The role of “smart-flap” of sternocleidomastoid muscle in cervical spine surgery: A proposal of a new surgical technique

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Introduction

The sternocleidomastoid flap is a pedicled flap that was first described by Jianu et al. in 1909 [1]. Since then, it has been used in various surgical fields: Reconstruction procedure after oncological surgery of head and neck (mandible, floor of the mouth, oropharynx) [2], prevention or treatment of Frey Syndrome after parotidectomy [3], revision procedures in anterior cervical spine surgery [4].

As described in literature, the SCM flap in cervical spine surgery can be harvested either partial or complete. The use of a partial and split SCM flap was firstly described by Alvarez in 1983 [5].

The principal implications of this flap in anterior cervical spine surgery are esophageal perforations [6] and dural tears [7]. The muscle tissue has the objective of reinforcement and/or repairing these points of weakness. Furthermore it is suitable also in selected cases of cervical spondylodiscitis to support the healing process: the high blood supply of the muscle is supposed to deliver more antibiotics selectively at the infectious site [8].

The risk of esophageal perforation is relatively low, with a medium rate of 2% [6], although the incidence of this complication could be underestimated because of the delayed clinical presentation and diagnosis [9]. This clinical event represents a life-threatening complication with high mortality rates (between 16% and 50%) [10].

Esophageal perforations can be classified in traumatic and iatrogenic. The latter one can be subdivided depending on the timing of presentation: intraoperative, early and delayed. In literature the difference between early and delayed is proposed with a cut-off ranging from 7 days [10] to 30 days after surgery [4].

The most common etiology of esophageal perforation after cervical spine surgery is represented by “hardware failure” (41%), followed by chronic erosion by hardware (31%), intraoperative injury such as retraction and operative tools (19%) and graft extrusion and penetration (7%) [4].

The clinical presentation may vary, depending on different factors: Etiology, location of the perforation and timing of presentation. It can range from asymptomatic cases to dysphagia, neck pain, neck swelling and abscesses, subcutaneous emphy-
Incidental dural tear during anterior cervical spine surgery is reported around 6% [19]. The reported risk factors in literature are age, smoking, pre-existing conditions (ossification of the posterior longitudinal ligament or ligamentum flavum, neurofibromatosis type 1, Marfan's disease, intradural disk degenerative spondylolisthesis, synovial cyst, dural ectasia in the case of large defects (more than 1 cm) the use of the whole muscle flap is preferred, while the use of muscle pedicle flap is suggested, in case of small defects (less than 1 cm) a split flap is indicated [5,8].

Dural tears that are not properly sealed, or those that are not recognized lead to recurrent CSF leakage that induces headache, nausea and vomiting. The subsequent possible complications are wound infections, meningitis, myelocutaneous fistula and pseudomeningocele [20].

In case of small defects (less than 1 cm) a split flap is indicated [5,8]. The vascular supply of the SCM muscle has been extensively described in previous studies [7,18,24]. The muscle receives its supply from three main branches (Image 1). The upper third of the muscle is constantly supplied by branches of the occipital artery, the middle third, whereas the supply from branches of the cervical artery. The inferior third is supplied by a branch of the thyrocervical trunk (supracaudal artery mostly).

The surgical technique [25] was conceived as less invasive as possible in order to decrease the morbidity of the donor site and to prevent aesthetic damage as well as the so-called "bulky" flap. Even if primary direct repair by a water-thigh suture is the preferred method of choice, dural tears in anterior cervical spine surgery are generally difficult to access due to the limited exposure. Many methods of durotomy coverage are described, such as application of tissue sealants, collagen matrix sponge, blood patches and tissue grafting [21]. The use of muscle flap to repair dural defect is a well-known technique. It was firstly employed in lumbar surgery as an alternative to sural nerve grafting [22]. The vascular supply of the SCM muscle is constant, both branches of the thyrocervical trunk [7] and a branch of the costocervical trunk, whereas the superior thyroid artery, whereas the inferior third is supplied by branches of the inferior thyroid artery. The middle third receives its supply from branches of the occipital artery. The inferior third is supplied by a branch of the thyrocervical trunk (supracaudal artery mostly).

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The procedure is designed to be performed with an enlarged antero-medial incision following the anterior border of the SCM muscle and by platysma muscle split along the line of its fibers. Depending on the distal extension of the incision the omohyoid muscle can be spared or cut. Once that the orthopedic procedure is over, the area to be covered must be measured and reported on the proximal or distal insertion of the SCM muscle (Figure 2).

The procedure will be described considering to be performed on the sternal portion: The muscle is split longitudinally to respect the fibers extending proximally as much as needed to cover the whole surface, but not exceeding the two thirds of the muscle belly in length [5].

The distal end (sternal portion) is cut at the junction with the manubrium and transposed or rotated of 180° to cover the defect (Figure 3).

Once in place the proximal part is secured through a sliding notch to the proximal part of the plate and the caudal part is secured directly to the bony surface through a surgical anchor (whether absorbable or not) that has to be placed 1 or 2 cm below the disc level (Figure 4).

A second sliding notch allows the flap to adhere completely to the plate without excessive tension on the flap itself.

The edges of the flap are then sutured on the surrounding muscles below the deep vertebral fascia to guarantee the maximal adherence to the plate without excessive tension on the flap. The incision is then closed by layer. The use of a surgical drain is suggested to prevent hematoma formation.

Case presentation

Case 1: Man, 85 years old, chronic renal failure secondary to nephroangiosclerosis and arterial hypertension. He was admitted to the Department of Orthopedics after a car crash. The CT scan at the admission revealed multiple fractures: ribs, left ileo and ischiopubic rami and C6-C7 (B3 according to AO classification) (Figure 5). The patient underwent a cervical spine MRI (Figure 6) that confirmed the diagnosis without any sign of medullary trauma.

Once hemodynamically stable the patient was submitted to anterior cervical spine surgery: anterior C6-C7 arthrodesis with plate and screws (Figure 7).

After 3 days of normal course the patient started to complain dysphagia and fever. A chest x-ray turned out to be negative. An emergency CT-scan with barium meal showed positive blush of contrast in the neck and subcutaneous bubbles of air suggestive for esophageal perforation. Together with the ENT surgeons the patient underwent a second procedure: Surgical toilette and closure of fistula reinforced by a smart SCM muscle flap. In 14th post-operative day the nasogastric tube was removed and the patient gradually went back to his normal eating habits. The patient was discharged in 20th post-operative day. At 3 months follow up he didn’t present any new complain and the implant maintains its stability without evidences of new esophageal fistula formation.
Figure 8: 

Case 2: Woman, 67 years old. She underwent right cervicotomy to remove a Schwannoma of the parapharyngeal space. After 45 days she complained worsening asthenia, dysphagia, bronchitis, lower limbs paraparesis and neurogenic bladder. She was admitted in another Hospital and treated as myasthenia gravis without any improvement. In the meantime, the clinical picture progressed to a complete tetraplegia. They performed an MRI (Figure 8) that showed a wide paravertebral and spinal abcess with medulla compression and signs of myelopathy.

At this point the patient came to our attention. We performed somatectomy of C6 and C7, anterior cervical arthrodesis C5-T1 with carbon fiber cage and plating and we covered it with a SCM smart flap. Posteriorly the procedure consisted in posterior arthrodesis C4-C5 to T1-T2. The neurologic condition improved immediately after the surgery. The intraoperative biopsies allowed the isolation of Streptococcus Oralis and Actinomyces Odontolyticus. After appropriate antibiotic therapy the patient was discharged with partial recovery of strength and sensibility to upper and lower limbs.

Discussion and results

The SCM smart flap is a novel surgical technique to perform a split SCM muscle flap. The technique has been designed as easy as possible in order to be performed without a member of the ENT department. One of the advantages of this procedure is represented by the limited extension of the flap resulting in a lower morbidity to the donor site associated with a decreased operative time. This decreases the complications described with the use of the standard SCM muscle flap: functional loss, myonecrosis, bulky flap and cosmetic alterations.

This flap has different applications: We already described its use in cases of dural tears as well as in oesophageal fistula. It could be used also in selected cases to prevent delayed oesophageal fistula. In literature the chronic friction between the posterior wall of the oesophagus and platting system with formation of adhesions and traction-type diverticulum is described as the most common etiology in delayed perforations [26,27]. Considering the level of implant, the most vulnerable pharyngo-oesophageal site is the Killian triangle, formed by the inferior constrictor pharyngeal and the cricopharyngeal muscles. In this region, corresponding to C5/C6, the posterior oesophageal mucosa is unprotected by muscularis and is separated from the retroesophageal space only by the buccopharyngeal fascia [16]. Patient related risk factors can be considered old age, alcohol abuse, long term intubation, malnutrition and smoking. Implant related factors seem to be associated with implant profile: A lower implant decreases friction on the surrounding tissues [4]. Another independent intraoperative factor that has to be considered is the direct ischemic effect of excessive pressure exerted on the soft tissues by the retractors. Moreover, the tissue could be already damaged by an underlying pathological process (for example spondilodiscitis).

The surgeon should be aware that the most common timing of presentation for a delayed oesophageal fistula is reported to be approximately two years whereas normal follow up for surgical uncomplicated patients is approximately one year. This could lead other physicians to difficult diagnosis in consideration of the more subtle and progressive symptoms that generally characterise the delayed lesions.

Furthermore, in literature removal of implants during these type of revisions is strongly suggested [10].

The esophageal tears in the delayed presentation appear to be bigger and with irregular edges which lead to a more difficult and invasive procedure [4].

Considering all these factors we suggest to prevent these complications performing the “smart” SCM flap directly during primary procedures in selected cases.

Conclusions

In conclusion, the “smart” SCM flap can be considered a good option in different applications: repair or prevention of oesophageal fistula, optional treatment in dural tears after anterior cervical spine surgery, additional mode of antibiotics vehicle in cases of spondilodiscitis. The ease of use of this surgical technique allows to perform it in primary procedures without the need of ENT specialist. The use of “smart” SCM flap as a prophylactic measure still needs time to evaluate its efficacy. Further studies are needed.

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References


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