NAL Neck Artificial Ligament Lifting: Neck Rejuvenation with Polytetrafuotoethylene (PTFE) Bands

[1,*]Alessandro Gennai, [2]Mattia Colli and [2]Andrè Salval

[1]Private Practice Via Delle Lame 98, Bologna, Italy and [2]Private Practice Via Podgora 7, Milan, Italy

Abstract: ***Background:*** The current surgical method allows a short recovery and minimally invasive technique with polytetrafluotoethylene (PTFE) bands application, minimal skin excision for a fallen platysma muscle and skin laxity in face-lift surgery; the clinical advantage of this method is a short recovery and an anatomic less invasive dissection, ideal for also younger patients who want more and more short healing times. ***Methods:*** Retrospective analysis of a 294 cases series of patients seeking platysma and skin laxity increase of neck-face region were included in the study. All of them were primary neck-face lift performed with PTFE bands of dual mesh that are customized for suture to the platysma and anchored to the mastoid, creating a neck artificial ligament (NAL) that is buried into the muscle and tightened, without modifying the superficial musculoaponeurotic system and platysma. ***Result:*** Data collection on surgery time, implant dimension selection, and postoperative complications were included. The most frequent complications were rare and include 5 case of superficial epidermolysis (healed within 21 days) and 1 case of mild band infection (treated with antibiotics). The surgical results are still stable over time, like those of a normal facelift after 6 months. ***Conclusion:*** minimally invasive NAL application avoids a large dissection and deep modifications of the superficial musculoaponeurotic system and platysma getting a strong upward tension that lasts over time with stable results.

Keywords: Cervicoplasty, Neck, Rejuvenation, Aging, Mandible, Platysma Muscle.

INTRODUCTION

Face-lift performing and lasting results over time with immediate healing is a major growing trend within aesthetic procedures. Patient needs a speed and short recovery, therefore we need less invasive procedures to guarantee results, even the youngest patients, increasingly attentive to small details and fierce in the fight against the time. These procedures recently have the highest growth rate among all cosmetic surgery procedures in Europe. Middle age patient (40-50 years old) with a thin face, lean skin and poor projection and young patients (32-40 years old) undergoing weight loss diets have no choice but undergo face-lift surgery since conspicuous donor areas are need for fat grafting or numerous volumetric injection of hyaluronic acid. Facial aging involves both the central area of the face and the neck. In the central area of the face, the aging process determines the descent and deflation of the soft tissue and aging of the skin [1-12].

Several conditions defines loss of aesthetic contour such as skin and platysma laxity, platysma bands, ptosis of salivary glands, mandibular and chin bone absorption. Mild fall of platysma muscle tone and of the skin atop in the cause of lack of definition of cervicomental angle, presence of platysma bands in the midline and lack of definition of the jaw edges. Techniques that claim to be minimally invasive are often focused on a skin stretching without any manipulation of platysma such as direct skin excision, “Z incision” with Z plasty closure, multi-Z incision, and wave plastyma technique with wave-like incisions [12-17].

Suspension techniques and liposuction are among the remaining solution for neck rejuvenation but they offers limited improvements because of the lack of resolution of skin excess and associated laxity in cervical region and unresolved problems related to deeper structures [18-19].

*Address correspondence to this author at the Private Practice Via Delle Lame 98, Bologna, Italy; Email: agennai@mac.com

Limited result may occur when applying suspension techniques and those have been criticized for such reason: a permanent hammock like suspension sutures to be anchored as a loop behind the ears is one of them for instance [20].

Non surgical face and neck rejuvenation is an option among others. Suture suspensions [21-23], can be used as a temporary procedure, until the aging appearance requires a more radical approach. Noninvasive skin lifting and tightening technique such as microfocused ultrasound system with visualization (MFU- V) and botulinum toxin infiltration24,25,26,27 has been proposed for patients rejecting surgery. These solutions claims to have the advantages of a faster execution and a short recovery time with a low rate of associated complications.

Surgical techniques that can achieve an effective platysma muscle tightening are, among others, the repositioning of the platysma muscle through a wide platysma flap dissection [28-32] and manipulating the subplatysmal structures (lipectomy, digastric muscle resection, submandibular glands resection, plication of the cervical fascia: those have the advantage of a more long lasting result while they are bothered with a longer recovery times and a reported complication rates maybe higher than non invasive techniques (hematoma, seroma, cervical nerve neuropraxis, and recurrent platysma bands) [33-42].

ePTFE (expanded polytetrafluoroethylene) dual-mesh band (Gore-Tex; W. L. Gore, Flagstaff, Ariz, USA) is an alloplastic material that is widely used in surgery, both general and plastic. First user of such material in aesthetic neck surgery was in 1993 by Conrad *et al.* [43-45] and has since been reported also by others authors.

The mid-face skin can be uplifted to expose the “platysma” through the mandibular border tunnel. Cadaveric dissection anatomy of the region is shown in Figure **1**.

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The current technique is accurate and minimally invasive, addressing both skin redundancy and platysma laxity with the help of ePTFE dual-mesh bands thus granting a stable and long lasting result. The neck artificial ligament (NAL) technique provides a tightening of the vector forces near the midline11 with a minimal skin removal. The bands are sutured onto the platysma muscle and fixed in the mastoid periosteum, creating a sort of “artificial ligament” which maintains the muscles secured in the new position. These artificial ligaments are hidden in the platysma muscle by reabsorbable running suture. Outcomes are stable over time, recovery is very fast and patient satisfaction is high. After many years from the permanent NAL implant, it can be pulled even more with a very small dissection of soft tissue around posterior ear scar if the patient wants a refresh the anatomic area. The NAL allows to control the fall of platysma and neck skin laxity over the lifetime of the patient.

MATERIAL AND METHODS

We present a retrospective observational study of implant-based NAL procedure performed in private clinical practice between January 2013 and May 2021: a total of 294 consecutive patients, 282 female and 12 male (96% female and 4% male), with soft, moderate and severe platysma muscle and skin laxity were treated according to the Facial Laxity Rating (FLR) Scale [18]. Patients with ptosis of the submandibular glands were excluded.

Informed consent was obtained prior surgery. Patients were 82 females and 18 males, from 30 to 69 years. The study followed the ethical guidelines of the 1975 Declaration of Helsinki, and all patients signed informed consent prior to surgery, for their inclusion in the study and for the use of their images. Patients with ptosis of the submandibular glands were assessed as poor candidates and thus did not undergo surgery. Preoperative indications included patients with soft, moderate and severe platysma flaccidity and skin laxity. Patients were photographed according to indications by the FLR Scale with a single lateral photograph that fully displays the neck profile of the patient, without obstructions; the front of the face is positioned with the mentum and forehead vertically aligned in an anatomically relaxed position.

Patient with a good skin, no face flaccidity, good platisma tone, no ptosis were assessed as poor candidates and thus did not undergo surgery. All patients received 0.7mm x 10cm ePTFE dual-mesh bands. Implant selection was made by carefully palpating skin thickness, volume and tension at the the jowl and neck area midpoint area; the first two are essential to understanding what will be the platysma neck artificial ligament (NAL) coverage.

Table 1: Patient demographics (294 patients).

Patient Demographics	All patient n= 294
Age (years)	
30-39	7
40-49	94
50-59	142
60-69	51
Sex	
Female	282
Male	12
Smokers	
Smokers	113
Non smokers	181

Table 2: Platisma Laxity.

FLR scale	Class	Facial compartments (distinctive signs)			
		Upper face (eyelid fold)	Middle face (nasojugal fold)	Lower face (jowls)	Neck (neck angle)
No Laxity	0	Absent	Absent	Absent	Acute Angle
Mild Laxity	1	Perceivable	Perceivable	Perceivable forward, absent downward	Acute semi-straight angle
	2	Well defined	Perceived as an indentation	Defined forward, absent downward	Straight angle
	3	Partially folding	One quarter into checkbone	Defined forward, perceivable downward	Straight angle interrupted by convexity + submental sagging
Moderate Laxity	4	Folding	One half into checkbone	Defined forward and downward	Straight angle interrupted by convexity + submental sagging
	5	Well-defined cyclid fold, still separated from cyclid border	Three quarters across checkbone	Protruding forward, defined downward	Submental sagging + 45^{o} interruption of neck angle
	6	Partially on eyelid border	Crosses checkbone	Protruding forward and downward	Multiple areas of submental sagging

Severe Laxity	7	Completely on eyelid border	Divided	Protruding forward, sagging downward	Complete submental sagging, concave angle
	8	Pushing eyelid border downwards	Flattened	Sagging forward and downward	Complete submental sagging, 45^{o} straight angle
	9	Interfering with pupil	Pulling down lower eyelid	Sagging forward, mixed downward with the neck	Complete submental sagging, convex angle

FLR scale was used to assess neck laxity aged related from 0 (no laxity) through to 9 (severe laxity) by the senior surgeons from both pre- and post-operative photographs. As the FLR scale evaluates four distinctive regions of the face and neck, for assessment purposes, we only considered the lower face and neck[46,47,48,49]. The ePTFE is a polymeric material, possessing a high grade of biocompatibility: ePTFE is nonallergenic or carcinogenic[18]. Its surface is arranged to form numerous pores (10– 30 μm in diameter) to allow for tissue growth and cell colonization. It can be modeled into numerous shapes and designs, from sutures to sheets[50,51,52].

With the patient seated in an upright position, implant selection is made by carefully palpating skin thickness and tension at the jowl and neck area; is essential to understanding subcutaneous volume for ePTFE coverage. The implant location head is outlined at the ideal point of maximum platysma laxity. Another point of reference is the mastoid tuberosity bone; this point is essential because it allows understanding where ePTFE superior limit will be fixed.

A line of the incision is drawn in the preauricular crease, which circles the earlobe, and goes upward in the retroauricular crease to the level of the tragus and then moves downward in the hairline for 4 cm. A second line marks the mandibular border. A third line is traced to identify the area of skin undermining. As the undermining skin is limited in front of the ear and is wide in the neck, the line should reach the lateral platysma band. Prophylactic antibiotic therapy with third-generation cephalosporin was administered 20 minutes before skin incision (cefazoline 2 g i.v.). Surgery time ranged from 120 minutes to 160 minutes (median 135 min minutes), confirming that this technique is among the fastest surgical procedures in neck & face lift. The surgery can be performed both with general anesthesia (GA) or office-based deep sedation (DS). The patient position is supin over the operating table with slightly raised back. Prior to skin incision, infiltrations of lidocaine (0.8%) and epinephrine are performed: by needle along the incision lines (20 ml per side) with epinephrine 1:100,000 and by a 2-mm-diameter multi-holes cannula with epinephrine 1:400,000 in the areas of skin undermining (150 ml per side). For the epinephrine to achieve the maximum vasoconstriction effect, it is mandatory to wait for 15 min before starting the dissection. This procedure is of paramount importance for the upcoming surgery. To reach the right plane of infiltration, the cannula get down under the skin then turn horizontally and move above to the platysma muscle to deliver the vasoconstrictive solution. After scrubbing the skin (chlorhexidine and alohol solution is preferred) and draping, a sterile gauze is tapered over the origin of the hair to isolate it.

Skin incision is made with a 15-scalpel blade, and then opening continues bluntly in the subcutaneous tissue with the scissors to reach the right infiltrate plane: is very important not see the scissor white color through the skin because this could be a sign of skin perforation. At the same time is very important to not cross deep to the platysma superficial fascia. The subcutaneous dissection is performed and limited to the preauricular area (4 cm in front of the tragus) and towards the platysma band according to the preoperative markings. The biomaterial is supplied sterile. Sharp instruments are used to trim the bands into the appropriate lengths, depending upon the depth of the dissection towards the platysma band (5–7 cm) and a standard width of 0.5 cm. The bands have two distinct surfaces identification. The textured surface should be placed face to tissues where tissue ingrowth is desired (in this case the platysma muscle). The other, smoother surface should be placed face to tissues where minimal tissue attachment is desired (in this case the subcutaneous tissue of the undermined skin). After the subcutaneous dissection, in the most medial area close to the platysma band, the platysma fascia is exposed (1.5×1.5 cm), permitting the fixation of the ePTFE head band to closest point the platysma with PFTE suture. Bleeding is carefully controlled. Once the head has been fixed with permanent suture (PTFE stitches), the tightness is checked by tensioning ePTFE band. Two or three starting Vycril suture points is placed behind the ePTFE head to bury the artificial ligament in the subcutaneous tissue and platysmaf muscle. in this phase it's very important the ePTFE can flow inside subcutaneous tunnel once buried; in this way the neck artificial ligament (NAL) will be created and can pulls plastysma upwards. An assistant surgeon then pulls the band towards the mastoid, thereby placing it under a great tension. The tension applied to the NAL depends on grade of laxity of the platysma muscle: for soft and moderate platysma laxity, band is retracted 1.0–1.5 cm with respect to a relaxed position; for several plastysma laxity, band is retracted 2.5 -3.0 cm with respect to a relaxed position. Another set of four PTFE stitches is placed in the mastoid area, anchoring the proximal edge of the band. Any excess band is cut and discarded, and a running 3/0 white Vycril suture is placed to bury completely the artificial ligament in the subcutaneous tissue and platysma muscle. The NAL ligament should not be fixed with vicryl stitches, but only covered of subcutis.

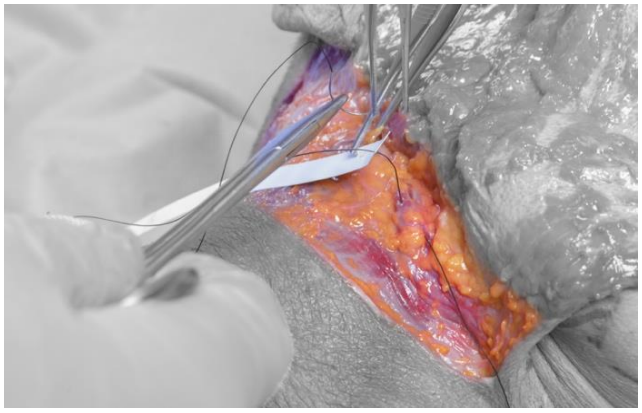

Figure 1: The needle is passed a first time through the ePTFE head band.

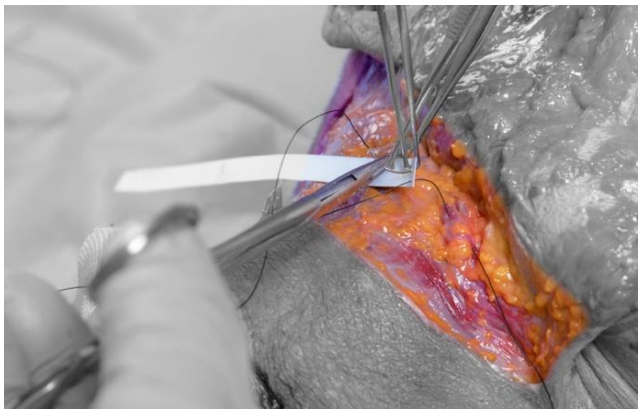

Figure 2: It is immediately passed through a second time forming a u-suture.

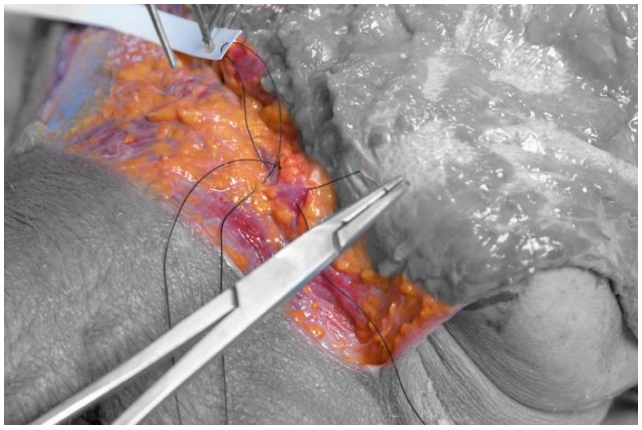

Figure 3: The anatomic medial plastism is anchored by the suture.

Figure 4: The stitch is tightened.

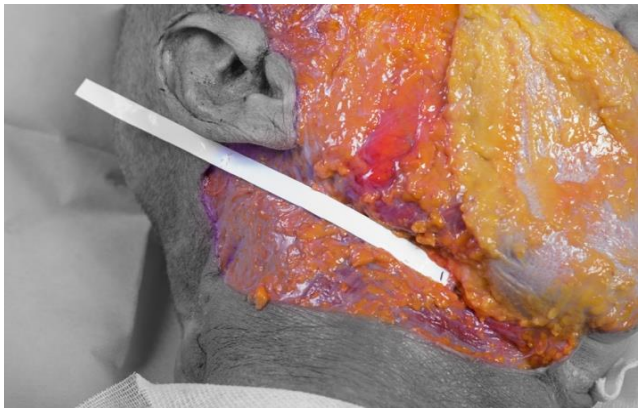

Figure 5 and 6: The correct direction of positioning of the ePTFE head band: it must be placed running along the lower edge of the mandible to going to reach the mastoid tuberosity bone; this point is essential because it allows understanding where ePTFE superior limit will be fixed.

Figure 7: The surgeon can pull the band towards the mastoid, thereby placing it under a great tension. The tension applied to the NAL depends on grade of laxity of the platysma muscle: for soft and moderate platysma laxity, band is retracted 1.0–1.5 cm with respect to a relaxed position; for several plastysma laxity, band is retracted 2.5 -3.0 cm with respect to a relaxed position.

Drainage is placed, and the procedure is repeated on the other side. In the case of patients with minimal subcutaneous fat in the neck area, particular attention is paid to burying the PTFE bands in the platysma muscle. Conversely, in cases of excess subcutaneous fat in the neck area, microliposuction is performed.

Patients have drainage removed and are discharged on post-operative day 1 with oral antibiotic prescribed for 5 days. Compressive dressing of the neck was not performed in any cases. Patients are advised to sleep in a supine position with a cervical pillow (to maintain the neck extended and avoid in voluntary lateral rotation) and to avoid physically stressful activity for a post-interventional period of 2 weeks. A daily application of antiseptic on the wounds is also advised until the removal of the stitches on post-operative day 21.

The same procedure is repeated for the contralateral side.

The NAL works as a new anatomical landmark structure: although the results are much more stable than classical neck and face lifts, if the patient wishes more aesthetic traction years later, only the post-auricular incision can be made to find the ePTFE and reposition it even higher; in this way we will pull the platysma withot carrying out all first dissection, necessary for its correct positioning.

RESULT

Due to bury the artificial ligament in the subcutaneous tissue and platysma muscle ePTFE bands are invisible in every position of the neck and face regions and almost impalpable, giving no clues that the operation was performed. The most common complication was delayed healing of post-ear scar which occurred in 11 cases, 7 monolateral and 4 bilateral. Dehiscence of the incision resolved alone with no need for surgical repair. Micro-asymmetry manifested in 2 patients (0.64%), with one implant slightly higher than the contralateral. There were no instances of damage of facial nerve or marginal nerve, which has been stated by many as a drawback of this technique but never supported by relevant literature. Only one patient presented an infection of monolateral implant and was treat with antibiotic therapy for 15 days; there no indication to remove the ePTFE band and repeat the unilateral treatment. There were no flipping of the ePTFE bands implant (rotation front-to-back). None of the patients of this series wanted (by the time of longest follow up) implant revision or replacement.

Table 3: Complications.

Postoperative complications in numbers	
Overall	0 (/)
Delayed healing of post-ear scar	11 (3,74%)
Wound Dehiscence	2 (0,7%)
Wound Infection with atb treatment	3 (1%)
Skin necrosis	0 (/)
Early (first 24h) hematoma	2 (0,7%)
Late hematoma	0 (/)
ePTFE dual-mesh band infection	1 (0,34%)

CASE REPORT

CASE 1: Female 56 yrs old: 6 months post op. NAL (Neck Artificial Ligament) Lifting, superior and inferior transconjunctival blepharoplasty, SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 2: Female 52 yrs old: 6 months post op. NAL(Neck Artificial Ligament) Lifting , SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 3: Female 55 yrs old: 8 months post op. NAL(Neck Artificial Ligament) Lifting , inferior transconjunctival blepharoplasty, SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 4: Female 54 yrs old: 6 months post op. NAL(Neck Artificial Ligament) Lifting , SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 5: Female 65 yrs old: 12 months post op. NAL(Neck Artificial Ligament) Lifting , SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 6: Female 51 yrs old: 6 months post op. NAL (Neck Artificial Ligament) Lifting , superior blepharoplasty, SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 7: Female 61 yrs old: 6 months post op. NAL (Neck Artificial Ligament) Lifting.

CASE 8: Female 56 yrs old: 6 years post op. NAL (Neck Artificial Ligament) Lifting , SEFFI (Superficial Enhanced Fluid Fat Injection).

CASE 9: Female 58 yrs old: 6 years post op. NAL (Neck Artificial Ligament) Lifting.

DISCUSSION

Polytetrafuotoethylene (PTFE) bands has a long surgical history; many techniques have described to correct moderate skin neck aging and minimal platysma laxity; the advantages of these procedures are the short recovery time and low rate of complications, but the result are relatively short lasting, mainly because they do not involve any tightening of plastysma muscle: minimally invasive procedures as barbed threads, for temporary suspension of the skin, internal and external radiofrequency, microfocused ultrasound, botulinum toxin or acid hyaluronic treatment usually achieve short time moderately satisfaction with real short lasting results. Other authors have described suspension techniques with strong and permanent cross-neck suspension sutures; liposuction in the neck area does not address the need for skin tightening and issues related to the deeper muscular structure. Other minimally invasive surgical procedures have also been proposed by many authors as “Z incision” with Z plasty closure [17]. More invasive procedures include the repositioning of the platysma muscle through wide platysma flap dissection. Compared with NAL technique, these procedures present the advantage of a satisfying and long lasting result, but the associated recovery time is long and the associated complications are relatively more frequent and severe[29,30,31,32]; The associated complications include great hematoma, seroma, cervical nerve neuropraxis [38].

Other surgeon proved longer lasting result with low complication rates using PTFE suture in neck rejuvenation, but they use a submental incision and a complete subcutaneous neck dissection [53], or a primary time ePTFE followed by a secondary ePTFE traction 3 or 4 weeks later [54]; these technique are not usually preferred by European patients.

In order to achieve long lasting result other authors suggested that it is necessary to first achieve an effective platysma tightening through the manipulation of the platysma muscle. The Gonzales technique [29] includes the retraction of the platysma held with suture, thereby applying traction as close to the midline as possible. The plastysma muscle incision and its plication definitely allows a better traction, but limited in the area of muscle overlap. Furthermore, the risks associated with this more invasive procedure are considered by the current authors as excessive for moderate lack of mandibular border and laxity of the platysma muscle. In the NAL technique this is achieved using the ePTFE dual mesh bands, which provide stronger traction than simple sutures, and more stabile results.

The NAL technique present a relatively short day-surgery hospitalization [55] in a safe office-based procedures with a very low rate of complications; usually the most invasive procedures for neck rejuvenation required 2- day recovery with few or mild complications.

Other advantages of this technique include the reduced operating time compared to more invasive [8] procedures. In the current study, the average operative time was 135 min, inferior to the average time for a subplatysma necklift of 295 min [56].

This study is mainly limited by the lack of a control group against which the outcomes could have been measured.

CONCLUSION

The NAL technique seems to achieve effective platysma tension and both patient and clinician satisfactory outcomes, without deep modifications of the superficial musculoaponeurotic system and platysma. The technique is an outcome for both young and older patients; the first usually present a low-moderate lack of mandibular border and laxity of the platysma muscle, while the seconds generally show medium-severe laxity of the muscle. The NAL procedure is also associated with a very low rates of complication and a short operative and recovery times.

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