Reconstruction of Laryngotracheal War Injuries with the Median Layer of the Deep Cervical Fascia

D Danić
MD

D Miličić
MD

D Prgomet
MD

Dept of Otorhinolaryngology and Cervicofacial Surgery, General Hospital "Dr Josip Benčević" Slavonski Brod, Andrije Stampara 42, 55000 Slavonski Brod, Croatia.

S Simović
MD

Clinic of Otorhinolaryngology and Cervicofacial Surgery, Medical School Zagreb, Šalata 4, 41000 Zagreb, Croatia.

SUMMARY: Surgical exploration and immediate reconstruction with the median layer of the deep cervical fascia (MLDCF) was performed in 8 of 22 patients with exogenous war injuries of larynx and cervical trachea. A surgical technique of reconstruction with the median layer of the deep cervical fascia is described. The 7 surviving patients had good respiration without signs of stenosis of the larynx and/or the trachea. Four had good and 3 satisfactory phonation, and none had swallowing difficulties. Owing to the simplicity of the surgical approach, its size and biological properties, the median layer of deep cervical fascia proved itself to be a suitable material in the immediate reconstruction of exogenous war injuries of the larynx and cervical trachea.

Introduction

Despite the superficial position of the larynx and trachea, the incidence of injury by exogenous factors is very rare during both peace-time and war (1). There were 13 patients treated at our department for exogenous injury of the larynx and the trachea during the period 1975 to 1984, representing 0.94% of all hospitalized patients with head and neck injuries during that period (2).

Data on the incidence of combat related laryngotracheal injuries is rarely found in the literature. Zayton *et al*, recorded 54 such patients among 1,021 wounded with head and neck injuries during the ten-year Lebanon war (3). The data on the incidence of such injuries could vary greatly during the same war, for example in the II Mobile Surgical Hospital in South Vietnam, among 1,011 wounded there were only 6 tracheal and cricoid cartilage injuries in the year 1966 to 1967 (4). However, from 1967 to 1968, 22 laryngotracheal injuries were registered in the "24th evacuation hospital in Vietnam" (5).

A number of authors have offered differing principles of treatment for peace-time injuries. These differing views and opinions are with regard to all stages of care; from indications, time of initial surgical care through to definitive surgical management (6-10). The absence of thyroid cartilage or exposure of tracheal cartilage surfaces, which favours infection and diminished

functional results of reconstructive intervention, prompted many authors to use different covering materials, with varying success. Krajina has used fascia of the sternohyoid muscle in the reconstruction of the larynx lumen in various types of partial laryngectomy since 1969, with excellent results (11). In the war situation we made use of this technique, improving it and widening its indications. A flap formed from the median layer of the deep cervical fascia (MLDCF) being used in the immediate reconstruction of 8 cases of laryngotracheal trauma.

Patients and Methods

During the 1991/1992 war in Croatia (12, 13), 7,003 wounded were treated at the Medical Center in Slavonski Brod (the region of Brodska Posavina, East Croatia) from July 1 1991 to December 31 1992. Our department of Otorhinolaryngology and Cervicofacial Surgery treated 728 head and neck injuries, of whom 22 (0.31%) had laryngeal and cervical trachea injuries. Sixteen of them had an injury of the larynx, 4 of the larynx and trachea, 1 of the trachea and 1 of the recurrent laryngeal nerve (Table 1).

Splinters of shells, mines and hand grenades caused injuries in 18, rifle bullet in 2 and plastic explosive in 1. contusion was responsible for one other (Table 2).

All wounded were male, 20 were soldiers and 2 were civilians, their ages ranging from 5 to 43 years. We hospitalised 21 patients, the patient with the laryngeal contusion being treated as an outpatient. Twenty wounded were hospitalised within the first three hours of injury. The patient with laryngeal contusion was treated on the second day after being wounded. The patient with the explosive laryngeal injury was transferred from another medical institution on the fifth day of the injury.

Only 2 of the wounded had isolated injuries of the larynx or trachea while the others had associated injuries of the neck and head or the neck and/or other parts of the body.

Endoscopic techniques, classical X-ray and CT-scan were used for pre-operative diagnosis.

The largest number of wounds were transglottic (nine), supraglottic (eight), glottic (three) and cricoid (six). Tracheal lesions were located in the cartilaginous skeleton up to the fourth tracheal ring and one of the wounded had a posterior membranous wall injury.

Twenty-one wounded were surgically treated, the one with the larynx contusion being treated conservatively. Eight of the 21 surgical patients were managed with median layer of the deep cervical fascia.

Surgically treated patients were divided into four groups (Table 3):

Table 3
Surgical treatment of 21 patients with laryngotracheal war wounds.

Group	No.	Treatment
Group 1 Hematomas, small lesions of laryngeal mucosa or cartilage	4	Surgical treatment of the wound without the exploration of the larynx
Group 2 Large lesions of mucosa especially at frontal junction, small fractures of the cartilage	4	Exploration of the larynx, conservative debridement, primary suture of mucosa
Group 3 Large mucosal lesions, multiple fractures with defects of cartilage, preserved stability of cartilaginous skeleton	10	Exploration of the larynx, MLDCF* reconstruction in 7 patients
Group 4 Instability of the cartilaginous skeleton	3	Exploration of the larynx, MLDCF reconstruction in one patient, stent

* MLDCF – median layer of deep cervical fascia used for reconstruction of laryngotracheal war injuries.

- Four patients had hematomas, or small lesions of endolaryngeal mucosa, and injury to the perichondrium but without fracture of the larynx or tracheal cartilage. These were treated surgically without exploration of the larynx or the trachea.
- Four patients had minor lesions of the endolaryngeal mucosa, especially in the area of the anterior commissure and smaller linear fractures of thyroid or tracheal cartilage but without any large dislocation or defect. The lesions of perichondrium were not significant. These were treated by exploration, and conservative debridement. The continuity of the mucosa was secured primarily by absorbable stitches 4-0 or 5-0.
- Ten patients had large lesions of endolaryngeal mucosa with damage to vocal cords and/or ventricular folds, multiple fractures of thyroid and cricoid cartilages, with defects in perichondrium and cartilage but with a preserved stability of cricothyroid ring. Seven patients were managed with use of the median layer of the deep cervical fascia. In 5 a reconstruction of the laryngeal lumen was performed by use of this tissue. The sixth patient also had a partial defect of the first two tracheal rings so that the median layer of the deep cervical fascia was used for the reconstruction of the lumen of both the larynx and the trachea. The seventh patient, in addition to damage to the cricoid and first tracheal ring, also had a penetrating wound of the oesophagus and seventh cervical vertebra. In the reconstruction of the cricoid and trachea a strap muscle flap, according to Miller-Duplechain (7), was used beside the median layer of the deep cervical fascia for the prevention of tracheoesophageal fistula.
- Three patients had massive lesions of the endolaryngeal structures, comminuted fractures and large defects of

Table 1
War wounds of the head and neck treated in the General Hospital "Dr Josip Benčević" Slavonski Brod from July 1 1991 to December 31 1992.

	No. (%) of patients/treatment		
	Outpatient	Hospitalized	Total
Head	187 (67)	354 (78)	541 (74)
Neck	60 (21)	57 (14)	117 (16)
Head and neck	32 (12)	38 (8)	70 (10)
Total	279 (38)	449 (62)	728 (100)

Table 2
The localization and etiology of war wounds of the larynx and trachea in 22 patients in General Hospital "Dr Josip Benčević" Slavonski Brod from July 1 1991 to December 31 1992.

Localization	(No.)	Etiology	(No.)
Larynx	16	Shells	18
Trachea	1	Bullets	2
Larynx and trachea	4	Plastic explosive	1
Recurrent nerve	1	Contusion	1

The shape and base of the flap, and whether it could or could not be used, was determined by the location, size, and shape of the laryngeal and tracheal wounds as well as the status of median layer of the deep cervical fascia vascularity. The flap was always approached from the sternohyoid muscle on the unharmed side of the neck with particular care to preserve its vascularization. Regardless of whether the base of the flap was cranial or lateral, it was always possible to explore the vital structures on both sides of the neck without damaging the vascularization of the flap. Due to its biological characteristics and length, the fascia also proved to be suitable for reconstruction of the first four tracheal rings, i.e. to the upper border of the formed tracheostomy.

The median layer of the deep cervical fascia proved to be useful for covering the denuded cartilaginous surfaces of the larynx and the trachea, for the formation of the lumen of the larynx and the trachea in immediate reconstruction when larger parts of cartilage skeleton were absent, and for the fixation of thyroid, cricoid or tracheal cartilage in the lesion which caused instability of laryngotracheal framework. In the latter case, a stent was placed endolaryngeally or endotracheally and the cartilage framework was fixed endo- and exolaryngeally.

The outcome of the treatment of laryngo-tracheal injuries, particularly with respect to the restoration of respiratory and phonatory functions, depended upon the following factors:

a) *Early surgical exploration and immediate reconstruction.*

In cases where the material for the reconstructive procedures on the larynx and the trachea is insufficient, we think the median layer of the deep cervical fascia should be used.

b) *The age of the wounded.*

In younger age groups cartilage framework is more elastic and less vulnerable and the wounds heal more easily.

c) *The nature of the wound.*

The majority of splinters from explosive devices are blunt or asymmetrically shaped and are made of steel or of a low-density material. Because of this, they quickly lose their speed in the air, do not penetrate tissues very deeply and their trace conforms to their size, remaining unchanged along the path.

Conclusion

In the treatment of exogenous laryngotracheal war injuries there is no standard surgical technique. Surgeons must be familiar with different techniques as every reconstruction of injured larynx must be approached individually. Surgical treatment of these injuries must be done during first 24 hours after the injury and the first treatment must be the definitive one. In cases in which there is not enough material for immediate reconstruction we recommend the use of median layer of the deep cervical fascia.

Acknowledgements

We thank Mr Rene Lui for translation of the paper and Drs Ana and Matko Marusic for critical review of the manuscript.

REFERENCES

1. BENT III JP, SILVER JR, PORUBSKY ES. Acute laryngeal trauma: A review of 77 patients. *Otolaryngol Head Neck Surg* 1993; **109**: 441-49.
2. MARINKOVIĆ M, DANIĆ D, FILOŠEVIĆ-HAVOIC M. Ucesce egzogenih mehanickih povreda larinksa i traheja u ORL traumatizmu. *Med Vjesn* 1986; **18**: 197-200.
3. ZAYTOUN GM, SHIKHANI AH, SALMAN SD. Head and neck injuries: 10-year experience at the American University of Beirut Medical Center. *Laryngoscope* 1986; **96**: 899-903.
4. JONES EL, PETERS AF, GASIOR RM. Early management of battle casualties in Vietnam. *Arch Surg* 1986; **97**: 1-15.
5. LEMAY SR. Penetrating wounds of larynx and cervical trachea. *Arch Otolaryngol* 1971; **94**: 558-65.
6. LEOPOLD DA. Laryngeal trauma. A historical comparison of treatment methods. *Arch Otolaryngol* 1983; **109**: 106-11.
7. MILLER RH, DUPLECHAIN JK. Penetrating wounds of the neck. *Otolaryngol Clin North Am* 1991; **24**: 29.
8. SCHAEFER SD. Acute surgical treatment of the fractured larynx. *Oper Tech Otolaryngol Head Neck Surg* 1990; **1**: 64-70.
9. SCHAEFER SD. The treatment of acute external laryngeal injuries. *Arch Otolaryngol Head Neck Surg* 1991; **117**: 35-9.
10. MAISEL RH. Penetrating trauma to the neck. In: Cummings CW, editor. *Otolaryngology-Head and Neck Surgery*. St Louis - Philadelphia - Toronto: Mosby Year Book, 1993: 1579-89.
11. KRAJINA Z. Horizontalna parcijalna laringektomija. *Symph Otorhinol Yug* 1973; **(1-2)**: 20-2.
12. LACKOVIĆ Z, MARKELJEVIĆ J, MARUŠIĆ M. Croatian medicine in 1991 war against Croatia: A preliminary report. *Croatian Med J (War Suppl.2)* 1992; **33**: 110-19.
13. MARUŠIĆ M. Do angels cry? *JAMA* 1993; **270**(5): 548.
14. VODOPIJA I, FRANCETIĆ I, TONKOVIĆ I, KALENIĆ S, LUETIĆ V. Zaštita od infekcije nakon ranjavanja. *Liječ Vjesn* 1991; **113**(7-8): 288-89.
15. Bennett T. Laryngeal trauma *Laryngoscope* 1960; **70**: 973-82.