Adding Nanofat to Fat Grafting to Treat Velar Scarring in Velopharyngeal Incompetence

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Abstract: Despite improved surgical techniques in palatoplasty a number of patients will present post-operatively with incomplete velopharyngeal closure due to several reasons including inherent shortness of the palate or midline scar contracture. This incomplete closure of the velopharynx during speech, known as velopharyngeal incompetence (VPI) causes hypernasality and nasal turbulence during speech. Treatment options in severe cases include revisions, pharyngeal flaps, and pharyngoplasties while in mild cases fat grafting has demonstrated its efficacy in improving velopharyngeal closure. Nevertheless, midline scarring can cause velar rigidity and inelasticity giving rise to inadequate velar elevation and retro position. Management of retracting velar scars is a real challenge. Despite an accurate surgical correction retracting scars tend to recur with negative effects on speech. Emulsified fat (nanofat) has proven to be a relevant source of stem cells and growth factors and has been successfully employed so far for the treatment of facial wrinkles and scars. The aim of this paper is to propose the application of the nanofat technique for the improvement of velar scar elasticity and pliability in addition to fat grafting to the posterior pharyngeal wall and the tonsillar pillars to further improve results when treating mild VPI. Studies with larger samples should follow to substantiate our findings but based on our preliminary experience, the authors feel that the nanofat could be a promising adjunct to the current repair procedures, due to its regenerative properties.

Key Words: Fat grafting, nanofat, tissue engineering, velopharyngeal incompetence

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Velopharyngeal incompetence (VPI) is defined as a defective closure of the velopharyngeal sphincter causing speech impairment, characterized by hypernasal resonance, nasal air turbulence, and articulation imprecisions. In this condition speech perceptual quality and intelligibility can be considerably altered.

Despite an accurate anatomical repair, the surgical treatment of cleft palate can leave an incomplete closure of the velopharyngeal port, as a sequela, due to several reasons including inherent shortness of the palate or midline scar contracture. Some patients acquire an efficient control of velopharyngeal closure, whereas others, despite speech rehabilitation, may keep a hypernasal speech and nasal turbulence which derive from a too short and rigid velum.

Surgical management of VPI depends on the severity of the clinical situation. Major cases, with an important nasal air escape, are best treated by revisions, pharyngeal flaps or pharyngoplasties, whilst in mild cases, with minimal air escape, fat grafting has demonstrated its efficacy in improving velopharyngeal closure.[1–5] Severe midline scarring gives rise to velar rigidity with reduced velar elevation and retroposition. The treatment of retracting velar scars is a real challenge. Few surgical techniques have been described so far to restore velar elasticity and pliability. Based on our previous experience,[1–4] we favor the fat grafting technique, capable of improving retracting scars with a minimal invasive procedure.

Fat harvested by liposuction and emulsified with 30 to 40 passages of the lipoaspirate between 2 Luer-lock 10 ml syringes connected with an adapter, becomes a mash of adypocites, named nanofat.[6]

Nanofat has proven to maintain the regenerative properties of the lipoaspirate, being a relevant source of stem cells and growth factors and has been successfully employed so far mainly for the treatment of facial wrinkles and of scars.[6–11] The aim of this paper is to propose the application of the nanofat technique to the improvement of velar scar elasticity and pliability in addition to fat grafting to the posterior pharyngeal wall and the tonsillar pillars to further improve result when treating mild VPI.

TECHNIQUE DESCRIPTION

Fat Harvesting and Processing. Placement

The procedure is performed under general anesthesia. The patient lies in supine position with the neck extended by placing a roll behind the shoulders, the operative field is exposed using a Dingman mouth gag. The fat harvested from the lower abdomen is purified according to Coleman, as previously described.[1–4] The odontoid process, site of contact between the velum and the posterior pharyngeal wall, is identified. A stab incision is carried out on either side of the posterior pharyngeal wall, approximately 7.0 mm laterally from the odontoid process. About 7.0/10.0 ml of fat is placed, using a 2.0 ml Luer-lock syringe with a 21-gauge, 60-mm long disposable malleable microcannula, bent as needed. The cannula is advanced in a cephalad and oblique direction to reach the atlas and then on a more lateral approach in the submucosal plane.

The assistance of a 70° Storz 4-mm rigid nasal endoscope, connected to a video camera and a monitor, is used to better visualize the nasopharynx and make the insertion precise. The parcels of fatty tissue are injected anterior to the prevertebral fascia, within the fibers of the superior constrictor muscle, to avoid dislocation of the graft caudally along the natural cleavage plane, in the loose space that exists immediately anterior to the bodies of

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the vertebrae. We use blunt cannulas and not sharp needles, to prevent the risk of injecting fat into the vessels or to injury the internal carotid artery, which courses laterally.

At completion of the management of the nasopharyngeal area, fat is injected into the velum. In particular, along the midline, site of the scar from previous cleft palate surgery, on the nasal aspect of the uvula, and on the posterior pillars.

A stab incision is made at the level of each arch of the tonsillar fossa, and on the uvula where 2.0 ml of microfat are placed to create a bulge for improving the contact between the velum and the posterior pharyngeal wall.

Management of the midline velar scar is performed using nanofat emulsion. Nanofat has been recently added to our armamentarium with the goal of softening the scar and releasing particularly stiff adherences. Emulsification is obtained by shifting the lipoaspirate between two 10-cc Luer-lock syringes connected to each other by a 3-way stop cock connector with 30 passages.[6] No filtration is performed. A total of 0.7 to 1 ml of nanofat is inserted within the scar tissue.

No special post-operative care is needed and no complications have occurred so far. Prophylactic antibiotic treatment is administered.

Outcome Measures

A multidisciplinary assessment is performed before surgical treatment of VPI and at each follow-up evaluation (every 3 months for the first year and then typically once a year). The team is composed by a plastic surgeon, a phoniatrician and a speech therapist, all experts in cleft patients' management.

The pre and post-operative evaluation includes:

- Videonasoendoscopy by means of a flexible endoscope. The VP closure gap is rated by the examining team during speech by a 5-point scale, ranging from 0 to 4 according to the entity of the closure gap: 0 = no gap; 1 = gap evidenced by mucus bubbling; 2 = gap < 25% of the VP port; 3 = gap > 25% and < 50% of the VP port; 4 = severe gap > 50% of the VP port. Patients with type 1 to 3 gaps are considered suitable to be treated by fat injection.[1]
- Perceptual speech evaluation including 3 parameters:
  - (i) Speech intelligibility rated by a 5-point scale (0 = no disturbance, 4 = severe disturbance);
  - (ii) Hypernasality scored by a 4-point scale (0 = normal, 1 = slight disturbance, 2 = moderate disturbance, 3 = severe disturbance).
  - (iii) Nasal air escape rated on a 4-point scale from 0 (normal) to 3 (severe escape).1

Speech samples are routinely recorded and evaluated blindly by 2 experienced speech therapists as independent listeners.

CLINICAL STUDY

A typical case of mild VPI, treated by concurrent microfat and nanofat injection, is presented in Figures 1 and 2. A 14-year-old non syndromic male was affected by VPI, as a sequela of cleft palate repair, operated on at the age of 12 months. Despite several courses of speech therapy, he maintained an hypernasal speech with perceivable nasal turbulence during phonation. He was a brilliant student, psychologically disturbed by his altered speech resonance. He was strongly motivated to correct the defect. On nasendoscopy the closure gap of the velopharyngeal sphincter appeared of mild degree, (type 2 according to our scoring system[1]) on the midline, with mucous bubbling clearly visible during speech. He was affected by a typical borderline VPI. Thanks to speech therapy he did not show any compensatory misarticulations. The scores deriving from his speech evaluation were: speech intelligibility: 0 (= normal); hypernasality: 2 (moderate disturbance); nasal air escape: 1 (=slight disturbance). We considered velopharyngoplasty to be an overtreatment due to possible post-operative morbidity and to the risk of developing an obstructive sleep apnea syndrome. Therefore, a mini-invasive procedure was proposed to manage the velar scarring and to obtain a bulging of the posterior pharyngeal wall. He underwent concurrent microfat and nanofat injections in the velum, especially along the midline scar, and microfat injections in the posterior and lateral pharyngeal walls. His immediate and late postoperative course was uneventful without post-operative signs of respiratory obstruction and no snoring.

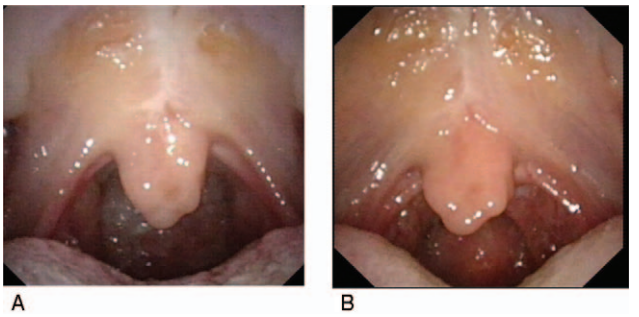

FIGURE 1. A: Extensive scarring on the midline of the velum, sequela of cleft repair, causing velar rigidity in a 14 years old boy. B: Three months after concurrent microfat and nanofat injections in the velum, especially in the midline scar, and of microfat injection in the posterior ad lateral pharyngeal walls.

Figure 1A shows the midline retracting scar of the velum, causing an impairment of velar elevation and retropulsion. In Figure 1B, the image demonstrates the result obtained 3 months after surgery: the scar is softened and released. Tissue pliability is improved.

The nasendoscopic views obtained on phonation pre- and post-operatively by flexible videoendoscopy are shown in Figure 2. In A and B, the pre-op views of the velopharyngeal port demonstrate a closure gap and nasopharyngeal mucous bubbling; in C, 3 months after concurrent microfat and nanofat injections complete closure of the velopharyngeal sphincter is achieved. The patient had no more perceivable nasality or nasal turbulence during speech due to the improved closure of the velopharyngeal valve.

At 6-month-follow up this favorable result is maintained as nasoendoscopy has shown complete closure of the VP sphincter (score = 0) and perceptual evaluation of his speech has demonstrated normal values for intelligibility, hypernasality and nasal air escape (score = 0).

DISCUSSION AND CONCLUSIONS

Our previous results in patients undergoing fat grafting of the velopharyngeal sphincter demonstrated its efficacy for cases of

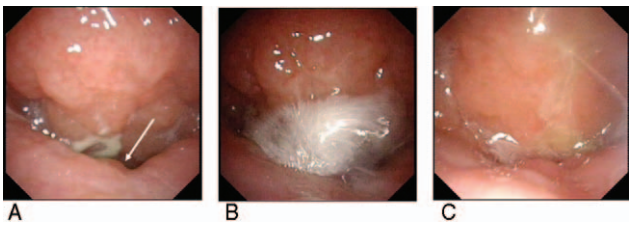

FIGURE 2. Nasendoscopic view of the velopharyngeal sphincter during phonation of the same patient shown in Figure 1. A-B: pre-op views. A: a closure gap can be seen; B: nasopharyngeal mucus bubbling is evident due to air escape; and C: Three months after surgery complete closure of the velopharyngeal sphincter is achieved. The patient has no more perceivable nasality or nasal turbulence during speech.

mild to moderate velopharyngeal incompetence.[1–4] This mini-invasive procedure offers several advantages to the patient: very low rate of intra- and post-operative complications, no risks of sleep apnea syndrome at long-term, an uneventful post-operative course and no modification of the anatomy of the velum and of the pharyngeal walls. Furthermore, the procedure can be easily repeated to enhance the results or if VPI recurs during the child's growth. Conversely, augmentation of the posterior pharyngeal wall using biomaterials or permanent implants could give rise to several sequelae such as migration, extrusion, or foreign body reactions.

This paper introduces a new application for nanofat grafting to improve the results in VPI treatment utilizing concurrent microfat grafting in multiple tunnels.[1–5] The current literature supports the possible role of nanofat to induce tissue regeneration.[6–10] Adipocytes are about 20% or less of the total number of cells in the lipoaspirate, while vasculature-associated cells represent over one-half of the total amount of cells.[12,13]

After fat grafting the host scar tissue undergoes a remodeling process which has been related to the adipose derived mesenchymal stem cells (ADSCs) and to the growth factors.[12–16] It is well known that ADSCs are capable of tissue regeneration and repair, thanks to their pluripotency and ability to differentiate into several cellular lines.[16]

We utilized unfiltered nanofat as described by Jan et al.[9] Nanofat emulsion keeps the content of stem cells, endothelial progenitor cells and growth factors intact.[6–10,15] The emulsification disrupts the adipocytes without damaging the other cellular components; the obtained fluidity of nanofat makes it suitable for injection by thin needles into the dermis for the release of scar tissue.[15] An improvement in tissue elasticity[6–11] is the primary goal and is attributed to its content in stem cells and growth factors, which play a key role in neoangiogenesis and regeneration of the host tissue.

In conclusion, nanofat injection is a simple and straightforward complementary procedure for treating velar scars with a regenerative purpose to improve the viscoelastic properties of a rigid velum. Tissue engineering techniques–such as concurrent microfat and nanofat grafting–are promising tools to regenerate a scarred tissue and to enhance its functions.

The validity of our proposal needs to be confirmed by further studies with larger samples but based on our preliminary experience we feel that the nanofat could be a valid adjunct to the current repair procedures for VPI.

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