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Frontalis suspension by a minimally invasive "harvesting-stripping technique" for congenital blepharoptosis in children under 3-years-old

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Abstract

Purpose: To describe a minimally-invasive "harvesting-stripping technique" on a small segment of autogenous fascia lata (AFL) in small children with severe blepharoptosis under 3-years-old.

Methods : A single-surgeon, uncontrolled surgical trial was designed for 25 eyelids of 18 small children (5 girls, 13 boys) with severe blepharoptosis. Single- and short-skin incisions (2-cm) were made on the thigh and a final 3X0.6-cm or 3.5X1-cm AFL segment was excised according to the ptosis laterality. The surface area of the harvested AFL was calculated and dissected for a final 9-cmX2-mm-long fascial strip for each eye. Functional and aesthetic outcomes of the upper eyelids were evaluated and the feasibility, effectivity and advantages of this novel approach in younger patients were assessed.

Results : The mean age was 28.3 months (17–35) with a mean follow-up of 34.3 months (6–96). All eyelids achieved good or excellent functional and aesthetic results (except one), with no peri- or post-operative severe complications such as haemorrhage, wound infection, hypertrophied thigh scar, muscle prolapses, eyelid contour abnormalities, ptosis recurrence or overcorrection.

Conclusions: "Harvesting-stripping technique" with the AFL may be an alternative approach to correct severe upper blepharoptosis in small children under 3-years-old, which offers various benefits over conventional methods with non-autogenous materials.

Keywords

Blepharoptosis, congenital, harvesting-stripping, small children, technique

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Introduction

Frontalis suspension surgery is indicated if the visual axis is blocked due to severe blepharoptosis as a result of poor levator function or when severe anomalous head posture is obvious. Autogenous fascia lata (AFL) is considered by many surgeons to be the best standard material for treatment and its harvesting is generally performed by ophthalmologists or oculoplastic surgeons. Although such an autograft is ideal for older children and adults in terms of favourable cosmetic results, duration of effect, tolerability and low complication rates, AFL is often not suggested in small children under 3-years-old because of their short leg sizes or poorly developed insufficient AFL, causing a difficult harvesting process and thigh scarring in case of long skin incision.[1] Instead, some alternative materials like banked human fascia and artificial materials (Silicone/Prolene/Mersilene) are used more frequently in this age group.[2,3] However, these non-autogenous synthetic materials have a lower

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short- or long-term efficiency and less favourable aesthetic results with more complications.

If we were able to obtain a short- and narrow-segment of AFL tissue from a single- and short-thigh incision (*i.e.* 1-2-cm), it would be possible to perform blepharoptosis surgery in small children using their autograft. Indeed, it is unclear if such an encouraging "harvesting-stripping technique" is feasible or beneficial for these younger children who have a limited amount of delicate AFL and are still at risk of deep amblyopia from the severely drooped upper eyelid, obscuring the visual axis.

Therefore, this study aimed ***(1)*** to describe a minimally-invasive surgical approach on the thigh in small children with severe blepharoptosis under 3-years-old; ***(2)*** to measure the surface area of the excised short- and narrow-segment of AFL; ***(3)*** to delineate the "harvesting-stripping technique" on this small AFL segment to prepare one or two pieces of long sling materials with adequate tensile strength; and finally ***(4)*** to investigate its functional and aesthetic results, feasibility, effectivity and advantages.

Methods

Interventional procedures were performed by a single surgeon at the Department of Ophthalmology, Division of Oculoplastic, Orbital and Lacrimal Surgery & Paediatric Ophthalmology and Strabismus. All patients were fresh referrals to the eye clinic and all approaches adhered to the tenets of the Declaration of Helsinki. The research was approved by the department's academic board and the Institutional Ethics Committee of Erciyes University. Written informed consent was obtained from the children's parents regarding the images to be published.

All eyes had obscured visual axes from severe blepharoptosis with anomalous chin-up head posture. The children had frontalis suspension surgery with the described "harvesting-stripping technique", which harvests a short- and narrow AFL graft as the sling material obtained from a single- and short-thigh incision.

All patients underwent pre- and post-operative complete ophthalmic evaluation including lid crease position. Eyelid margin level was measured during primary gaze below the superior limbus. Severe blepharoptosis was defined if the eyelid margin was ≥4-mm below the superior limbus in the primary position, obscuring the visual axis.[4] Levator function was measured by the maximum eyelid margin excursion as the child was following a target from extreme downward to upward gaze, while the examiner's thumb pressured over the brow. All children had severe upper blepharoptosis with a poor or absent levator function (between 0–4 mm). Postoperative final lid levels were measured in terms of margin reflex distance-1 (MRD1).

Surgical technique

Harvesting technique

The term "minimally invasive" defines the mini segment of AFL that is harvested from a single lateral thigh incision in the short legs of small children. Under general anaesthesia, the child was positioned in the supine position, the leg was straightened, and the toe was turned medially. After antiseptic preparation of the child's lateral thigh, the harvesting area was draped. The skin incision was positioned on the line between the superoanterior iliac crest and the lateral tibial condyle (LTC). A surgical pen was used to mark a single 2-cm-long line, starting 5-cm above the LTC that extended upwards. A vertical skin incision was made with a number-15 scalpel blade and was carried down through the subcutaneous tissue until exposing the delicate fascia lata, which can be seen as white glistening fibres running parallel to the thigh axis. Minimal superficial bleeding, if present, was controlled with a simple wet compression. No cautery was needed in any case. The little finger was used for further 1-cm manual dissections in either direction of the main incision borders.

An assistant used skin retractors to expose the graft and two vertical 1-cm-long full-thickness AFL cuts were performed with the blade through and parallel to the fascial fibres. The distance between these two parallel cuts was 0.6-cm (unilateral) or 1-cm (bilateral). Both vertical fascial cuts were then extended superiorly and inferiorly using a Westcott scissor for a final of 3-cm-long (unilateral) or 3.5-cm-long (bilateral) cuts. Two additional horizontal cuts (perpendicular to the fibres) connecting these two vertical parallel incisions were performed to the superior-most and inferior-most AFL. The final dimensions of the harvested graft were 3X0.6-cm (Figure 1(a)) or 3.5-4X1-cm (Figure 1(b)) for unilateral and bilateral cases, respectively. The surface area of the harvested graft was calculated. The fascial defect was left open. The subcutaneous deep layers and the skin were closed with absorbable sutures. Topical antibiotic ointment was given to the suture line for 7 days. Skin sutures were removed after 2 weeks.

Stripping technique

The harvested small graft segment was separated from any attached fat or muscles. The graft was then placed on a stainless steel medical tray or on a 6-mm-thick plain square glass (it has a smoother and slippery surface) and was subdivided into 2-mm-wide continuous strips using a number-11 scalpel blade for a final configuration of 'Z' or 'M' (Figure 1(b)). The strip was folded on itself at the continuous corners and sutured together at the cut ends using one 6-0 Vicryl to strengthen it against traction. The final 9-cm-long (unilateral) (Figure 1(c)) or 17-cm-long

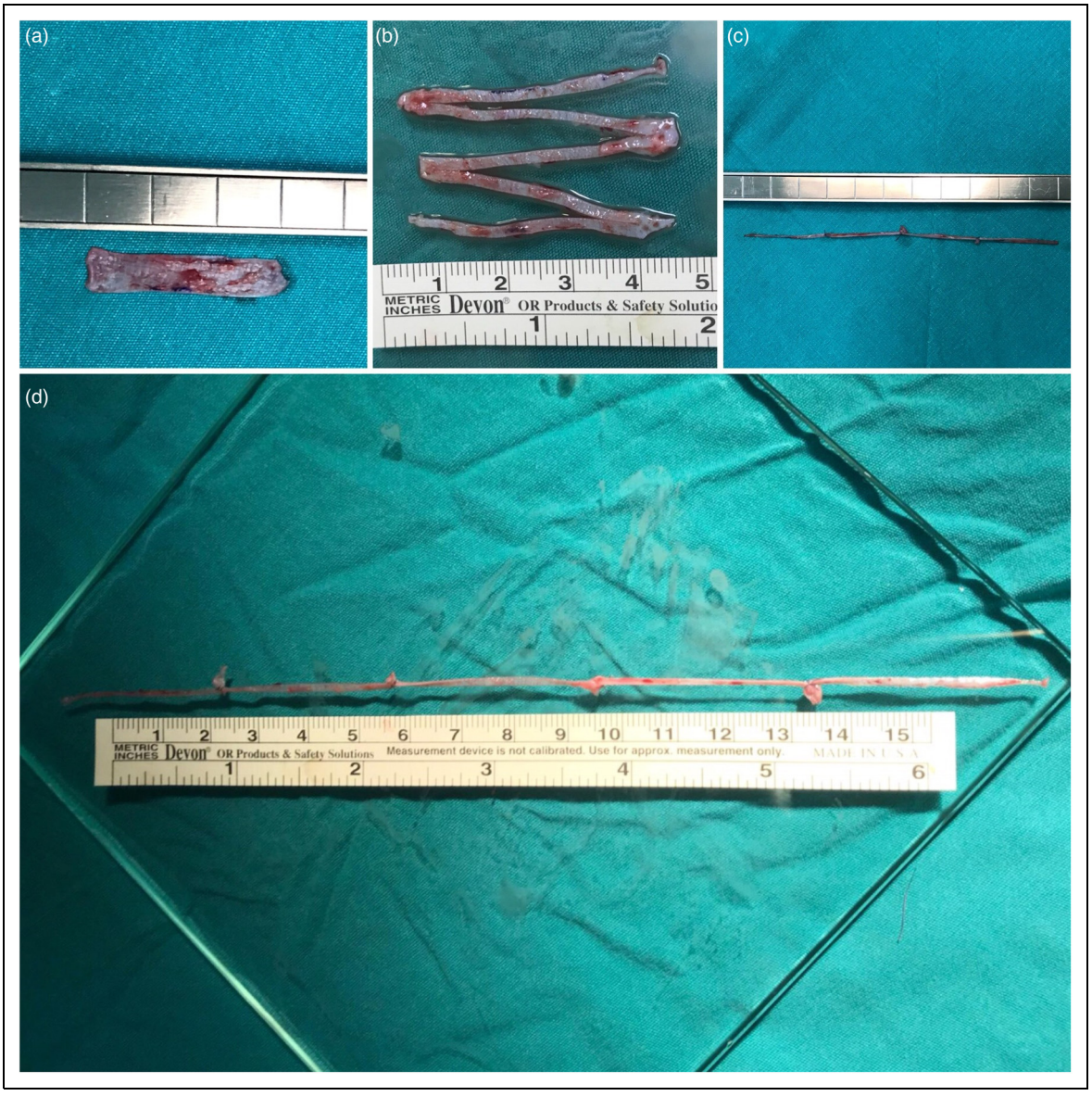

Figure 1. (a) A harvested fascia lata segment from a child with unilateral severe blepharoptosis who needed only a 3-cm-long and 0.6-cm-wide autograft. (b) About 4-cm-long, 1-cm-wide fascia lata segment was harvested in the first 17-month-old child with bilateral severe blepharoptosis, though a 3.5-cm-length of the graft was obtained afterward from all children with bilateral cases. The excised graft is placed on a thick regular glass to cut and subdivide it into 2-mm-wide continuous strips (parallel to the fascial fibres) using a number 11 scalpel blade for a final configuration of 'Z' or 'M'. The final length of the sling material is a 9- to 11-cm-long strip for unilateral (c) and a 17- to 18-cm-long strip for bilateral cases (d).

(bilateral) (Figure 1(d)) AFL strip (2-mm wide) was kept in saline solution until frontalis sling operation.

Frontalis suspension surgery

The modified Fox[5] pentagon technique with five stab skin incisions was used conventionally (two above the eyelashes medially and laterally on the tarsus; two in the forehead medially and laterally just above the eyebrow; one upper-most central incision between the two eyebrow incisions and 0.6-cm higher; Figure 2(a)).

A curved fascia lata needle with a hole in it was inserted from lateral to medial pretarsal incisions. One end of the AFL strip was passed through the hole and the needle was withdrawn back. The AFL strip was sutured to the tarsus using 6-0 Vicryl. No technique was attempted to create an eyelid crease. The free ends were pulled to check their stability against traction and effectiveness. The needle was then inserted from the lower eyebrow

Figure 2. (a) The modified Fox pentagon technique with five stab skin incisions was preferred. (b) A child with severe bilateral blepharoptosis greater than 6 mm with no levator muscle function who had anomalous head posture (c), who needed surgery for functional reasons. At the postoperative 9th month, both the functional and aesthetic outcomes of the upper eyelids were excellent (d), though there was a mild paracentral lateral peaking on the right upper eyelid margin (yellow arrow) and mild asymmetric eyelid crease on the left (green arrow).

incision to the pretarsal incision and each strip-end was withdrawn back in the usual way. Finally, both free strip ends were externalized from the uppermost superior incision for a final of a single rhomboid configuration. The AFL ends were tied together like shoelaces (two times) and the position of the eyelids was adjusted bilaterally (Figure 2(a)).

In bilateral cases, the upper eyelid margins were adjusted perioperatively to a position 1-mm below the superior limbus. A limited upper eyelid correction was aimed for (the lid margin positioned 1.5-2 mm below the superior limbus) in case of poor Bell's phenomenon to avoid postoperative lagophthalmos or exposure keratopathy.[6] In unilateral cases, symmetry was considered with the opposite upper eyelid margin. A 6-0 Vicryl suture was passed through the knot several times and then sutured to the frontalis muscle in the uppermost forehead incision with the same suture. All stab skin incisions were closed using the same absorbable suture.

The hospitalized children were discharged from the clinic the next day after the first evaluation. Broad-spectrum oral antibiotics plus analgesic anti-inflammatory drugs were prescribed (1 week) along with topical antibiotic ointment on the incision sites (2 weeks). Patients' families were

Figure 3. (a) A child with blepharophimosis syndrome had a previous frontal sling surgery with a silicone rod, demonstrating bilateral exposure and undercorrection at the fourth month after the surgery. In this patient, the silicone rods were first removed (b) and then frontal suspension surgery by the presented "harvesting-stripping technique" was performed in the same session. The family did not want to have a further operation for telecanthus of the child. At 2 years after the operation, the functional result was good and the aesthetic outcome was excellent (c).

instructed to observe their children when asleep for possible lagophthalmos and instructed to use lubricating drops if needed. The children were seen at the first and second weeks, and then followed up every 3- to 6-months.

The assessment at each visit included evaluation of the upper eyelid margin level. The final contour and symmetry in the primary gaze were evaluated by photographic review and the **cosmetic success** was defined as **excellent** (less than 1-mm difference between the eyelid heights with an acceptable contour), **good** (1-mm difference between the eyelid margins), or **poor** (more than 1-mm difference in the height of the upper eyelids with a contour asymmetry).

The final eyelid position was measured and the **functional success** was classified as **excellent** (eyelid margin 1-mm below superior limbus), **good** (eyelid margin at the superior pupillary margin but remained clear of the visual axis) or **poor** (eyelid partially obscured the visual axis). Donor site morbidity on the lateral thigh was also evaluated and noted, if present.

Results

Twenty-five eyelids of 18 children (5 girls, 13 boys; 11 unilateral, 7 bilateral) with severe blepharoptosis were

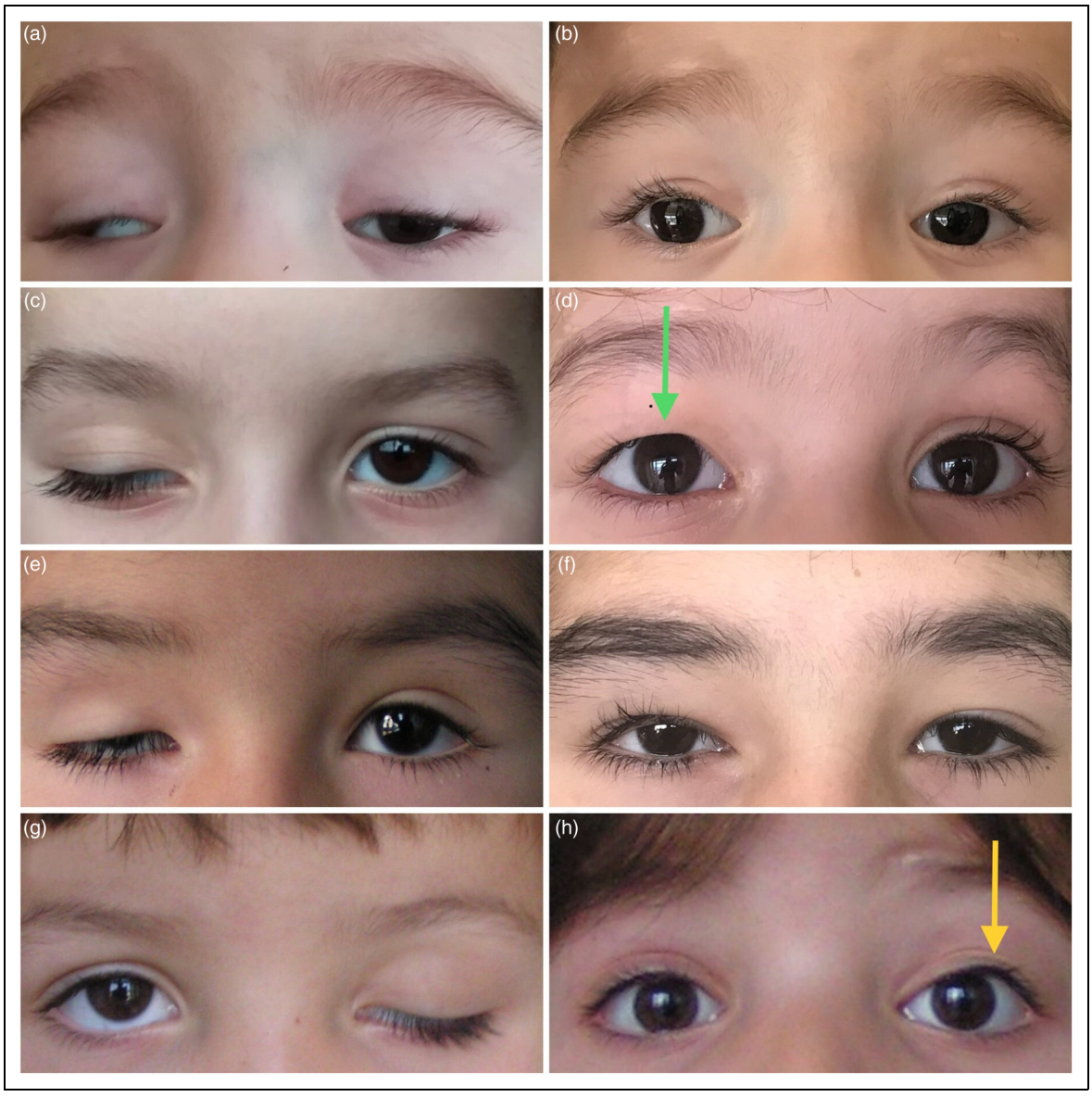

Figure 4. All children had bilateral (a) or unilateral (c, e, g) severe blepharoptosis obscuring the visual axis and the functional results were excellent (b, d, h) or good (f) whereas the aesthetic outcomes were excellent in all children (b, d, f, h) at the final visit. There was a mild paracentral lateral peaking in one upper eyelid (h, yellow arrow) and asymmetric eyelid crease in another case (d, green arrow).

corrected by frontalis suspension surgery using this "harvesting-stripping technique" on the AFL. None of the severe unilateral cases underwent bilateral surgery. One child had horizontal strabismus, one had bilateral congenital dacryocystitis (simultaneously treated) and two had blepharophimosis syndrome. All children had severe blepharoptosis with poor (below 4-mm) or no levator function (Figure 2(b)). Blepharoptosis was greater than 6-mm with anomalous head posture (Figure 2(c)) in all children and surgery was performed for functional reasons in these eyes (Figure 2(d)). Of 25 eyelids, 4 had abnormal preoperative eyelid crease and 21 had no crease. One girl with blepharophimosis syndrome had undergone a previous sling surgery with a synthetic material in a private hospital, demonstrating silicone rod exposure and bilateral undercorrection at the fourth month postoperatively (Figure 3(a)). In this patient, the silicone rods were first removed (Figure 3(b)), and then frontal suspension surgery was performed in the same session (Figure 3(c)). The remaining 17 children had this operation as a primary procedure.

All children were compliant with the follow-up visits. The mean age was 28.3 months (17–35) with a mean follow-up period of 34.3 months (6–96). The mean preoperative MRD1 was 0.0 mm and the mean postoperative

Figure 5. The functional results for children with bilateral (a, g) or unilateral (c, e) severe blepharoptosis were excellent for one upper eyelid (h-*left*), or good (b, d, f, h-*right*), whereas the aesthetic outcomes were excellent (b, d, f) or poor (h, red arrow) at the final visit. In addition, asymmetric upper eyelid creases were present in 2 cases (d, f, green arrows).

MRD1 was 3.4 mm (1.6–5.6). The mean skin incision length was 2 cm and the mean AFL length was 3.2 cm (3–3.5). Of 25 operated eyelids, the functional results were excellent for 12 lids and good for the remaining 13 lids (Figures 4–6). On the other hand, cosmetic results were excellent in 15 patients, good in 2 (Figures 6(d), 5(f)) and poor in one patient (Figure 5(h), red-arrow). Twenty-four of 25 operated eyelids had a postoperative eyelid crease and only one had no crease (Figure 5(h), red-arrow). Of 18 children, 15 had symmetric eyelid creases after the surgery. There were contour abnormalities on two eyelid margins as mild paracentral lateral peaking (Figures 2(d), 4(h), yellow-arrows). In addition, non-satisfactory asymmetric upper eyelid creases were present in 5 cases (Figures 2(d), 4(d), 5(d), 5(f), 6(e), green-arrows). None of the cases underwent a second surgery for contour defects or lid fold asymmetry.

Peri- or post-operative severe complications such as wound infection, stitch granuloma, fistula, graft extrusion, muscle prolapses and hypertrophied scar formation at skin incision sites were not encountered. Similarly, pain on walking or playing was not described by the parents of the small children. However, mild intraoperative bleeding was observed during harvesting in some cases. Twelve children had mild lagophthalmos without corneal exposure keratopathy when asleep within the first few days. There

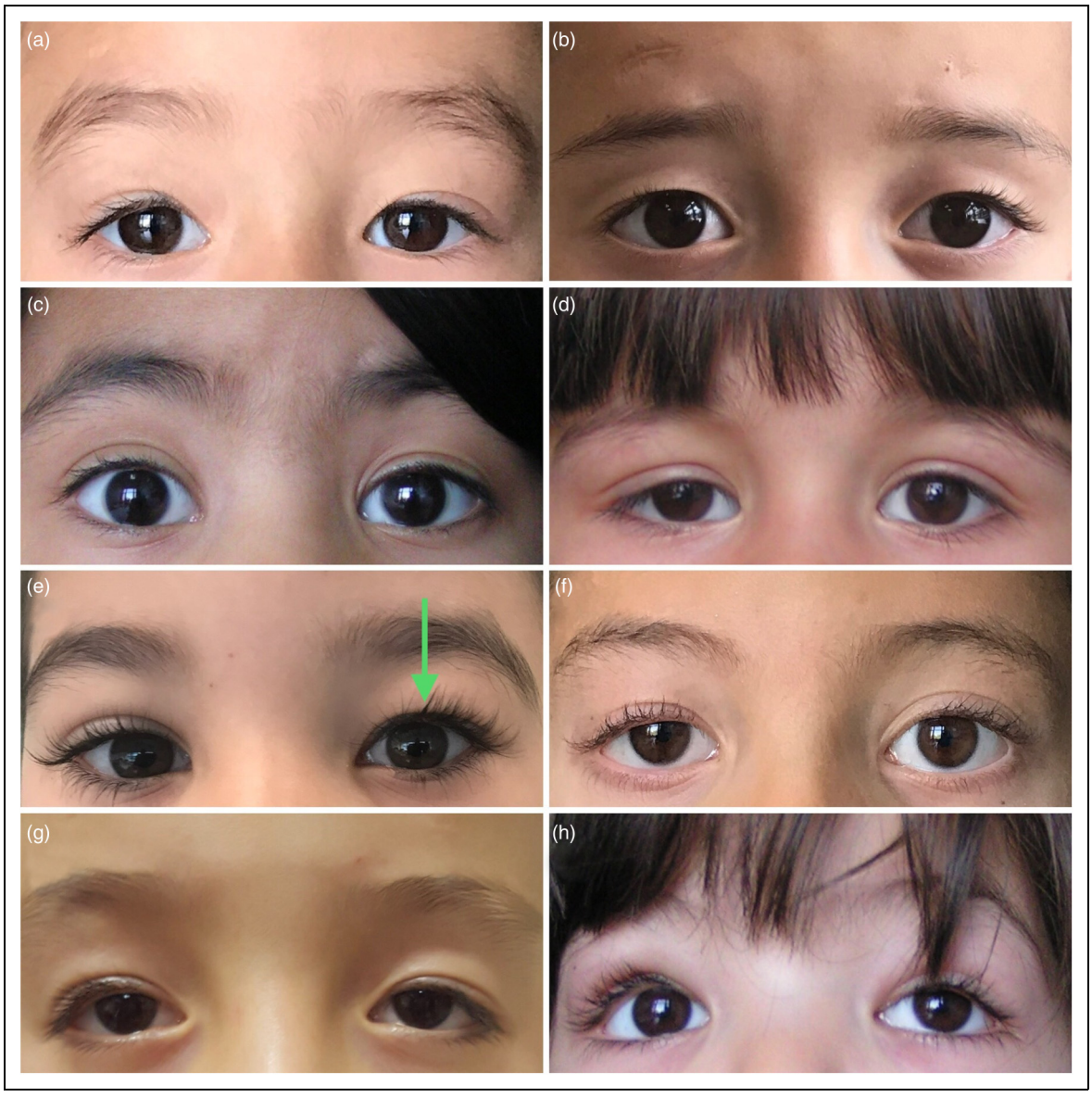

Figure 6. The long term surgical results for unilateral (a-*right*, c-*left*, d-*right*, e-*left*, f-*right*, h-*right*) and bilateral (b, g) severe blepharoptosis demonstrated excellent (b, c, e, h) or good (a, d, f, g) functional outcomes whereas the aesthetic results were excellent (a, b, c, e, g, h) or good (d, f) at the final visit. One eyelid demonstrated an asymmetric upper eyelid crease (e, green arrow).

were no cases of over-correction or ptosis recurrence, but one under-correction (Figure 5h).

Harvesting of the AFL graft took approximately 10 min, and a single lateral thigh incision was sufficient in all children, even in bilateral cases. The stripping technique on the graft for the sling preparation took another 10 min.

Discussion

Children are at risk of developing amblyopia if the upper eyelid blocks the visual axis from severe congenital blepharoptosis, which needs frontalis suspension surgery.[1] Although synthetic materials or banked fascia may be readily available,[2] they are temporary procedures that may need a subsequent replacement for recurrence or possible complications (local inflammatory reactions, infections, granuloma formation, extrusion, absorption).[1,7] Therefore, AFL is considered the gold standard because it is durable, has outstanding tensile strength, easy handling and low complication incidences with a very high success rate.[8] Moreover, it has been reported that the restrictive effect of banked fascia during blinking was more variable than that of AFL.[9] Similarly, banked fascia is associated

with later recurrences and host reabsorption whereas AFL is not degraded and remains in place as "living sutures" for a long period of time.[10] On the other hand, harvesting and stripping of the AFL prolongs the surgical procedure and causes in some cases a linear scar on the thigh.

The most ideal homologous tissue for frontalis suspension is therefore AFL in patients with severe blepharoptosis since it has a high success rate, superior cosmetic results and a longer-lasting effect when compared with the above-mentioned artificial materials. However, there are some difficulties in harvesting this poorly developed delicate AFL in small children under 3 years of age as a result of their very short leg sizes and insufficient amounts of AFL.[1] Moreover, haemorrhage and long-lasting pain on walking or limping may be encountered if a large surface area of AFL is harvested in these patients.[11–13] Similarly, visible muscle bulging at the donor site is the major problem that may be seen in some older children. Such a cosmetic complication is a major concern with younger children as they have smaller thigh sizes. Therefore, it is clear that some new and minimally-invasive alternative approaches are mandatory not only at the skin harvesting site on the thigh but also for the excised graft size and stripping technique in these young children.

The described "harvesting-stripping technique" is easy. A very short and narrow but still sufficient amount of AFL graft was achieved in all cases. There were no cases of recurrences during the follow-up, with satisfactory cosmetic and functional results. In other words, the tensile strength of the structured strip was strong enough against traction on a short- and long-term basis.

In older children, a recent study has used a two hole technique during harvesting of a long (12–15 cm) AFL for frontalis suspension.[14] However, there are two papers using AFL for small children. Leibovitch et al.[15] performed not only a longer (6- to 8-cm) skin incision on the thigh, but also a longer and wider AFL excision to harvest a final of 7- to 9-cm-long and 1- to 1.5-cm-wide graft, which seems to be not short enough in such small children with short leg sizes. Similarly, Philandrianos et al.[16] used two different skin incisions on the same thigh and obtained a longer- and wider-AFL graft than ours. Both studies incised the eyelid crease and exposed completely the tarsus by dissecting the preseptal and pretarsal orbicularis muscle. As a result, both approaches seem to be relatively invasive surgeries in that small age group. In the present article, both the harvesting approach on the leg as well as the stripping technique on the excised smaller autograft were minimally-invasive. Indeed, all of our children not only had one short-skin incision on the thigh, but also the size of the harvested autograft was smaller with its shorter (3- to 3.5-cm-length) and narrower (0.6- to 1-cm-width) dimensions when compared with these two previous articles. If we compare the surface area of the harvested autogenous tissue, Leibovitch et al.[15] excised up to 9X1.5-cm AFL graft (13.5 cm^2 surface area) in their small children whereas the present technique obtained only a maximum 3.5X1-cm graft (3.5 cm^2 surface area) in bilateral cases (except in the first case = 4X1-cm). Both the length and the width of the autograft are lower in the present technique. Moreover, this approach needs only a 3X0.6-cm AFL graft (1.8 cm^2 surface area) for unilateral involvement. Furthermore, if the mono-triangular technique was to be preferred by the surgeon, less than 3X0.6-cm of AFL would be sufficient, which is vital in infants. Therefore, neither muscle herniation in the harvesting area nor difficulty in walking and limping was encountered in the present approach.

The most frequent question about the "harvesting-stripping technique" is whether the lengthened piece of strip presents fragility or is torn at the junctions of the smaller pieces when it is pulled down. No, it does not. As stressed in the technique section, I took special measures to prevent such a potential complication by folding the smaller segments at the junction and strictly suturing them together from their continuous corners using 6-0 Vicryl to strengthen against traction.

The introduced "harvesting-stripping technique" in small children offers the following advantages over previous approaches: ***(1)*** it requires only a single-thigh incision on the upper-knee, avoiding double-thigh or double-leg skin incisions, which minimizes the number of scar formations; ***(2)*** it minimizes the length of the thigh skin incision, which avoids traditional long-leg incisions with poor cosmetic appearances; ***(3)*** it minimizes the total surface area of the AFL graft to be harvested, which preserves the majority of poorly developed fascial tissue; ***(4)*** it reveals broader areas of remaining AFL support for the leg muscles, resulting in lower possibility of visible or invisible muscular hernias; ***(5)*** the "harvesting-stripping" procedure is comfortable, safe, effective and easily mastered for oculoplastic surgeons since the surgery is entirely done under direct observation of the graft to be excised; ***(6)*** it avoids blunt dissections during the surgery with less probability of unwanted trauma to the surrounding tissues; ***(7)*** it reveals easier control of peri-operative small haemorrhages, if present, since it dissects a very small segment of graft from the leg with no postoperative haematoma formation; ***(8)*** it reduces the possible complications of non-autogenous materials and blepharoptosis re-operations; ***(9)*** it may be used in case of blepharoptosis recurrence in the same children or on legs that have previously undergone AFL surgery by another classical technique, and finally; ***(10)*** both the skin and fascial incisions are performed manually with no need for AFL stripper or other sophisticated expensive devices, requiring only ***(i)*** simple conventional instruments (number-11/15 blades, Westcott scissors) for harvesting; ***(ii)*** a 6-mm-thick plain glass for stripping, and ***(iii)*** the surgeon's little finger for AFL dissections during graft harvesting. In addition, if an

alternative fascia is to be preferred, the "harvesting-stripping technique" described here may also be applied to the temporal fascia in small infants since they have a very small amount of such tissues. Similarly, it may also be tried in an 'upper thigh' approach or at the region of the iliac crest according to the preference of the surgeon.[17]

In conclusion, the first results of this minimally-invasive "harvesting-stripping approach" in small children under 3 years of age are encouraging. It is not only a simple, feasible and effective treatment, but is also a safe procedure that respects thigh integrity in that younger age group. The success rate is excellent or good, offering predictable and satisfactory long-lasting outcomes. It needs a short training-learning curve and has low morbidity that avoids possible complications of other non-autogenous materials with minimal functional and cosmetic sequela at the harvesting site.

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The author alone is responsible for the content and writing of the paper.

Consent

Informed consent was obtained from the parents for publication of related images.

Declaration of conflicting interests

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