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Technical note

Keys to successful type-1 thyroplasty with Montgomery® implant for unilateral laryngeal immobility in adults

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ABSTRACT

Based on a review of the medical literature, the authors document the key technical points and pitfalls in type I thyroplasty with Montgomery® implant, and the main results and indications in unilateral laryngeal immobility.

1. Introduction

With more than 1300 references for "thyroplasty" in PubMed (on April 16, 2020), this would seem to be a "recognised" surgical option in unilateral laryngeal immobility. The present technical note aimed to detail and discuss the key-points in type 1 thyroplasty with Montgomery® implant, the pitfalls and difficulties encountered, and the results in unilateral laryngeal immobility in adults. Indications have been dealt with elsewhere [1–4].

2. Technique

First described by William Wayne Montgomery, type 1 thyroplasty, with an implant definitively named for this American otorhinolaryngologist who died in 2003, is "ideally" performed under local anesthesia so as to be able to adapt the implant to be the best intraoperative acoustic result [1,2].

The patient is positioned, disinfection is performed, and the drapes are laid [5]; then local anesthesia is performed with 1% adrenaline–lidocaine, level by level, down to the thyroid cartilage. Cervicotomy is performed, lateralised to the paralysed side, in the transverse cervical fold so far as possible, next to the superior edge of the cricoid cartilage. The platysma, anterior jugular vein and subhyoid muscles are sectioned. The thyroid cartilage wing ipsilateral to the paralysis is widely exposed after elevating the external perichondrium, incised at the anterior angle and inferior edge of the thyroid cartilage plate, and the adjacent sternothyroid muscle. Classically, using the calibrated gender-adapted instruments developed by William Montgomery, a transcartilage window of 5×10 mm in females and 7×12 mm in males is positioned after creating what Montgomery [2] called the "virtual line" corresponding to the maximal height of the window and the "key point" corresponding to the anterosuperior angle of the window. It can be difficult to locate these points as the anterior angle of the thyroid cartilage is sometimes, and frequently in females, flattened and the inferior edge of the cartilage is often not rectilinear. Several procedures then seem useful. The first is cervicotomy beyond the midline, to visualise the whole anterior angle of the thyroid cartilage from the superior notch to the inferior edge. The second is to locate the whole thyroid tubercle, to facilitate drawing the "virtual line" that gives the maximal height of the window and on which the "key point" is placed. The pitfall, as several studies stress [6–9], is to position the window too high or too posteriorly on the thyroid cartilage plate. In our experience, positioning the anterior edge of the window about 5 mm from the midline, corresponding to the anterior angle and inferior edge of the cartilage, and about 2 mm from the inferior edge of the thyroid cartilage plate (Fig. 1a) avoids this pitfall, which would give a poor vocal result. Once the window has been well delineated, the transcartilage window is created using a saw, and resected (Fig. 1b,c). If, in so doing, the lower edge of the thyroid cartilage is damaged, the implant can be stabilised by a non-absorbable suture. The ipsilateral internal thyroid perichondrium is incised. The gender-specific calibrator is used to check the size of the cartilage window; if it needs enlarging, a diamond blade should be used to saw the inferior edge. Phantoms are used to select implant size according to target vocal outcome. During the intraoperative phonatory maneuvers,

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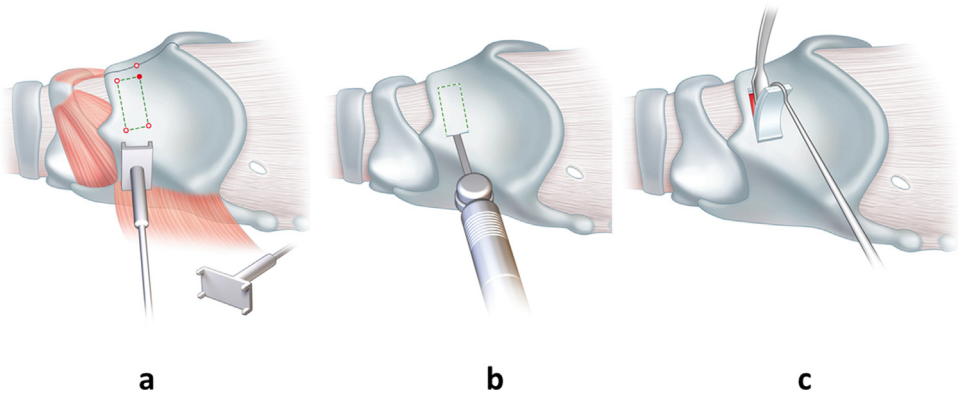

Fig. 1. Positioning and creating the thyroid cartilage window.

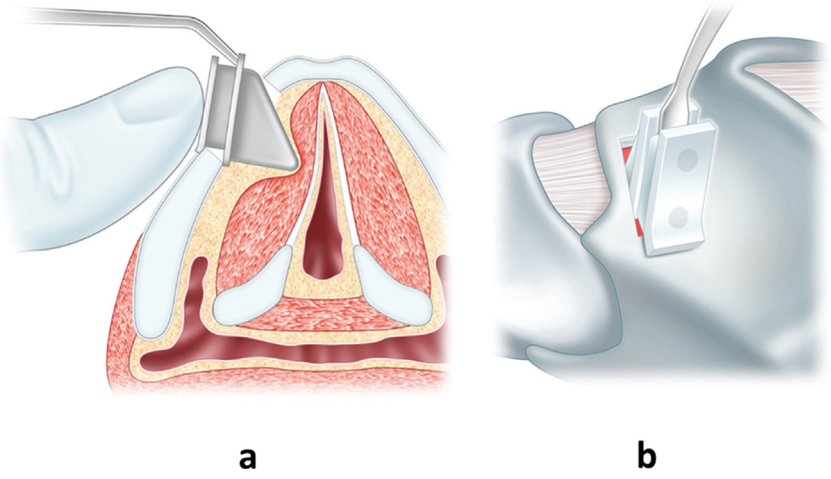

Fig. 2. Implant positioning.

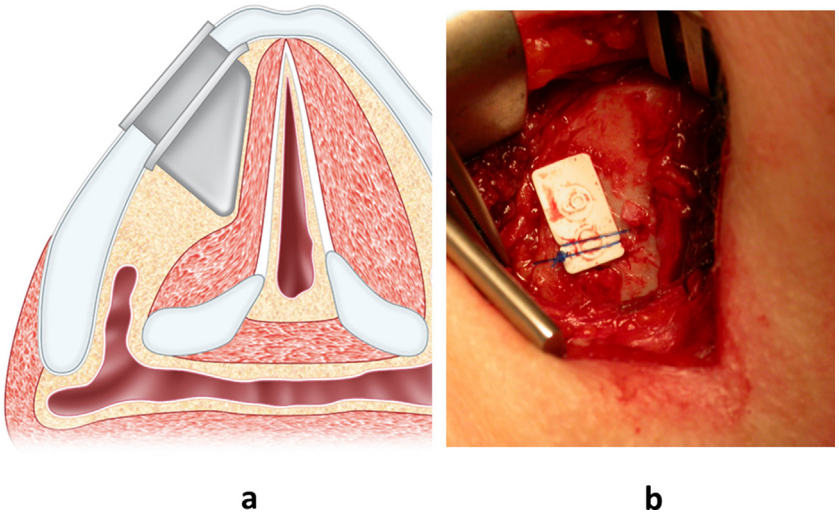

Fig. 3. Implant in position.

care must be taken not to artificially medialise the larynx by pressing too hard on the phantom, and time should be taken to let the compensatory vocal mechanism (often, a supraglottic behaviour used by the patient in the absence of the implant) subside. The selected implant, corresponding to the calibrator that gives the best vocal result, is inserted forward in the cartilage window (Fig. 2 a,b). A stabilising non-absorbable suture (Fig. 3 a,b) can be used if the difference in thickness between the implant "tenon" and cartilage "mortise" stops the implant clipping into position posteriorly. After checking hemostasis, the subhyoid and subcutaneous muscular planes are sutured (Vicryl 3/0). Depending on local hemostasis and comorbidity, and aspiration drain may be used and the patient kept in overnight. Postoperative care, initiated at the end of surgery, includes step I analgesia

(paracetamol 1 g × 3 times daily for 8 days), antibiotic prophylaxis and steroidal anti-inflammatory drugs (prednisolone 1 mg/kg/for 5 days).

3. Discussion

In their articles of 1993 and 1997, Montgomery et al. [1,2] described an original technique of type-1 thyroplasty to counter the effects of unilateral laryngeal paralysis. The technique differed from the other techniques and implants available in standardising the procedure in terms of the positioning and dimensions of the cartilage window, the use of phantoms (6 per gender, allowing the size of the definitive implant to be selected according to vocal result), the absence of intraoperative implant sizing, considerably reducing surgery time, the self-retaining character of the implant, and above all its shape, which optimally resituated the arytenoid cartilage and the vocal fold, put under tension without being simply medialised [1,2].

The Montgomery Thyroplasty Implant System (MTIS) (both technique and implants) has been implemented for more than a quarter of a century now, in Germany, Belgium, the USA, Spain, France and Italy, with all reports agreeing on its great efficacy [3,4,10–15]. Phonatory results are excellent, especially for maximum phonation time (MPT) and Voice Handicap Index (VHI-30) [3,4,11,13–15]. They are comparable to those reported for other types of implant, whether machined like Freidrich's titanium implant [16], semi-machined like Netterville's silicone implant [17] or modelled by the surgeon intraoperatively like en-bloc silicone or Gore-tex implants [18,19]. Swallowing impairment and aspiration, seen in a non-negligible number of cases of unilateral laryngeal paralysis, is also decreased [1,3,4]. All this, combined with the absence of "sex change" in the voice [20], goes to improve quality of life [21].

One of the main advantages of the MTIS is its ease of use and acquisition. Results do not depend on the surgeon's experience, and complications are few [4,14,22]. Intraoperatively, optimal implant size is easily determined by ear, assessing MPT and whether the voice is "strained" [2,4,11]. One team [10] found benefit of intraoperative subglottic pressure analysis by a catheter introduced at the cricothyroid membrane, but without really demonstrating superiority to simple perceptual assessment; and a recent review of the literature [11] reported that subglottic pressure (estimated rather than measured) was not a reliable predictor of phonatory results after type-1 thyroplasty, unlike intraoperative analysis of MPT. Secondary displacement after a later intubation is rare [23]. There was one report of a case of silicone allergy [24], resolved by implant removal. Results can be considered permanent: several studies [3,4,13] reported stable vocal results at more than 10 years.

Practically, surgery time is less than 60 minutes, skin to skin, limiting discomfort on the operative table [14]. Comfort is further improved by the absence of general anesthesia, shortening recovery time, and allowing the procedure to be used in patients considered as weak, broadening indications, including in oncology [1,3,22,25]. A recent study, based on 3D laryngeal CT in MTIS, focused on the interaction between the implant and arytenoid cartilage [15]. The implant apex interacts ideally with the vocal apophysis, raising it and imposing internal rotation [15], thus medialising and stretching the ipsilateral paralysed vocal fold (Fig. 3a). Posterior glottic gap thus treated without resorting to adduction or arytenoidopexy. This is especially true in the most frequent cases where the paralysed vocal fold lies below the normal fold with an anterior shift of the arytenoid. In very rare cases where the paralysed vocal fold lies above the normal fold, arytenoid surgery may be needed to correct glottic leakage in the vertical plane. The importance of these differences in glottic level was highlighted in a recent report showing a relation between vertical difference in vocal fold level and vocal result following type-1 thyroplasty [26]. Analysing relative level is not always easy, however, and is best conducted under direct laryngoscopy or indirect 3D laryngoscopy; a deep measurement technique using indirect laser laryngoscopy is currently under study [26].

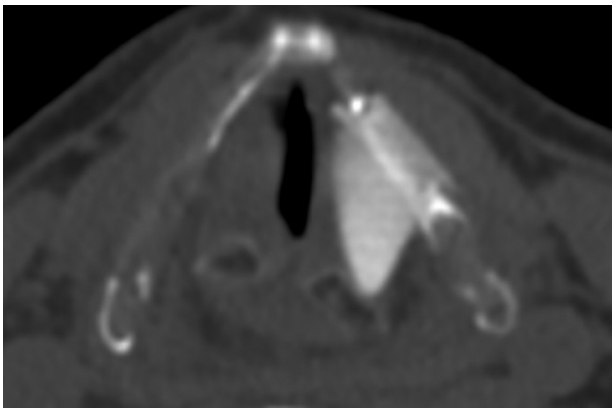

Fig. 4. Implant positioned too posteriorly.

This great efficacy and "simplicity" of MTIS is not without reserves, and the surgeon needs to be able to make intraoperative decisions and adaptations. Several studies noted that Montgomery's technique sometimes needs to be slightly modified [5–9]. One such study reported poorer efficacy in terms of MPT in females [7]. The female thyroid cartilage shield generally has a wider anterior angle, and an implant clipping onto the cartilage walls needs greater depth and angulation to enable effective medialisation as the distance to the bisector between the two cartilage wings is greater than in males; thus, female patients often require larger implants. Another study demonstrated the importance of good positioning of the cartilage window, which determines the definitive position of the implant [8]. The study compared the topography of the windows the surgeon actually created versus virtual topography on 3D CT reconstruction following an ideal Montgomery procedure, and assessed respective results in terms of MPT and VHI-30. The findings were in favour of locating the window as inferiorly and anteriorly as possible [8]. These conclusions were recently borne out by a Spanish team who developed a dedicated set of narrower metal phantom measurers that allowed upward or downward adjustment of the window according to intraoperative laryngoscopy findings [6,9]. Positioning the anterosuperior angle of the window, defined by Montgomery [2] as the "key point", is hindered by variant anterior cartilage angles and/or inferior edge irregularities with significant protrusion of the thyroid tubercle, and we would advise surgeons to position the window 5 mm from the vertical midline corresponding to the closure of the anterior angle of the cartilage shield, but no more posteriorly so as to avoid excessive interaction between the implant apex and the arytenoid cartilage body. Likewise, we advise positioning the window as low as possible, ideally 2 mm from the inferior edge of the thyroid wing (Fig. 1a–c). This attitude avoids locating the window too superiorly and/or posteriorly, which would medialise the Morgagni ventricle and induce an inward tilt of the arytenoid cartilage (Fig. 4), impairing acoustic results and potentially causing respiratory problems. In a large majority of cases, the implant will then be well positioned; however, any resistance to implant introduction, with a rebound not explained by greater anterior than posterior cartilage plate thickness (Fig. 3a) and not easily reducible by means of a posterior suture (Fig. 3b), casts doubt on correct window positioning, and reduction of the anterior part of the implant by a cold

blade should be considered if its position is too anterior, or of the posterior part (apex) if too posterior. Thus, the illustrations accompanying the present article are a little different from Montgomery's [2].

4. Conclusion

The Montgomery® silicone implant is easy to use and gives excellent vocal results in the vast majority of cases of unilateral laryngeal paralysis in adults, adapting to all clinical profiles and especially to those involving severe comorbidity and/or with general anesthesia risk: recent pulmonary resection, elderly patient with stroke, or patient with terminal malignancy. However, it is advisable to assess intraoperatively the thyroid cartilage plate that is to receive the implant and to ensure that the anteroinferior cartilage window frame avoids the two pitfalls of the procedure: implant positioned too high and not medialising the vocal fold, and/or positioned too posteriorly and interacting too strongly with the arytenoid cartilage. The simplicity and standardised nature of the Montgomery implant and its associated procedure (MTIS) do not mean that the surgeon need show no adaptability according to intraoperative circumstances.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgments

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