GON. They also reported tenderness on the nuchal line along the incision site compatible with the location of the GON. Some suffered permanent analgesia or dysesthesia. As these manifestations suggested iatrogenic damage to the nerve, we sought to improve our wound dissection technique.

The GON emerges from the spinal ganglion of C2 between the C1 and C2 laminae; it has three portions (P1, P2, and P3) and two angles (A1 and A2). It initially courses in a caudal, lateral, and dorsal direction (P1). This portion extends to the caudal edge of the inferior oblique muscle by forming an angle (A1) it courses around this muscle. The second portion (P2) runs in a cephalad and medial direction. It courses through the semispinalis capitis muscle, the second muscle layer, which forms a second angle (A2) resulting in a change from caudal-to-cephalad orientation and deep-to-superficial location. In the third portion (P3), the nerve runs between the

dorsal aspect of the semispinalis capitis muscle and the deep aspect of the trapezius muscle, the direction is cephalad and lateral. It then courses through the tendinous part of the trapezius muscle and reaches the subcutaneous layer in the occiput (►Fig. 2A). In 20 to 45% of the cases, the GON pierces the trapezius muscle 1.5 to 3.5 cm (mean 2.4 cm) lateral and 0 to 3 cm (mean 1.2 cm) caudal to theinion.^{1,2} The semispinalis capitis muscle is almost always pierced by the GON (90 to 100%),^{1,2} 0.5 to 2.5 cm (mean 1.6 cm) lateral and 1 to 5 cm (mean 3.7 cm) caudal to theinion.²

Due to its proximity to the midline and the site where it pierces the semispinalis capitis muscle, the GON may be damaged iatrogenically at each step of wound manipulation during FMD. Upon dissection of the superior attachment of the trapezius muscle with retraction of the wound edge, the GON is stretched and/or directly transected where it pierces the muscle just beside the midline. In addition, the GON may be damaged by constriction after deep stitching and by mechanical pressure due to the retraction of insufficiently detached trapezius and semispinalis capitis muscles following a small skin incision (►Fig. 2C). Direct retraction of the site where the GON pierces the semispinalis capitis muscle ~4 cm caudal to theinion,² that is, the center of the wound cannot be ruled out as a cause of damage to the nerve (►Fig. 2D).

Our technique aims at relaxing the GON and the nuchal muscles containing the nerve during wound retraction. It is important that the scalp and nuchal muscles be dissected as a single layer in the cephalad part of the wound. This manipulation involves minimal opening of the wound in a lateral

direction before dissection of the nuchal muscles to avoid stretching the GON between the scalp and the point where it pierces the trapezius. In addition, gentle and wide subperiosteal detachment of the semispinalis capitis and trapezius muscles at the nuchal line in a caudal-to-cephalad direction is necessary. Although to date, we subjected only five patients to our new dissection technique, comparison with the results obtained in patients operated with the conventional method suggests that our method is safe and efficacious.

In conclusion, our anatomically rational dissection may reduce postoperative pain to levels manageable with mild analgesics in patients treated by FMD. It may also be applicable in patients undergoing midline suboccipital craniotomy for posterior fossa lesions. An understanding of the relationship between the GON and neighboring soft tissues is necessary for minimally invasive dissections.

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