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Review

Experience with cortical tunnel fixation in endoscopic brow lift: The "bevel and slide" modification☆

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ABSTRACT

Background: Endoscopic brow lift has become a popular method for rejuvenation of the upper third of the face and in the treatment of functional brow ptosis. Controversy, however, remains over the optimum technique for the fixation of the forehead and brow. This paper presents a single surgeon's experience with a technical modification to McKinney's original description of paramedian cortical tunnel fixation in patients undergoing endoscopic brow lifts.

Patients and Methods: A case note study of all patients who underwent a modified cortical tunnel endoscopic brow lift fixation by a single surgeon over a 4-year period (2003–2006) was undertaken. The technical modification to cortical tunnel sculpting was introduced to prevent suture associated complications which had occurred in two patients prior to the study. Brow position was maintained with 2/0 polypropylene sutures anchored through modified paramedian cortical bone tunnels. Temporal fixation of superficial parietal to the deep temporal fascia was achieved with the same suture material.

Results: Between January 2003 and December 2006, 30 patients had endoscopic brow lifts performed for aesthetic and functional reasons. All cases were bilateral. Twenty-three patients (77%) were female and seven (23%) were male. The median age was 60 years (range: 34–76). Patient follow-up ranged from 3 to 24 months (mean: 12 months). Twelve patients (40%) had another aesthetic procedure carried out at the same time.

There were no early postoperative complications (bleeding, VII nerve palsy or infection). One patient had a fixation suture removed under local anaesthetic 6 weeks postoperatively due to ongoing dysaesthesia localised to that particular suture site. A second developed significant intermittent forehead/scalp dysaesthesiae, which was treated conservatively. Notably, there were no cases of alopecia at the incision/fixation sites, relapses of brow ptosis, or troublesome scalp itching. No endoscopic cases were converted to an open/coronal brow lift procedure.

Discussion and Conclusion: Cortical tunnel suture fixation provided a simple, stable, and reproducible method of maintaining brow position in endoscopically assisted forehead/brow lift with low morbidity. Our modification introduces a refinement to the technique, which allows easy passage of the fixation suture needle and prevents exposure of suture ends, thereby minimising the risk of knot-associated complications.

1. Introduction

Since the introduction of endoscopic brow lifting in the early 1990s,[1–9] it has become widely accepted as a method of rejuvenation of the upper third of the face and the treatment of functional brow ptosis.[1–10] Its popularity stems from the excellent exposure for release of periorbital adhesions, muscle modification and sensory and motor nerve preservation. Apart from the need for special equipment and the learning curve involved, a principal disadvantage is the need for additional fixation to maintain brow position. There are numerous techniques by which brow fixation can be achieved and a certain amount of controversy still exists regarding the optimal method of fixation.[11–15] In 1997, Rohrich and Beran analysed the available fixation methods for endoscopic forehead surgery and arbitrarily classified them into exogenous and endogenous techniques.[13] This distinction, between endogenous and exogenous, was primarily based upon whether 'external hardware' was utilised in the fixation (Table 1). The paramedian cortical tunnel suture fixation method is an endogenous fixation

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Table 1
Types of endogenous and exogenous methods of endobrow fixation (after Rohrich et al., 1997[13] and Nahai, 2005[12]).

Endogenous	Exogenous
Galea-frontalis-occipitalis release	K-wire fixation
Lateral spanning suspension sutures	External screw fixation
Bolster fixation sutures	Internal screw or plate fixation
Anterior scalp port excision (V–Y closure of scalp excision)	Mitek anchor fixation
Galea-frontalis advancement	Endotine fixation device
Cortical tunnel suture fixation	
Tissue adhesives, e.g. fibrin glue	

method, which is popular among surgeons,[16–19] effective, has wide patient acceptance and carries low morbidity.[16,20,22] This paper documents a single surgeon's (CMM) experience with the endogenous method of paramedian cortical tunnel fixation and presents a "bevel and slide" modification to the technique as originally described by McKinney et al.[16]

2. Patients and methods

2.1. Preoperative assessment

All patients requesting or referred to the senior author (CMM) for endoscopic brow lift underwent thorough examination that included assessment of the forehead (rhytides; glabellar frown lines; eyebrow position with respect to the supraorbital ridge and height of the forehead) along with a full assessment of the upper lids.[21]

All patients were photographed and marked preoperatively in the sitting position. The midline was marked, along with the surface markings for the supratrochlear and supraorbital neurovascular bundles, which can be consistently found at 18 and 28 mm from the midline.[23–25] If clearly visible, the position of the sentinel vein was also marked, in addition to the temporal crest. The amount of the desired lift was determined by marking the position of the supraorbital ridge on the brow in the preoperative ptotic position, and then remarking the level of the supraorbital ridge while elevating the brow to the new desirable position. The vector of the pull of the brow was determined subjectively by what gave a nice aesthetic appearance. The sites of paramedian incisions and thus the cortical tunnels was marked on the frontal scalp in relation to the junction of the lateral 1/3 and medial 2/3 of the brow (approximately 5 cm from the central midline incision). The temporal incisions were marked bisecting a line joining the alar base and outer canthus but below the temporal crest.

3. Operative technique

The surgical technique used is a synthesis of the descriptions of Isse, Vasconez and the Emory University group.[1–12] The procedure is performed under general anesthesia with local anesthetic solution (1% lignocaine with 1:200,000) infiltrated into the incision sites, the eyebrows, temples and the subperiosteal plane at the operative site. As well as being haemostatic this initial hydrodissection aids the subsequent subperiosteal dissection.

Surgical access to the brow is obtained through five scalp incisions as described by Isse,[1,7] one in the midline; two paramedian (parasagittal) incisions, through which bony fixation is secured via sculpted cortical tunnels; and two temporal incisions which are the sites of standard fascial fixation. The incisions are 1.5 cm in length and approximately 1.5 cm behind the frontal hairline, with the exception of the two temporal incisions, which may be up to 5 cm behind the temporal hairline.

Initial dissection is blind and in the subperiosteal plane, extending posteriorly to a variable extent, sometimes up to the occiput, and onto the forehead to a point 2–3 cm above the supraorbital ridge. Dissection over the temporal region is undertaken in the plane superficial to the deep temporal fascia. Following periosteal release from the temporal crest, all three pockets are subsequently joined, and at this point the endoscope is introduced into a frontal pocket. Dissection is continued under direct vision towards and below the supraorbital ridge. Care is taken to preserve the supratrochlear and supraorbital neurovascular bundles at all times and undue pressure on the frontal branch of the facial nerve is avoided. Endoscopic dissection over the temporal area identifies the sentinel vein and divides all the adhesions surrounding it, while preserving it and avoiding damage to the frontal branch.[11,12] A transverse periosteotomy +/− myectomies are undertaken to ensure full mobilization of the brows. Following the subperiosteal and soft tissue releases, the tissues are elevated and then fixed in position parasagitally and temporally. Paramedian brow fixation is achieved using 2/0 prolene sutures passed through the periosteum anterior to the paramedian incision and then anchored in cortical bone tunnels.

Creation of the parasagittal cortical bone tunnel was undertaken using a 2.5 mm (round) rose burr (on an air drill), to make two drill

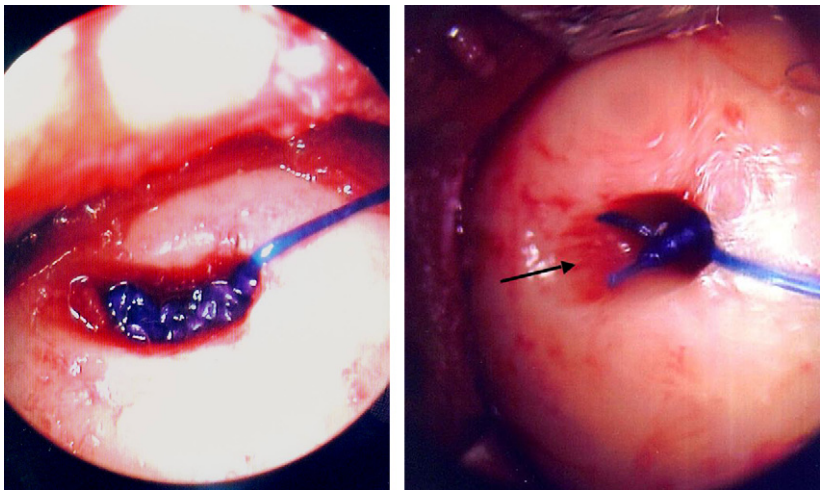

Fig. 1. Endoscopic images of the "*bevel and slide*" technique: The shoulders preceding the tunnel are bevelled (indicated by the arrow). This aids passage of the suture needle and allows the knot and suture ends to be slid down into the tunnel and underneath the cortical bone bridge.

Table 2
Ancillary aesthetic procedures.

Procedure	Patients
Upper lid blepharoplasty	7
Lower lid blepharoplasty	1
Face lift	4

holes about 1 cm apart and at 30 degrees to the outer table of the cranium (the latter to avoid penetration of the inner table). No specialized burr guide instruments advocated by others were used.[17,18] Our modification to McKinney's original descriptions focuses upon beveling the entrance and exit to the bone tunnel.[16,22] This manoeuver utilises the same hand-held burr and has a two-fold effect. Firstly, it allows a smoother passage for the suture needle and secondly, it permits the knot of the fixation suture to be slid down or buried within the tunnel itself (Fig. 1). The final size of the bone bridge or cortical bar after drilling was about 6–8 mm (more that the minimum 2 mm requirement from cadaveric studies.[19] This "bevel and slide" technical modification is shown in Fig. 1.

Temporally, the anterior superficial temporo-parietal fascia is fixed to the deep temporal fascia posteriorly and superiorly using the same suture material. All incisions were stapled prior to applying a compression dressing. No drains were used and all patients received 24 h of intravenous dexamethasone and broad spectrum antibiotics followed by 5 days of oral antibiotics upon discharge from hospital the next day.

4. Results

Between January 2003 and December 2006 30 patients had endoscopic brow lift fixation using the modified (paramedian) cortical tunnel suture technique carried out by the senior author (CMM). These patients were retrospectively evaluated. Twenty-three patients (77%) were female (age range, 34–76; mean = 42 years) and seven (23%) were male (age range, 46–68; mean = 52). Eighteen patients (60%) were referred from the opthalmologists. This referral group consisted of patients with documented visual field changes secondary to functional brow ptosis. The remaining cases were aesthetic and were either self-referrals (8) or referred from General Practice (four patients). Patient follow-up ranged from 3 to 24 months (mean: 12 months). Twelve patients (40%) had an ancillary facial aesthetic procedure (Table 2) the most common of which was blepharoplasty. All patients had bilateral brow lifts.

There were two early complications. One patient had a fixation suture removed under local anaesthetic 6 weeks postoperatively due to ongoing dysaesthesia, localised to that particular suture site. A second developed significant intermittent forehead/scalp dysaesthesiae, which was treated expectantly and resolved eventually. No endoscopic cases were converted to an open (coronal) brow lift

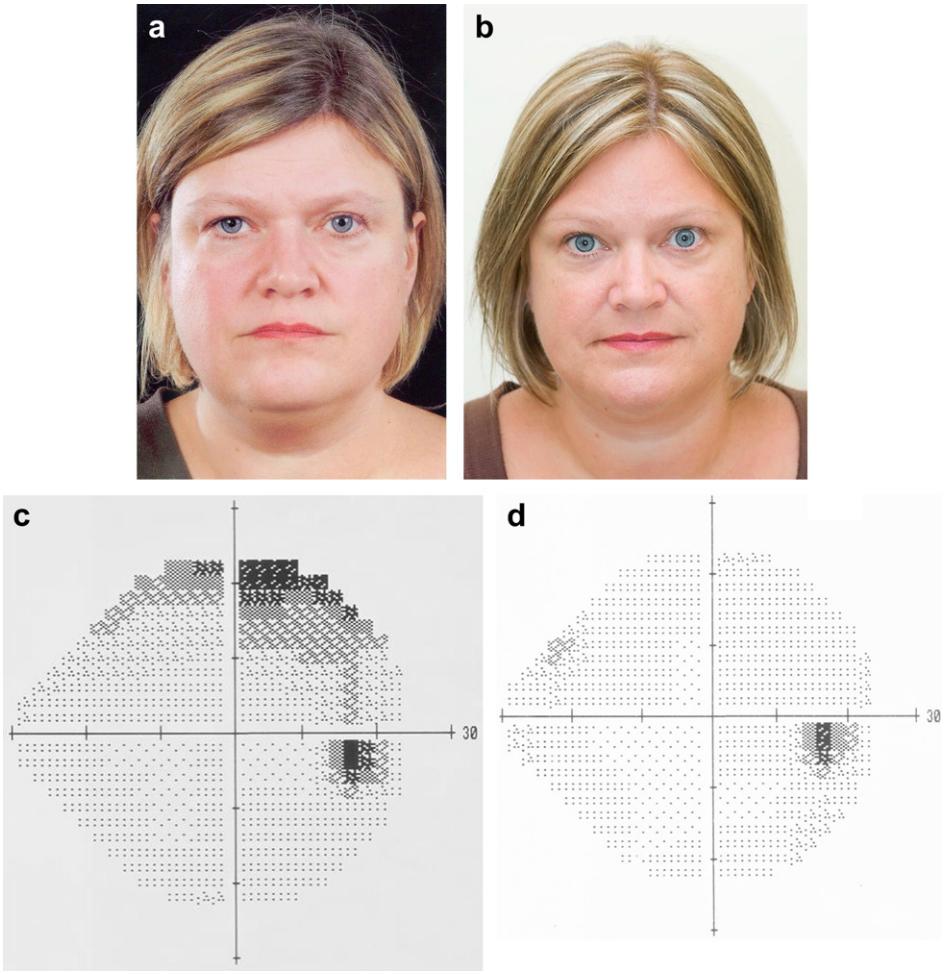

Fig. 2. A typical case of functional brow ptosis in a young woman (a). The grey area on the preoperative Howarth chart indicates the area of impairment of the visual field (b). The impairment resolved following endoscopic brow lift and fixation (c). Postoperatively the eyes (palpebral fissures) look wider, her face appears more open and less "severe". The forehead is smoother (d).

procedure. There were no bony tunnel problems such as brisk bleeding after drilling through the calvarium, bone bridge fractures, or the need for second tunnels to be made. None of the patients developed haematomas, infections, troublesome bleeding, CSF leaks or paralysis of the frontal branch of the facial nerve. Notably, there were no cases of alopecia at the incision/fixation sites, relapses of brow ptosis, or troublesome scalp itching. An illustrative example is shown (Fig. 2) of a 43-year old woman with asymmetrical functional brow ptosis. She was referred from the oculoplastic ophthalmologists with a right upper lateral quadrant visual field impairment (demonstrated by the grey area on the Howarth chart). She successfully underwent endoscopic brow lift surgery with complete resolution of the visual field defect. In these ophthalmic cases, stability of the fixation is paramount since recurrence of ptosis can have functional consequences. Stability of fixation is also important in cosmetic or purely aesthetic endobrow lift cases in which rejuvenation of the

Fig. 3. (a) A 39 year old with soft tissue laxity and early generalised facial ageing underwent an endoscopic brow lift with the bevel and slide cortical tunnel suture fixation of the brow and a face lift. She is shown 6 years postoperatively. Note the stable brow position and the smooth forehead. (b) This 34 year old lady was dissatisfied with the look of fullness of her upper eyelids and brow prior to surgery. After 12 months following endobrow lift and upper lid blepharoplasty she has a stable subtle change with which she was very pleased.

periorbital area is undertaken simultaneously with the endoscopic brow lift (Fig. 3). One patient (male) with a receding hairline was noted to have a depressed area on the forehead underneath the periosteal bite of the fixation suture. He did not complain about it and he was pleased with the improvement in brow ptosis and the functional improvement in his symptoms (Fig. 4).

5. Discussion

There are numerous techniques by which fixation in endoscopic brow lift surgery can be achieved and the best technique is yet to be discovered.[12,13,15] Our experience supports the findings of others that brow fixation with sutures tied through bone tunnels is safe, stable, reliable, simple and has reproducible long-term results.[20,22] It is simple to teach and can be safely used by an average aesthetic plastic surgeon.

This small but single operator series demonstrated that the paramedian cortical tunnel suture fixation technique gives stable and reproducible fixation of brow position following endoscopic brow lifting. It has minimal morbidity as shown by the absence of further complications following modification of the technique and high patient acceptance, as many of our patients do not like the idea of a screw in their heads, even if it is only temporary. A drawback of this technique is the need for special equipment, but this comprises only a dental drill which is readily available in all UK hospitals. Any noticeable depression of the forehead/scalp skin (at the site of the paramedian suture "bite" into the periosteum, Fig. 4) is easily hidden in patients with thick hair and also by positioning the paramedian incisions at least 1 cm posterior to the hairline. Others have advocated the use of the Endotine eyebrow suspension device to avoid this.[27–29] Alopecia at the fixation sites, which may be a problem with techniques using external hardware (exogenous methods); was not encountered, similar to the findings of McKinney and Sweis,[22] and perhaps reflects the absence of direct tension on the hair bearing scalp.[10,21] Unlike in screw, k-wire and bolster fixations, cortical tunnel fixation applies tension to the periosteum not to the scalp.

The pupil to eyebrow distance was not recorded in the initial part of the study, therefore there are no objective measurements in the improvement in brow position.[16,20] In the latter part of the study, the vertical height/distance between the central pupil and the highest point of the brow with the seated patient looking directly forwards has been adopted because of its simplicity and reproducibility.[16,20,28]

It was our experience that rigidly adhering to McKinney et al.'s original description of cortical tunnel fixation, not only made passage of the suture needle through the bone tunnel difficult, with some inevitable needle bending required, but also meant that exposure of the knot could potentially lead to complications. It was with this in mind that we slightly modified the original description. McKinney in a later article advocated drilling the bone 'trenches' at a 45 degree angle to facilitate the passage of the anchoring suture needle.[22] However, no mention is made of burying the knot as we advocate. Our line of pull is also different and the paramedian sites are more lateral than the parasagittal one used by McKinney which is too close to the midline. Our line of pull, i.e. vector, gives or maintains a more natural brow appearance.

Rohrich and Beran arbitrarily divided fixation techniques into endogenous and exogenous methods and comprehensively described the advantages and disadvantages of each. In general terms, the exogenous fixation techniques are considered to be more precise, but technically more challenging, whereas endogenous methods do not need external hardware, and are said to be cheaper, safer and easy to learn.[13] Our introduction of the "bevel and slide" modification to the endogenous technique of cortical tunnel fixation confers two further advantages. Firstly, it is simpler to pass the suture needle through the cortical tunnel without blunting it. Secondly it avoids problems with the suture knot and sharp ends.

Fixation of the brow using an endoscopic technique, unlike the open technique, is dependent upon skin retraction and tension-free scalp fixation during the process of wound healing to maintain the desired brow position. Previous authors have commented on the potential of bristles from the fixation suture to become involved with the overlying wound and this problem was highlighted in McKinney's 5-year follow-up which resulted in him switching from polydiaxone (PDS) to softer polyglactin 410 (vicryl) sutures in order to avoid coarse bristles in the overlying wound.[22] Following brow lifting (endoscopic or otherwise) fixation longer than a few weeks is, however, needed.[26] McKinney and Sweis (2001) contend that the 6–8 week fixation provided by vicryl (polyglactin 410) is sufficient, but this has been disputed by others.[30] Given the sparsity of basic scientific evidence that exists with respect to this last point, some surgeons find the idea of a non-absorbable fixation suture appealing.[26] Unlike Jones and Grover we use prolene instead of

Fig. 4. Depression of right forehead skin caused by the temporal fixation suture seen in a 68 year old patient with a receding hairline, thick sebaceous (oily) heavy skin. He presented with functional brow ptosis causing visual field defects. He underwent endoscopic brow lift (with cortical tunnel temporal fixation) and trimming of the upper eyelid skin. Please note the contrast in the forehead appearance between the right and left lateral views. The patient was not concerned about this appearance. The right paramedian fixation site is still indented 12 months following surgery. The appearances are stable and there was significant improvement in his visual fields.

PDS, as used by the Emory University group because it is non-absorbable and therefore gives longer lasting results. We avoid the problem of bristles in the wound by burying the prolene knots in the tunnel. During cortical tunnel creation care must be exercised when drilling to sculpt the calvarial bone bridge, especially in elderly patients whose calvarium may be thin. The technique that we have introduced not only enables easier passage of the fixation suture needle, but allows the knot and suture ends to be effortlessly slid into the tunnel and underneath the bony bridge so that the suture knot and ends are easily placed well away from the overlying wound (Fig. 1). In doing so, giving the peace of mind a permanent fixation suture affords, while avoiding the potential complications caused by suture ends becoming involved in the overlying wound.

6. Conclusion

This small but single operator series adds weight to larger studies which show that the paramedian cortical tunnel suture fixation technique gives stable and reproducible fixation of brow position following endoscopic brow lifting. We have introduced the 'bevel and slide' refinement to the technique, whereby beveling the shoulders of the cortical tunnel and burial of the fixation suture knot into it, can reduce the risk of knot-associated complications.

Conflict of interest

None declared.

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Ethical approval

Patient consent for inclusion in possible publication was obtained for all of those included in the manuscript.

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