The orbicularis oris muscle: a functional approach to its repair in the cleft lip

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Summary—Using electrical stimulation the different muscular components of the orbicularis oris muscle are defined at the time of operation for repair of the cleft. By wide dissection and differential re-arrangement, these muscular components can then be brought into their normal position. Not only is a better cosmetic and functional result achieved immediately but it is suggested that some common growth deformities will be avoided.

The repair of a cleft lip, indeed the repair of any deformity, aims to restore the normal anatomy as far as is possible. Such a repair must be based on a thorough knowledge of the normal anatomy and a proper understanding of such displacements as may occur. In the case of cleft lip deformities this is particularly true of the anatomy of the orbicularis oris muscle.

The anatomy of the orbicularis oris muscle

In the classical textbook accounts (Brescia, 1971; Grant, 1952; Last, 1972) the orbicularis oris muscle is described as having intrinsic and extrinsic fibres (Fig. 1). The former are deep to the other structures and bilaterally placed. The latter are superficial and form the bulk of the muscle, coming principally from the buccinator, with the uppermost and lowermost fibres passing straight on into their respective lips whereas the middle fibres decussate. Unfortunately many of the factors which should be taken into account during the repair of a cleft lip are not clearly described. No indication is given of the precise insertion of the extrinsic fibres and of the muscles of facial expression. No mention is made of the formation of the vermilion, which is never dissected in the specimens shown as examples. The formation of the philtrum is not satisfactorily explained (Monie and Cacciatore, 1962) and the impression is given that the orbicularis oris muscle is mainly a continuous sheet of fibres extending from one commissure to the other as a largely homogenous structure.

Several authors (Charpy and Poirier, 1904; Delaire et al., 1977; Lightoller, 1925; Nairn, 1975; Stricker et al., 1977) have given a more precise description of the muscle. Although each author's account may vary in detail the main features are agreed.

There are two well-defined parts of the muscle, deep and superficial (Fig. 2), corresponding to the double function of the orbicularis oris. One function is related to catching food with a general sphincteric activity in association with the other muscular loops of the oropharynx. This is the "archaic" part of the muscle. The other function relates to facial expression and the very precise movements of the lips needed in speech. This part is supported by a complex superficial network of muscle fibres.

The deep orbicularis oris muscle (Fig. 3) originates from the modiolus on each side. It is horizontal with continuous fibres passing from one commissure to the other across the midline and lies...
Insertion of retractor muscles—Superficial orbicularis oris

Superior incisive muscle near bony attachment

Peripheral fibres
Marginal fibres
of Deep orbicularis oris

Figure 2—Diagrammatic representation of a sagittal section of the upper lip to show the superficial and deep orbicularis oris muscle components.

Figure 3—Diagrammatic representation of the deep orbicularis oris muscle.
close to the inner mucosal surface. Its lower border curls upon itself forming the vermilion by evertion the mucous membrane. At the comissure, the curled border of the upper lip muscle divides and the curled border of the lower lip muscle inserts between these slips (Nairn, 1975). When the fibres shorten to close the lips, the margins flatten out and the interdigitation provides a scissor-like motion which seals the angles of the mouth.

The superficial orbicularis oris muscle (Fig. 4) appears to originate from the muscles of facial expression and consists of an upper and lower bundle. The lower or nasolabial bundle derives its fibres from the depressor anguli oris muscle on each side. They insert in the skin forming the philtral ridges (Fig. 5) with short fibres ending in the ipsilateral ridge and long fibres crossing the midline to insert into the contralateral one.

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**Figure 4**—Diagrammatic representation of the superficial orbicularis oris muscle.

**Figure 5**—The philtral ridges. Horizontal section of the upper lip to show formation of philtrum.
The upper, or nasal, bundle represents the common insertion of the fibres of the zygomaticus major and minor, levator labii superioris, levator labii superioris alaeque nasi and transversus nasi. They insert into the anterior nasal spine, the septo-premaxillary ligament (Latham, 1970) and the nostril sill, passing deep to the alar base.

The functional anatomy of a cleft or damaged lip

In a divided but otherwise normal lip, such as encountered in trauma, these three muscular bundles are identifiable and it is felt that they should be repaired independently to avoid unjustified distortion and to restore full function.

Similarly, in a congenital cleft lip the normal structures should be sought and as far as possible restored to their proper position. However, inaccurate anatomical descriptions of the cleft muscle have been unhelpful and misleading. Fara (1968), when studying biopsies, investigated the microscopic distribution of the muscle fibres in cleft lip cases. He described muscle bundles running "... along the edges of the cleft turning upwards towards the line of the nasal wing on the lateral side and to the base of the columella on the medial side". He also stated that "... the muscles of the philtral side of the cleft were always more hypoplastic and did not extend so far towards the edge of the cleft as they did on the lateral side". This description, although precise, is only approximately true as it refers only to the nasolabial bundle and not to the entire muscle.

Pennisi et al. (1969) again examined histological material taken from incomplete unilateral clefts high up just below the columella and went so far as to state "... we can say with relative assurance that if this section could be extended further laterally across the entire cleft side of the lip, the entire mass of the orbicularis oris muscle would be formed in a vertical direction".

These extrapolations from the histological findings seem unjustified as they are based on incomplete evidence. Such a dogmatic statement and the assumption that the orbicularis oris muscle is a simple continuous sheet extending from modiolus to modiolus lead to the simplistic view that it is simply interrupted by the cleft and displaced totally on either side in a vertical direction.

To assess the position of the muscle bundles, electrical stimulation at the time of operation for repair of the cleft has been performed as proposed by Kernahan (1978). The results have been recorded using stereo-photograms, measured on a stereo comparator (Nicolau, 1980; Nicolau et al., 1981) and preliminary findings provide a clearer understanding (Fig. 6).

The deep sphincteric part of the muscle does not reach the extremity of the interrupted vermilion. The muscle fibres are not distorted by the cleft but simply interrupted. They end on either side of the cleft at the point where, in classical descriptions, the skin/vermilion ridge is shown to become thin.

The superficial muscle, which normally inserts either side of the midline, is misdirected by the cleft.

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**Fig. 6A**

Figure 6A—Normal arrangement of the orbicularis oris muscle fibres.

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**Fig. 6B**

Figure 6B—The orbicularis oris in a complete unilateral cleft: there is interruption of the deep bundle and abnormal insertion of the superficial bundles on the cleft side.
and its two components find a new and abnormal insertion on the cleft side and a partially distorted insertion on the non-cleft side.

On the cleft side, the lateral part of the nasolabial bundle is normal and passes from below upwards from the modiolus towards the midline. However, it changes in direction at a point below the displaced alar base, running almost vertically, becoming attached to the nostril and the periosteum of the piriform aperture. Contraction therefore results in a marked lateral bulge.

Stimulation of the nasal bundle on the cleft side could be obtained only after pushing the needle electrode almost down to the bone on the lateral aspect of the ala nasi and in the nasolabial fold. Its pull laterally and upwards appears to be the main cause of the typical nostril deformities.

On the non-cleft side, stimulation of the most medial part of the nasolabial bundle reveals the formation of an almost normal Cupid's bow. It appears that the cleft is disrupting the normal bilateral insertion and that the fibres crossing through the preserved philtral ridge insert into the cleft edge almost perpendicular to it. The lateral part of the nasolabial bundle, away from the cleft, seems totally normal in direction and function as its stimulation reproduces normal lip movements. The nasal bundle appears normal too and is not affected by the cleft as its most medial insertion point is the nasal spine. Nevertheless its unopposed lateral and upwards pull might contribute to the anterior septal deformity.

Clinical implications of the anatomical observations

These findings can facilitate a more accurate lip repair which should include steps to unite the deep bundle thus recreating the sphincter, to re-establish the normal insertion of the two components of the superficial muscle and so provide a proper functional balance.

The failure of some commonly practised lip repairs to include the steps described would account for some of the poor results seen in clinical practice. Equally a clue is provided towards understanding some of the secondary deformities which are encountered in many repaired lips, either immediately or later as growth develops.

In all the procedures where there is a low linear cut into the philtral area to provide the insertion of a flap from the cleft side, as in the techniques described by Le Mesurier (1949); Tennison (1952); Skoog (1958); or Randall (1959) (Figs. 7 to 10), no proper rotation of the lateral muscle is achieved. Furthermore, there is an interposition of muscle brought from the philtral side into a vertical position by the perpendicular split created in the lower philtrum. These fibres inevitably degenerate into a bundle of scar tissue which will compromise normal function. It is particularly noticeable in the Le Mesurier and Tennison repair. Again, the failure to rotate the lateral muscle fibres results in an end-to-side and even side-to-side union which can contribute to both secondary elongation or shortening. This is also true for the Brown-McDowell procedure (1950) (Fig. 11).

The best muscular approximation of the nasolabial bundle in all these "through and through" procedures is achieved in the Millard correction (1964) (Fig. 12). Here the entire abnormal insertion of the muscle is freed by the lateral incision and advanced medially. Unfortunately, it is not necessarily rotated into position. Furthermore none of these techniques, as described, recognise the nasal bundle which is left abnormally attached.

Unsatisfactory results have led surgeons to pay more attention to function and for many years authors have emphasised the importance of muscle repair.

Skoog in 1971 described how he repaired the muscle but there is limited dissection and no rotation or re-insertion to the nasal spine as the muscle mass is split transversely.

Randall et al. (1974) recognised the importance of shifting the misdirected muscle with a major dissection from skin and mucosa on the cleft side (Fig. 13). However, they made no differentiation between deep and superficial fibres. On the philtral side, the nasolabial bundle is widely undermined to free it from its normal insertion into the nasal spine and rotate it downward across the midline into as abnormal a position as the other side, as the bundles are over-rotated and crossed over the midline. Not only is there no correction of the nasal bundle but the normal philtral ridge is destroyed. The end result as it appears on the photographs shows no correction of the lateral bulge, a midline deformity and an emptiness of the median tubercle.

In 1979, Heckler et al. correlated the severity of the nasal deformity with the severity of the orbicularis oris muscle abnormality. They advocated the rotation/advancement technique but once again the part played by the nasal bundle in the formation of the deformity was missed.
Figure 7—The Le Mesurier technique of lip repair. Figure 8—The Tennison technique of lip repair. Figure 9—The Skoog technique of lip repair. Figure 10—The Randall technique of lip repair. Figure 11—The Brown and McDowell technique of lip repair. Figure 12—The Millard rotation-advancement technique of lip repair.
Millard in 1976 explained his refinement for muscular correction. He elevated a superiorly based muscle flap from the edges of his incisions medially or laterally, the only purpose of which was to fill a gap in the suture line when needed and not to give a better anatomical reconstruction.

**Method of repair**

Muscle reconstruction would therefore appear to be the single most important manoeuvre in the repair of a cleft lip and any of the classical operations can be modified to include the necessary dissection (Figs. 14 to 16). The rotation advancement technique is a personal preference as the technique discards a minimal amount of tissue.

Once the skin has been opened the muscle on the cleft side is widely freed from skin and mucosa almost to the nasolabial fold. The marginal bundle is freed from the nasolabial bundle by scissor dissection. The abnormal attachment of the nasolabial fibres into the cleft nostril and the ala is severed. By rotating the bundle medially and

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**Fig. 13**

Figure 13—Illustration from the paper by Randall *et al.* published in *Plastic and Reconstructive Surgery*, 1974. **54.** 316, (reproduced by kind permission of the Editor, Author and Publishers).
Figure 14A—Pre-operative view. Note the deformity of the left ala and of the columella and the flattening of the lip. Figure 14B—Identification of the muscle bundles after subcutaneous scissor dissection. The arrows on the muscle indicate the direction of the pull obtained by electrical stimulation. Figure 14C—The three components of the muscle have been freed allowing easy mobilisation. Figure 14D—The orbicularis oris has been reconstructed with proper orientation and insertion of its fibres. Figure 14E—Pre-operative profile view. Note the drooping tip and the recessed alar base. Figure 14F—Post-operative profile view ten days later. The alar base has been brought medially and forward improving the shape of the nostril and of the dome.

downwards its deep attachment to the periosteum and to the nasal bundle is recognised below the alar base and freed allowing easy and full mobilisation. The nasal bundle is found deep to the nasolabial bundle. It is elevated with its perioisteal attachment and brought towards the midline to be sutured to the nasal spine, bridging the cleft of the alveolus and helping to bring the alar base forward. It is therefore necessary to elevate the mucosal flaps to reconstruct the buccal sulcus before the repair of the muscle.

On the philtral side, the dissection of the muscle is limited to the sphincteric part only and the nasolabial bundle. It is very restricted under the skin to avoid disruption of the normal philtral ridge, but is more extensive on the mucosal surface. Both bundles are freed from each other and sutured to their corresponding units on the cleft side, the uppermost part of the nasolabial bundle being attached to the nasal spine below the repaired nasal bundle. The dissection in itself releases so much tension that muscle union can be achieved with 6/0 suture material. No particular method of suturing muscle fibres is used as no undue tension is encountered. Generally, at this stage, the skin closure is almost complete and the sutures merely provide perfect approximation of the cutaneous edges.

In some cases it has been found helpful to use a nerve stimulator during the operation to confirm the orientation of the muscle bundles and of the correction achieved. Post-operatively, there may be some swelling and bruising due to the wider dissection but this disappears in a matter of days.

Conclusion

The restoration of the functional integrity of a cleft lip should be based on a proper anatomical assessment aided by preliminary electrical stimulation of the muscle bundles.
The three different bundles of the orbicularis oris muscle must be repaired independently to allow each to fulfil its separate function. Only the insertion of the nasal and nasolabial bundles into the anterior nasal spine will establish the proper balance needed for harmonious growth.
Figure 16A—Although the cleft in this child does not appear to involve all the elements of the lip, note the gross alar deformity due to total muscle disruption which was well shown by electrical stimulation. At operation only fibrous tissue was found at the level of the cleft. Figure 16B—The three muscle bundles have been dissected and re-orientated in their correct position. Figure 16C—The orbicularis oris has been reconstructed. Figure 16D—Immediate post-operative appearance using a Tennison-Randall type of closure. Note the absence of tension at the suture line and the correction of the nostril deformity.
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