OPEN

PRS GLOBAL OPEN

IDEAS AND INNOVATIONS

Reconstructive

Restoration of Neck Extension after Severe Oncological Surgery of the Posterior Cervical Trunk

Jose M. Lasso, MD, PhD

Summary: Reconstruction of posterior cervical trunk defects secondary to tumor resection carries significant morbidity when vertebral hardware or the spinal cord is exposed, and neck extension is interrupted. Complete reconstruction includes the coverage and obliteration of dead spaces, but functional outcomes are necessary to prevent the head dropping. This report documents the first known technique, using a free latissimus dorsi neurovascular flap to provide neck extension after ablative oncological surgery affecting trapezium and paraspinal muscles of the neck. The author explains the method by using a branch of the accessory nerve as the donor nerve. While keeping the head in a neutral position, the tendinous part of the neurovascular flap was firmly attached to the occipital periosteum and to the cephalad remnants of the trapezius, splenius capitis, and semispinalis muscles. At the caudal portion of the defect, cardinal notches were used to set the muscle at rest, avoiding excessive fiber tension. The maximal length of the muscle at rest was measured before flap elevation, calculated via the anatomical 3D print model. The thoracodorsal nerve was stimulated until the muscle shortened its length to 50%. Head extension was tested several times via neurostimulation and electromyographic control. The described procedure may provide neck extension and circumvent the problem with donor nerve providing synergy to the desired function. *(Plast Reconstr Surg Glob Open 2021;9:e3567; doi: 10.1097/GOX.0000000000003567; Published online 13 May 2021.)*

INTRODUCTION

Reconstruction of posterior cervical trunk defects secondary to tumor resection carries significant morbidity when vertebral hardware or the spinal cord is exposed, there is cerebrospinal fluid leakage, or neck extension is interrupted. Complete reconstruction includes the coverage and obliteration of dead spaces; functional outcomes are necessary to prevent the head dropping. We performed a reconstructive functional surgery of the posterior neck in a 27-year-old patient who presented 9 years previously with recurrent synovial sarcoma of the paraspinal muscles.

Ablative surgery consisted of a wide resection that included bilateral segments of trapezium, semispinalis capitis, splenius capitis muscles, and hardware (Fig. 1) followed by intraoperative radiotherapy. Immediate reconstruction was performed using the right pedicled latissimus dorsi flap (LDF). External radiotherapy and chemotherapy completed the treatment. Intramedullary tumor recurrence occurred 2 years later and chemotherapy was required. A permanent support collar was needed to keep the neck straight because the patient was unable to raise the head while standing.

From the Department of Microsurgery, Plastic and Reconstructive Surgery, Hospital Gregorio Marañon, Universidad Complutense de Madrid, Madrid, Spain.

Received for publication August 26, 2020; accepted March 9, 2021.

DOI: 10.1097/GOX.0000000000003567

SURGICAL TECHNIQUE

We devised a novel technique using a latissimus dorsi neurovascular free flap (LDNVFF). The patient was placed in a decubitus lateralis position for operation in 2 fields. An initial incision was done at the midline, and the previous LDF flap was separated into 2 halves. Irregular parts of the spinous processes were rongeured. Remnants of the trapezium were identified.

The left transverse cervical artery and the superficial jugular vein were dissected for recipient vessels. On the left side, the rest of the accessory nerve was identified and tested via neurostimulation; sternocleidomastoid muscle motion was observed. This finding indicated

Disclosure: *The author has no financial interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

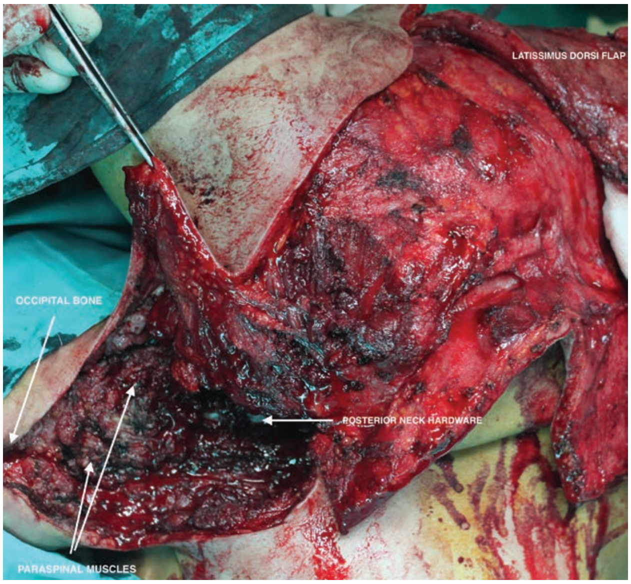

Fig. 1. Posterior neck defect after ablative surgery. LD flap is seen on top, before insetting. White arrows show muscles involved in neck extension and hardware.

that circumventing the problem of neck extension with a direct donor nerve providing synergy could obtain the desired function.

Precisely 18 cm of the proximal portion of LDNVFF was elevated, including the thoracodorsal nerve. A custom-designed skin paddle provided fatty tissue, which prevented hardware decubitus. A 3-dimensional (3D) print model of the neck bones was sterilized and used to simulate LDNVFF orientation and placement at rest (Fig. 2).

Recipient vessels were turned posteriorly for performing end-to-end microanastomoses. While keeping the head in a neutral position, the tendinous part of the flap was firmly attached to the occipital periosteum and the cephalad remnants of the trapezius, splenius capitis, and semispinalis muscles. At the caudal portion, cardinal notches were used to set the muscle at rest, avoiding excessive fiber tension. The maximal length of the muscle at rest was measured before flap elevation, taking into account the length of the surgical defect, and the length calculated via the anatomical 3D print model.

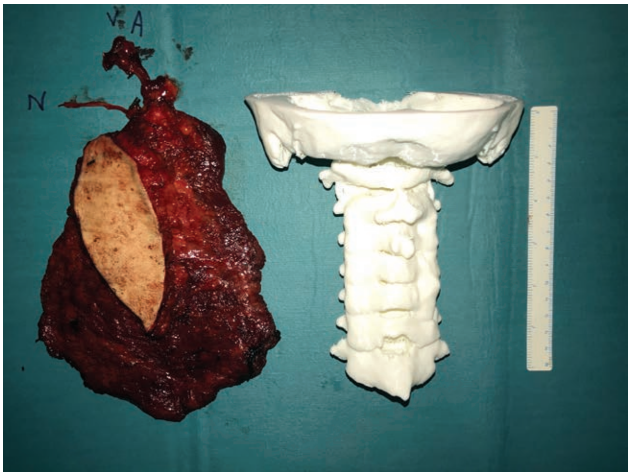

Fig. 2. Sterilized 3D model and LDNVF prior to reconstruction. The model was useful to orientate the flap adequately.

The thoracodorsal nerve was stimulated with 0.1–1 mA intensities (increased stepwise by increments of 0.1 mA), until the muscle shortened its length to 50%. Then mattress sutures were placed between the LDNVFF and the rest of the trapezium muscle, the previous LDF, and the remnants of the paraspinal muscles to decrease dead spaces and increase adhesion to the cervical area. Head extension was tested several times via neurostimulation.

Finally, the left lateral aspect of the muscle was detached to implement the neurorraphy (end-to-side sutures from the thoracodorsal nerve to accessory nerve; 2 fascicles were used, to respect sternocleidomastoid functionality) (Fig. 3). Then the lateral aspect was resutured and the excess distal flap was removed.

We declined using a collar during the first postoperative month to avoid injuries to the vascular pedicle and nerve. After this period, rehabilitation was started with passive movements of the head (flexo-extension) and electromyostimulation. Motion was notable after 4 months. The patient showed normal function 8 months after surgery. (**See Video [online],** which displays a MRI showing the posterior neck defect, followed by accessory nerve testing, free latissimus dorsi flap under electrostimulation, and postoperative flexo-extension of the neck.)

DISCUSSION

Posterior cervical wounds after oncological surgery are difficult to treat when accompanied by poorly vascularized tissue due to irradiated fields and the severe amputation of tissue. Devalupalli classified these defects into 2 types: cervical (16.3%) and cervicothoracic (10.7% of cases respectively). He recommended immediate reconstruction to help reduce complications.[1]

Reconstructive options have focused on muscle or myocutaneous flaps. Chun reported on using a vertical trapezius musculoskeletal flap.[2] In certain cases, LDF can be used when the trapezius has previously been used.[3] Other options include the extended vertical trapezius flap,[4] the bilobed fasciocutaneous flap,[5] cervical spine paraspinous muscle flap,[6] and free flap[7] methods.

Few et al presented their experience with microvascular reconstruction in the "hostile" back,[8] which is defined as containing >200 cm^2 defect, a previous history of irradiation, and multiple attempts at reconstruction, which also describes our patient. We did not find references for the functional outcomes of the hostile back other than the aggression of surgical amputations; these gaps in knowledge would benefit from the further development of our functional reconstruction methods.

The LDNVFF flap is a reliable option for performing functional reconstructions like facial motion,[9] limb flexion or extension,[10] cardiomyoplasty,[11] and bladder detrusion.[12]

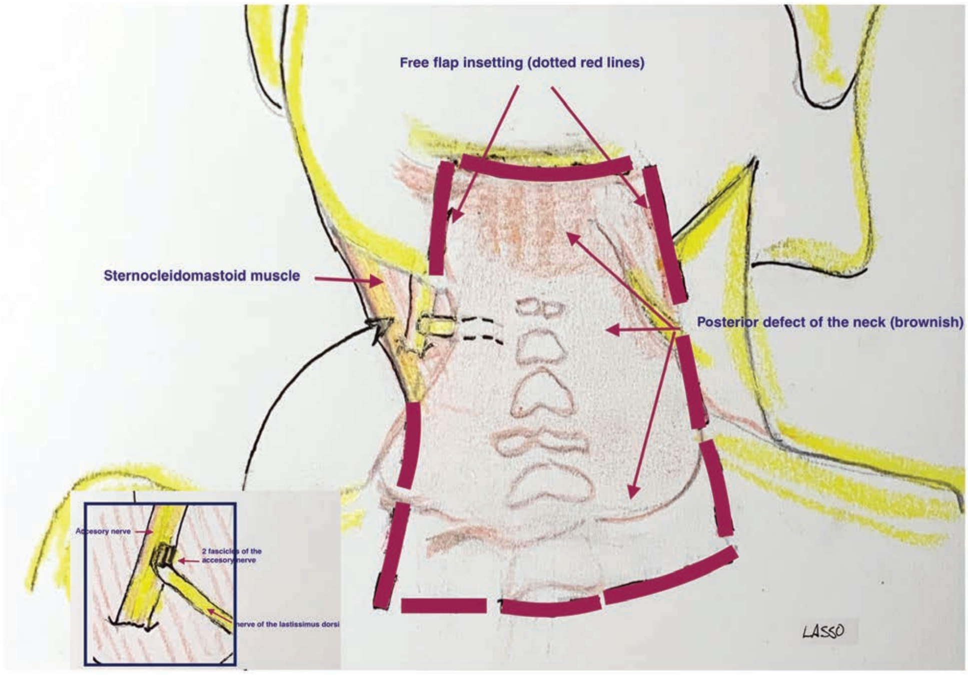

Fig. 3. Schematic representation of a posterior cervical defect: Red lines represent the setting of LDNVFF. The tendinous part of the muscle is anchored to the periosteum and muscle remnants of the occipital area. The distal part is attached to the rest of the trapezium muscle. End-to-side nerve anastomosis is represented in the augmented view.

It has an appropriate dynamic structure for meeting functional needs due to its sufficient cross-section and mass for exerting force and suitable fiber length for excursion.[13,14]

As neck extension requires a powerful muscle, we recommend using the proximal third of the muscle because it is stronger than the distal part. The distal flap can be poorly perfused and yields more complications such as dehiscense, seroma, and lesser excursion. However, appropriate muscle tension is of utmost importance for providing the desired extension and avoiding a vascularly compromised flap. Both sternocleidomastoid were left intact and cooperated to extend the head but it was insufficient to maintain it straight, resulting in dropping head. LDNVFF associated to these muscles improved functionality. Electromyostimulation was started early to avoid muscle atrophy and obtaining the desired functional outcome.

Donar nerve motor units are of utmost importance because even with excellent clinical outcomes, nerve regeneration and recovery within the muscle are incomplete.[15] The accessory nerve is an excellent supplier of motor fibers.[16]

CONCLUSION

The LDNVFF method is a reliable option for establishing neck extension after a severe oncological resection of the paraspinal muscles of the posterior neck.

Jose M. Lasso, MD, PhD
Hospital Gregorio Maranon
C/ Dr Esquerdo 46, Area3400. Plastic Surgery
Madrid 28007
Spain
E-mail address: jmlasso@ucm.es

REFERENCES

1. Devulapalli C, Broyles JM, Bello R, et al. Soft-tissue reconstruction of large spinal defects: a 12-year institutional experience. *Plast Reconstr Surg.* 2017;140:806–814.
2. Chun JK, Lynch MJ, Poultsides GA. Distal trapezius musculocutaneous flap for upper thoracic back wounds associated with spinal instrumentation and radiation. *Ann Plast Surg.* 2003;51:17–22.
3. Mathes DW, Thornton JF, Rohrich RJ. Management of posterior trunk defects. *Plast Reconstr Surg.* 2006;118:73e–83e.
4. Uğurlu K, Ozçelik D, Hüthüt I, et al. Extended vertical trapezius myocutaneous flap in head and neck reconstruction as a salvage procedure. *Plast Reconstr Surg.* 2004;114:339–350.
5. El Kathib HA. Bilobed fasciocutaneous flap for reconstruction of the posterior neck after necrotizing fasciitis. *Plast Reconstr Surg.* 2004; 114:885–889.
6. Mericli AF, Mirzabeigi MN, Moore JH Jr, et al. Reconstruction of complex posterior cervical spine wounds using the paraspinous muscle flap. *Plast Reconstr Surg.* 2011;128:148–153.
7. Yanko-Arzi R, Gur E, Margulis A, et al. The role of free tissue transfer in posterior neck reconstruction. *J Reconstr Microsurg.* 2014;30:305–312.
8. Few JW, Marcus JR, Lee MJ, et al. Treatment of hostile midline back wounds: an extreme approach. *Plast Reconstr Surg.* 2000;105:2448–2451.
9. Chuang DC. Free tissue transfer for the treatment of facial paralysis. *Facial Plast Surg.* 2008;24:194–203.
10. Stevanovic M, Sharpe F. Functional free muscle transfer for upper extremity reconstruction. *Plast Reconstr Surg.* 2014;134:257e–274e.
11. Barron DJ, Etherington PJ, Winlove CP, et al. Combination of preconditioning and delayed flap elevation: evidence for improved perfusion and oxygenation of the latissimus dorsi muscle for cardiomyoplasty. *Ann Thorac Surg.* 2001;71:852–861.

12. Stenzl A, Ninkovic M, Kölle D, et al. Restoration of voluntary emptying of the bladder by transplantation of innervated free skeletal muscle. *Lancet*. 1998;351:1483–1485.
13. Ninković M, Stenzl A, Hess M, et al. Functional urinary bladder wall substitute using a free innervated latissimus dorsi muscle flap. *Plast Reconstr Surg*. 1997;100:402–411.
14. Lieber RL, Friden J. Clinical significance of skeletal muscle architecture. *Clin Orthop Relat Res*. 2001;383:140–151.
15. Becker MH, Wermter TB, Brenner B, et al. Comparison of clinical performance, histology and single-fiber contractility in free neurovascular muscle flaps. *J Reconstr Microsurg*. 2000;16:525–534.
16. Svenberg Lind C, Lundberg B, Hammarstedt Nordenvall L, et al. Quantification of trapezius muscle innervation during neck dissections: cervical plexus versus the spinal accessory nerve. *Ann Otol Rhinol Laryngol*. 2015;124:881–885.