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Laser-assisted microsurgical techniques for the treatment of cervical ossification of the posterior longitudinal ligament

Posterior longitudinal ligamanın servikal ossifikasyonunun tedavisinde lazer-yardımlı mikrocerrahi teknikleri

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Objectives: Ossification of the posterior longitudinal ligament (OPLL) is one of the common causes of cervical myelopathy in Asian countries. The purpose of this study was to evaluate the efficacy of CO_2 laser-assisted microsurgical corpectomy in the treatment of cervical OPLL.

Patients and methods: We retrospectively reviewed the medical records and radiologic images of 47 patients (36 males, 11 females; mean age 54.7 years; range 41 to 70 years) who underwent microsurgical corpectomy and fusion with the use of CO_2 laser for cervical OPLL. Control examinations were made after 1, 3, and 6 months and then, every six months postoperatively. Functional outcome following surgery was assessed according to the Nurick scale. The mean follow-up period was 22.7 months (range 16 to 44 months).

Results: All the patients demonstrated symptomatic improvement postoperatively. Thirty-three patients (70.2%) showed improvement of at least 1 Nurick grade at the final examination. None of the patients developed neurological deterioration. Two patients had cerebrospinal fluid leaks and one patient had transient hoarseness. Two patients underwent reoperation due to plate pullout accompanied by a screw fracture and progressive displacement of the graft, respectively. Forty-two patients (89.4%) showed successful fusion. Five patients were determined to have a stable fibrous union.

Conclusion: Removal of cervical OPLL using the anterior route is quite different from that of cervical spondylosis in many aspects. Laser-assisted microsurgical techniques enable safe removal of cervical OPLL using the anterior route.

Key words: Carbon dioxide; cervical vertebrae/surgery; lasers/therapeutic use; ossification of posterior longitudinal ligament/surgery; spinal fusion/methods; spine/surgery.

Amaç: Posterior longitudinal ligamanın servikal ossifikasyonu (PLLO) Asya ülkelerinde servikal miyelopatinin yaygın bir nedenidir. Bu çalışmada, CO_2 lazer yardımlı mikrocerrahi ile korpektominin servikal PLLO tedavisindeki etkinliği değerlendirildi.

Hastalar ve yöntemler: Servikal PLLO için CO_2 lazer kullanılarak mikrocerrahi ile korpektomi yapılan 47 hastanın (36 erkek, 11 kadın; ort. yaş 54.7; dağılım 41-70) hastane kayıtları ve radyolojik görüntüleri geriye dönük olarak değerlendirildi. Ameliyat sonrası kontrol incelemeleri 1, 3, ve 6. aylarda, daha sonra da altı aylık aralıklarla yapıldı. Cerrahi sonrası fonksiyonel sonuçlar Nurick derecelendirme sistemiyle değerlendirildi. Ortalama izlem süresi 22.7 ay (dağılım 16-44 ay) idi.

Bulgular: Tüm hastalarda ameliyattan sonra semptomatik iyileşme görüldü. Son kontrol muayenelerinde 33 hastada (%70.2) en az 1 Nurick derecesinde düzelme saptandı. Hiçbir hastada nörolojik kötüleşme gelişmedi. İki hastada beyin-omurilik sıvısı kaçağı; bir hastada geçici ses kısıklığı görüldü. İki hasta plak gevşemesi yüzünden yeniden ameliyat edildi; bunların birinde vida kırığı, birinde de greftte sürekli bir kayma vardı. Kırk iki hastada (%89.4) başarılı füzyon elde edildi. Beş hastada sonuç stabil fibröz kaynama şeklinde değerlendirildi.

Sonuç: Anterior yol ile servikal PLLO'nun temizlenmesi, servikal spondilosizin tedavisinden birçok açıdan farklılıklar gösterir. Lazer yardımlı mikrocerrahi ile, anterior yaklaşım kullanılarak servikal PLLO güvenli bir şekilde temizlenebilmektedir.

Anahtar sözcükler: Karbon dioksit; servikal vertebra/cerrahi;lazer/terapötik kullanım; posterior longitudinal ligaman ossifikasyonu/cerrahi; spinal füzyon/yöntem; omurilik/cerrahi.

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Ossification of the posterior longitudinal ligament (OPLL) is one of the common causes of cervical myelopathy in Asian countries.[1,2] As cervical OPLL frequently involves multiple levels[1] and has a tendency to adhere to the underlying dura matter, safe removal of cervical OPLL using the anterior approach is not easy. Besides, incomplete removal of cervical OPLL may be a cause of postoperative hematoma that may induce a catastrophic event as OPLL is rich in vascular network. Occasionally, the consistency of OPLL is softer than expected. Hence, thinning of OPLL using a high-speed drill is not always feasible. Through our ripe experience, we have become sensible of the use of CO_2 laser as an effective adjuvant for complete removal of OPLL.

This study was designed to evaluate the safety and effectiveness of our renewed surgical techniques in the treatment of cervical OPLL.

PATIENTS AND METHODS

Ninety patients suffering from cervical OPLL underwent surgery in our institute between January 2001 and May 2003. Microsurgical corpectomy and fusion with the aid of CO_2 laser was performed in 47 patients (36 males, 11 females; mean age 54.7 years; range 41 to 70 years), the remaining patients underwent discectomy and undercutting of segmental OPLL and were excluded. After corpectomies, all the patients underwent fusion using a fibular allograft and plates. Dynamic plates were used in 33 patients and semi-constrained plates in 14 patients. Control examinations were made after 1, 3, and 6 months and then, every six months postoperatively. Functional outcome following surgery was assessed according to the Nurick scale. The patients' medical records and radiologic images were retrospectively reviewed.

Surgical technique

The patient is placed supine. Prior to induction of general anesthesia, a safe range of cervical motion should be checked to avoid any cord injury during intubation. After induction of general anesthesia, two rolls are placed beneath the shoulders and neck, respectively, to maintain a slight neck extension. A right-sided approach is preferred for a right-handed surgeon except in cases of lower cervical levels below the C6 vertebra. After incision of the skin and platysma, extensive undermining of platysma is routinely performed to prevent excessive retraction. The prevertebral fascia is divided in the midline and retracted laterally. The medial portion of the longus colli muscle is cauterized using a bipolar coagulator and retracted laterally using the subperiosteal dissection technique. We always expose the medial portion of the uncovertebral joints bilaterally to ensure the midline. A lateral plain radiograph is obtained to verify the level of interest. Then, a self-retaining retractor with a blunt tip is applied. After partial discectomy using a blade and pituitary forceps, the operating microscope is brought in. The trenches are made bilaterally with the use of a high-speed drill with a cutting burr, and then a trough is made using a rongeur. At this point, we usually replace the cutting burr with a diamond burr, because it considerably causes less bleeding from the cancellous portion of vertebral bodies. It should be borne in mind that the central portion of OPLL must be removed first to avoid floating thereof. When an eggshell-like thinned cortical bone remains, the authors usually replace the diamond burr with the TURQ-L8 burr (Anspach Effort, Inc., Palm Beach Garden, FL, USA). It has a blunt tip and cuts along its side, helping us avoid excessive pressure while drilling. After some portion of the dura matter is exposed, the opening is enlarged using a microhook and a 1-mm Kerrison punch (Fig. 1). Sometimes, OPLL may be unexpectedly softer than the vertebral body and densely adhered to the underlying dura. In such circumstances, we make the cleavage plane first using the microhook and a microdissector. Then, a specially designed angled microdissector is placed under the OPLL to protect the spinal cord during the use of CO_2 laser (Fig. 2). Ossification of the posterior longitudinal ligament can be vaporized by a focused laser beam with a spot size of 0.46-0.85 mm. A 5 Watt pulser-single pulse mode laser is sufficient to vaporize a thinned OPLL or an osteophyte. A CO_2 laser system (Sharplan Laser Industries, Tel Aviv, Israel) attached to the operating microscope and a red He-Ne aiming beam enable us to perform this work with safe precision. Keeping the surgical field moistened during the use of CO_2 laser is important to minimize the risk of inadvertent injuries, as water can absorb the energy of CO_2 laser immediately.[3] After com-

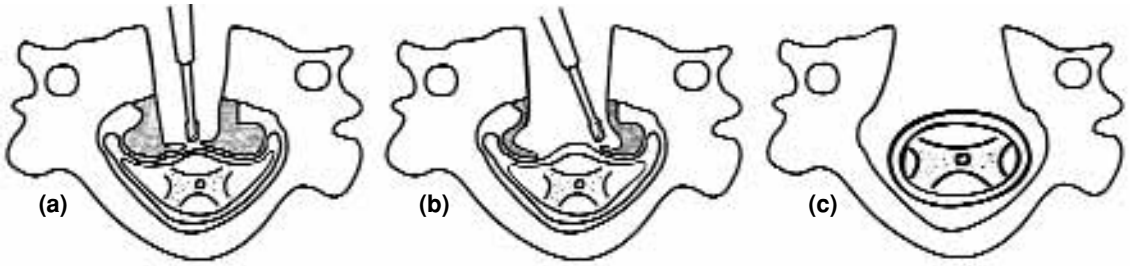

Fig. 1. (a) After a trough is made, the central portion of OPLL should be thinned first with a high-speed drill with the TURQ-L8 burr till some portion of the dura mater is exposed. **(b)** The opening is enlarged laterally using the burr, curette, and 1 mm-Kerrison punch. **(c)** After complete removal of OPLL, the trough is widened laterally till the lateral margin of the thecal sac is defined.

plete removal of the OPLL, we usually undercut the vertebral bodies using burrs and Kerrison punches till we define the lateral margin of the spinal cord (Fig. 1). Once decompression is complete, the authors usually use a high-speed drill to contour the flat surface to prepare the graft bed and to make a small posterior lip to prevent displacement of the graft (Fig. 3). With a gentle manual distraction, a fibular allograft is placed, and then, a lateral radiograph is obtained to confirm the position of the graft and the alignment of the spine. Properly contoured plates are fixed with screws.

The mean follow-up period was 22.7 months (range 16 to 44 months).

RESULTS

All the patients demonstrated symptomatic improvement postoperatively. Thirty-three patients (70.2%) showed improvement of at least one Nurick grade at the final examination. None of the patients developed neurological deterioration. There were two cases of cerebrospinal fluid leaks. One patient had transient hoarseness. Two patients underwent reoperation due to plate pullout accompanied by a screw fracture and progressive displacement of the graft, respectively. Forty-two patients (89.4%) showed successful fusion. Five patients were determined to have a stable fibrous union.

DISCUSSION

Ossification of the posterior longitudinal ligament has a tendency to adhere to the underlying dura

Fig. 2. An illustration showing the surgical technique for removal of densely adhered OPLL using CO_2 laser and angled microdissector located between OPLL and the dura mater.

Fig. 3. The technique for the preparation of the graft bed. The marginal osteophyte of the cephalad vertebra and some portion of the endplate are removed to flatten the surface for graft placement. A small posterior lip is made at the caudal vertebra with the high-speed drill. Black colored areas show portions to be removed.

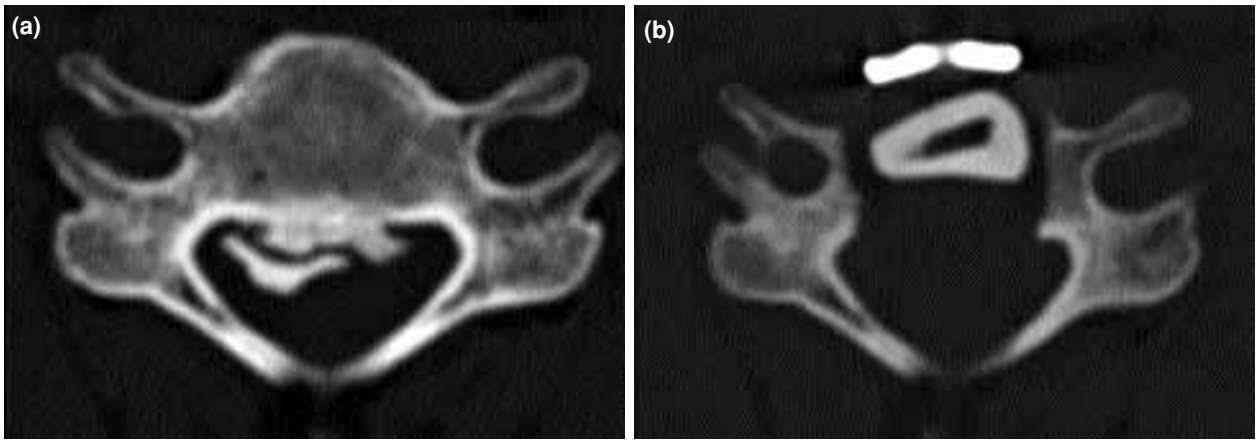

Fig. 4. A 54-year-old male patient who had walking difficulty underwent corpectomy and fusion using laser-assisted microsurgical techniques. **(a)** A preoperative axial CT image shows huge OPLL with the "double-layer sign". **(b)** A postoperative axial CT image demonstrates full decompression of the spinal canal.

matter. Besides, it may often be unexpectedly softer than the vertebral body itself. Excessive traction of adhered OPLL with a Kerrison punch may injure the spinal cord or cause a dural tear. In the presence of an adhered OPLL, the use of CO_2 laser is very helpful. As a CO2 laser at a power setting of 5 Watt is known to penetrate the outer table of the bone,[4] vaporization of an already thinned OPLL or small osteophytes can be sufficiently performed with irradiations of 5 Watt.

Despite the presence of experimental data concerning an adverse effect of CO_2 laser on bone regeneration and a reducing effect on epidural scar formation,[5] we do not have sufficient evidence supporting these observations. In contrast, we expect that the use of CO_2 laser for the treatment of cervical OPLL may have a positive aspect. Complete removal of cervical OPLL by corpectomy is a more demanding procedure in comparison with laminoplasty. However, microsurgical techniques and the use of CO_2 laser have made it possible to remove cervical OPLL more safely using the anterior approach. The authors could make a cleavage plane in most cases in which adhesions were observed intraoperatively between the OPLL and the dura matter. Although Gropper et al.[6] reported the feasibility of CO_2 laser-assisted anterior cervical discectomy in 1984, there have been few reports about the application of CO_2 laser in cervical spine surgery.[4] We have been using CO_2 laser as an effective adjuvant for the treatment of cervical OPLL since 1995. Laser-assisted microsurgical techniques proved feasible and uneventful even in patients with a huge OPLL presenting with the "double-layer sign", predictive of dural penetration by OPLL1 (Fig. 4).[7,8] We have not experienced any catastrophic event related to the use of CO_2 laser. The operating microscope and a high-speed drill with a diamond burr are indispensable for safe removal of cervical OPLL using the anterior approach. Our experience is that CO_2 laser should also be regarded as an integral tool for the treatment of cervical OPLL.

In conclusion, removal of cervical OPLL using the anterior route is quite different from that of cervical spondylosis in many aspects. Laser-assisted microsurgical techniques enable safe removal of cervical OPLL using the anterior route.

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