

Restoration of the Collapsed Maxillary Arch by Rapid Expansion and Bone Grafting

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This paper describes a combined orthodontic and surgical approach to the problem of permanent restoration of the collapsed maxillary arch which we believe to be original. It consists of rapid orthodontic expansion, using fixed appliances, and maintenance of the corrected position with a bone graft. Twenty-four cases have been treated over a period of three years without relapse. Treatment can be commenced as soon as sufficient permanent teeth have erupted to permit fixation of the appliances, in practice this means from about the eighth year. There appears to be no upper limit to the age at which the method can be used. It is as readily applicable to adults as to children.

It is well known that the unavoidable scar tissue, which results from the raising of subperiosteal flaps to close maxillary clefts, restrains the subsequent growth of the bone. This restraint adds to the deformity which inevitably occurs in all these cases because of the partial failure of development of the maxilla. But avoidance of this restraint by postponing closure until after the growth period handicaps the child so seriously educationally, psychologically, and socially that it is unacceptable.

These facts compel an attempt to correct the deformity secondarily. In addition to achieving this the method described here confers the following advantages.

AIRWAY. The obstructed airway which often results from repair of complete clefts is a source of upper respiratory tract infection, sinusitis, and otitis media leading to poor physique, deafness, bronchitis, and other ailments besides handicapping the individual's exercise tolerance for life. It is extremely difficult to correct by operations on the soft tissues despite the multiplicity of ingenious techniques described. Maxillary expansion achieves this more completely and more certainly than any other method known to us and the operation is worth doing for this purpose alone. According to Schwarz the average size of a nostril of a boy

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aged 8 to 10 years is 40 square millimetres (5). The average maximum height of the nasal cavity at this age being approximately five centimetres, the airway will be increased by 50 square millimetres by widening it by as little as one millimetre—by more than the size of the whole nostril aperture. Since the width is increased by much more than one millimetre and because the floor is lowered as well by expansion, the increase in air space is sufficient to restore normal nasal breathing. These findings have been confirmed by Derichsweiler by tomography and by direct measurement (3).

FACIAL CONTOUR. The expansion of the maxilla stretches the tight upper lip and the support afforded by the graft lifts the fallen ala and fills out the flattened cheek. Also in bilateral cases the depressed nose tip can be elevated and the rotated premaxilla straightened.

TEETH. Besides the restoration of a more normal occlusion, for which the procedure was designed, the distraction of the maxillary segments enables teeth to erupt which would otherwise remain buried and facilitates prosthetic improvement of the position of teeth bordering the cleft. The stable graft also facilitates the fitting of a denture or a bridge to conceal the dental deficiency.

Orthodontic Treatment

Rapid expansion of the collapsed maxilla is not new. The first case was described by Angell in 1860 (1) and rapid expansion was later practised by many others, but failure to maintain expansion by the insertion of a bone graft led to a high rate of relapse. Goddard (4) used an appliance similar to that recently suggested by Derichsweiler (3) when reporting a series of 400 cases. In 1912, Wright (6) measured the increase in width of the nasal airway in 30 cases and found it to range up to 6.5 mm, following Brown's observation in 1903 (2) of the improvement in the airway following expansion. In 1956, Ziegelmayer (7) demonstrated on cadavers the ability of orthodontic expansion to split the maxilla with a fixed appliance.

In our series, expansion has been undertaken in both mixed and permanent dentitions. The only limiting factor is the need to have sufficient permanent teeth to which to cement each section of the splint. This consists of a sectional cap splint the lateral elements of which cover all teeth distal to the canine. In bilateral cases, and in unilateral cases in which there is retrusion of the premaxillary segment, a third section of the splint covers the incisor teeth.

Each segment carries retention wires on its lingual aspect for inclusion in the acrylic in which the expansion screw is set. The screw is of the Fischer type. The heavier model allows for 11 mm of expansion; the lighter model, eight millimetres. The screw is set in the acrylic so that it lies over the midline of the palate and is at the same angulation to both

lateral segments. With careful positioning in this way overdistracted of the greater segment in unilateral cases has not occurred. The lesser segment which needs more distraction than the greater has moved more and the resulting occlusion on both sides has been satisfactory.

In cases in which the premaxilla has needed to be moved forward a second screw has been incorporated at right angles to the first. This is attached in front to the premaxillary segment of the splint and behind to a free moving square rod and tube set into the acrylic in front of and parallel to the screw moving the maxillary segments.

The upper surface of the acrylic is relieved to allow for the downward movement of the palate as the segments are distracted and the acrylic is polished so that the mucosa can be observed through it. If more expansion is needed than one Fischer screw can provide, as is often the case, it is cut out when fully expanded and a new unexpanded screw is inserted, using rapid setting acrylic after protecting the palatal mucosa with tin-foil, which is subsequently withdrawn.

The patient or parents are instructed to turn the screw three times a day and to report for observation at frequent intervals. Expansion is complete in three weeks or less. The patient experiences no pain but a sense of heaviness along the line of the palate during the first few days, at which time it can be demonstrated radiologically that the bony elements are splitting along the line or lines (in bilateral cases) of the original cleft. No mucosal tear has occurred and existing fistulae are not demonstrably enlarged. The patient is instructed in oral hygiene to ensure that food does not lodge in the apparatus.

Surgical Treatment

The bone graft is best taken from the thin inner table of the ilium. A piece measuring 4 x 5 cm is needed for the average unilateral cleft and 5 x 7 cm for a bilateral cleft. Bleeding is copious from the soft tissues of the buccal sulcus and since accurate dissection is a prerequisite a hypotensive anaesthetic is of great assistance.

Technique

UNILATERAL CASE. The operation is performed with the expansion splint in situ. The upper lip is retracted and the buccal sulcus incised sufficiently widely to expose both bony margins of the cleft. Complete haemostasis is then secured. The dissection across the soft tissue gap is made with meticulous care to minimize the chances of injuring the buccal or nasal mucosa or of increasing the size of existing fistulae. These dangers are reduced to a minimum by dissecting from each bony margin in turn toward the centre of the cleft because the orthodontic distraction loosens the buccal and nasal mucoperiosteal layers from the bony surfaces, making it relatively easy to find the correct tissue plane. When the

gap has been spanned in this way, the layers are separated to a depth of about five centimetres. In doing this the margins of any fistulae encountered are incised so that the nasal mucosa is completely separated from its buccal lining. Any fistulae or any tears made during the dissection in either layer are then carefully repaired with catgut using a Jalaguier needle. The measurements of the dissected space are then carefully taken and the angle of obliquity needed on the anterior alveolar border of the graft is noted, remembering that if the lesser segment is underdeveloped a tongue of bone can be left on the graft to build it forward, so providing a platform on which the ala can rest. The graft is then cut to the requisite size and shape so that when in position it forms a platform sandwiched between the mucosal layers and completely filling the dissected space. It is usually narrowest in its alveolar part, opening out a little in front and more behind; thus it resembles in shape a lady's hand mirror, unless a laterally directed pre-alveolar tongue is needed as well to augment the lesser segment.

In the early cases the graft was always cut so that its periosteal surface lay beneath the nasal mucosa, but more recently the periosteum

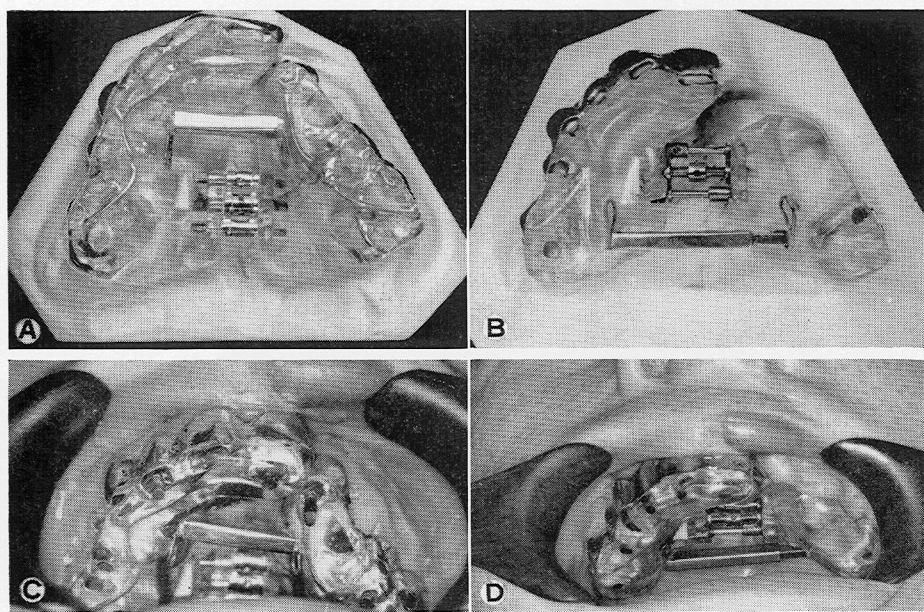


FIGURE 1. Case I: unilateral cleft. (a) Splint on model before expansion. (b) Splint on model after expansion. (c) Splint in situ before expansion. (d) Splint in situ after expansion. (e) X-ray films showing splint before and after expansion. (f) X-ray films before expansion and after expansion and insertion of bone graft. (g) Articulated models before and after expansion. (h) Bite before expansion. (i) Bite after expansion and insertion of bone graft. (j) Gap created filled with two teeth on denture.

has been placed against the buccal mucosa if this contained a fistula or was torn at dissection because it seemed likely to offer better resistance to infection if closure was not watertight. This change of technique was made on theoretical grounds because no infection has so far occurred. When the bony platform is in place, its stability is ensured by the insertion of match stick bone pegs along its medial and lateral edges. If the periosteum of the main graft is apposed to the nasal mucosa, the pegs are placed below it with their periosteal surfaces against the buccal mucosa and vice versa. The incision in the buccal sulcus is closed with silk stitches which are removed after 10 days. Antibiotics are given for a week post-operatively and the retention splint is left in place for seven weeks. A removable appliance is worn at night for three months subsequently, and then discarded in favor of a denture or, in an adult, of a fixed bridge (see Case I shown in Figure 1).

BILATERAL CASE. The procedure is essentially the same as for the unilateral case. But the incision in the buccal sulcus goes from one maxillary segment to the other, leaving no uncut mucosa over the pre-maxilla. This ensures the maximum exposure and is without danger to

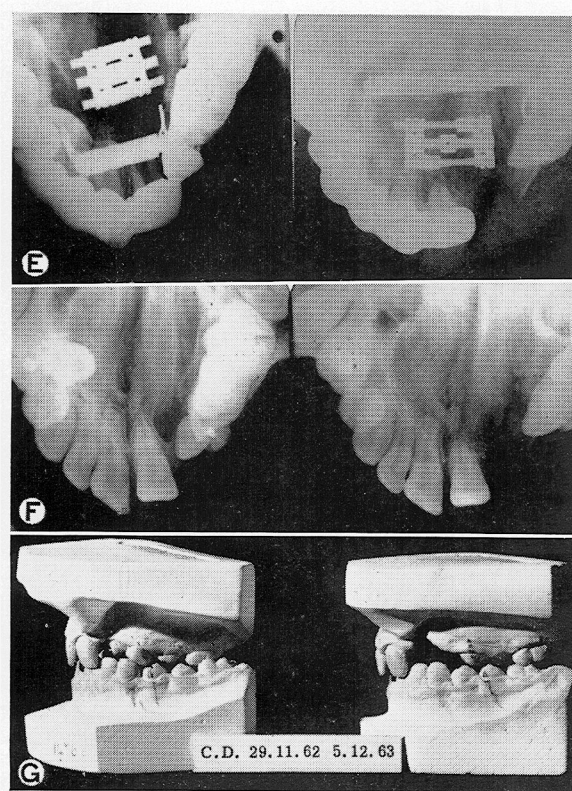


FIGURE 1. (e-g)

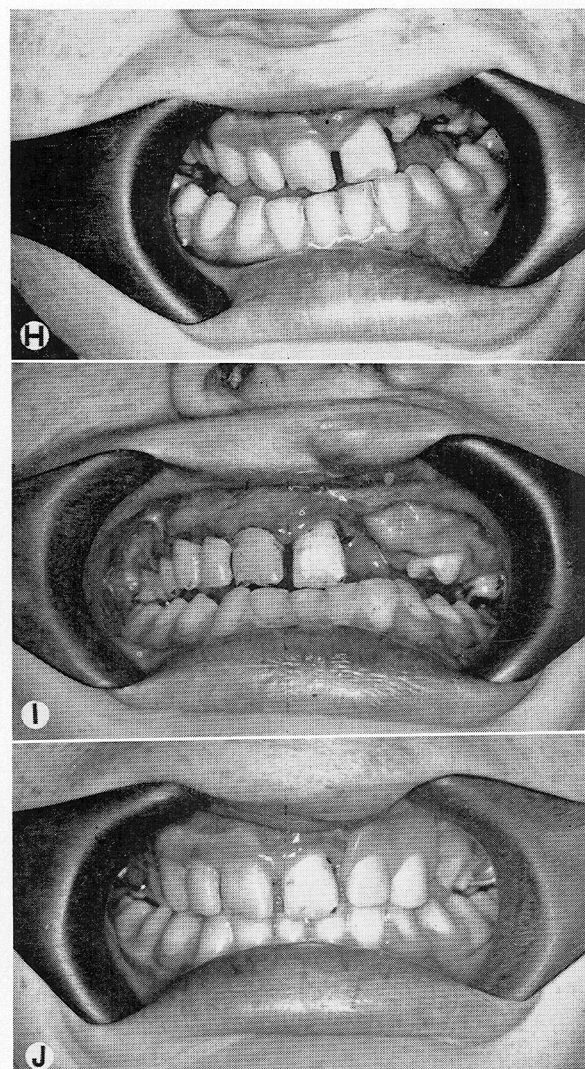


FIGURE 1. (h-j)

the viability of the premaxilla. A graft is fashioned for each cleft and when in situ the two are separated from each other by the lower margin of the septum. Post-operative management is as already described for the unilateral cleft (Figure 2).

Modifications of Technique

ABSENT PREMAXILLA. In bilateral cases in which the premaxilla is grossly hypoplastic or absent, the graft is best cut as a single shelf, the shape of which is dictated by the disposition of the cavity. When in

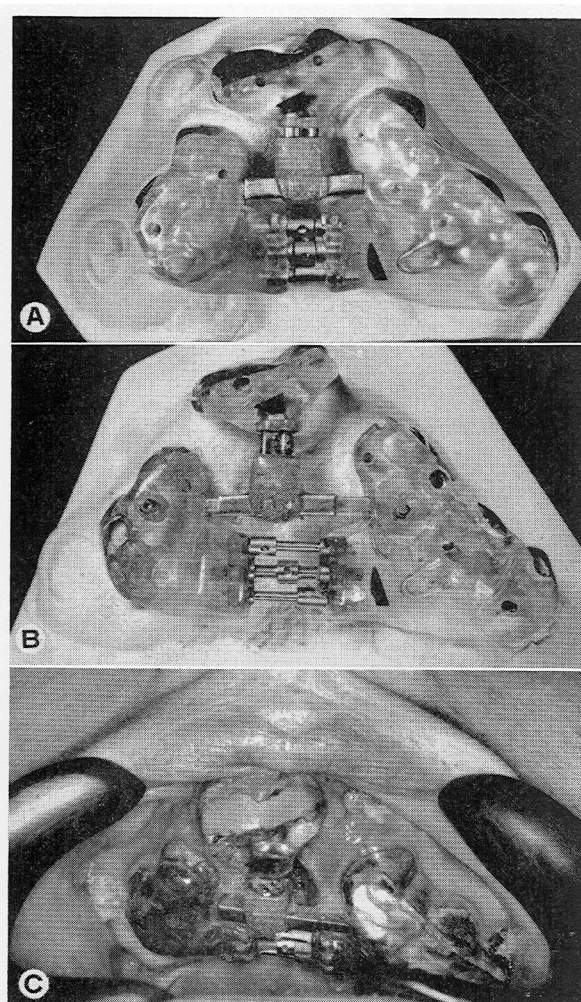


FIGURE 2. Case II: bilateral cleft. (a) Splint on model before expansion. (b) Splint on model after expansion. (c) Splint in situ after expansion. (d) X-ray films of splint before and after expansion. (e) X-ray films before expansion and after expansion and insertion of bone graft. (f) Articulated models before and after expansion. (g) Bite before expansion. (h) Bite after expansion.

place, it surrounds the front of the septum and passes beneath its anterior extremity for at least a centimetre.

DEPRESSED NASAL TIP. The tethered tip, so often seen in bilateral cases, can be released by dissecting the septal mucosa freely on both sides and cutting the septum across immediately above the premaxilla. The line of section traverses the nasal spine which is easily divided with a dental drill. The space so created between the septum and the premaxilla is then filled with a thin triangular plate of bone set perpendicularly and resting inferiorly on the upper surface of the premaxilla (Figure 3).

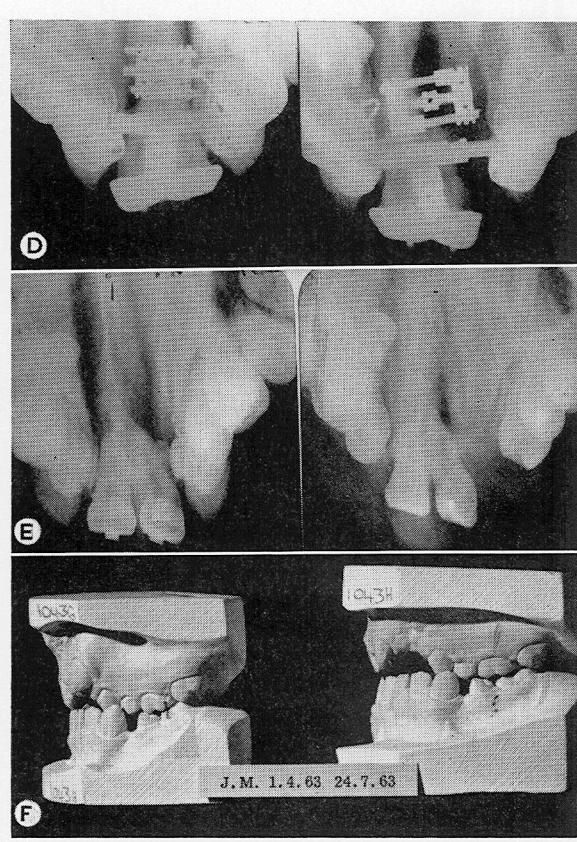


FIGURE 2. (d-h)

ALIGNMENT OF MAXILLARY SEGMENTS. As is well known, the lateral maxillary segments may also be displaced in the vertical plane in cases of collapse of the arch causing an open bite. The whole lesser segment may be elevated or, more commonly, its anterior end rotated upwards.

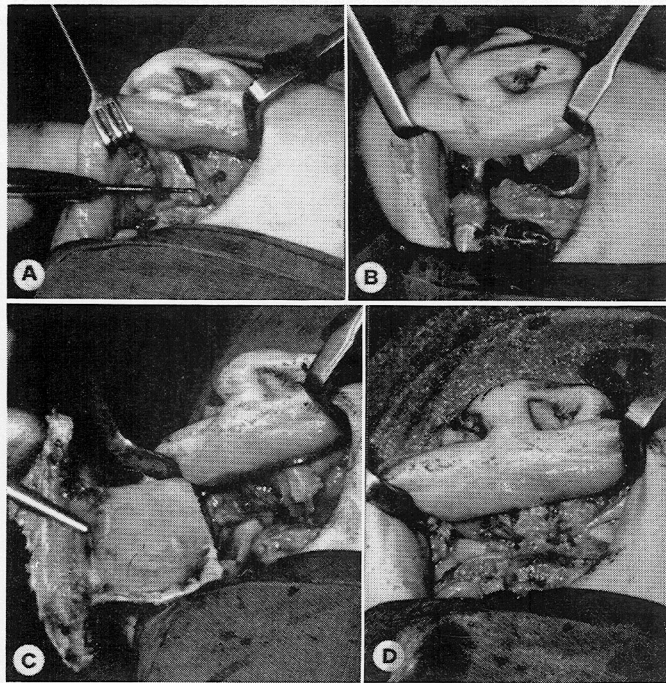


FIGURE 3. Case III: operative technique. Bilateral case with freeing of depressed nasal tip. (a) Cutting septum from nasal spine with dental drill. (b) Cavity prepared for bone graft. (c) Bone graft with big anterior tongue to support nasal base (d). Bone graft in situ with bone pegs above it.

Similarly in bilateral cases the premaxillary segment may be too high despite the nose tip being depressed. Correction of these deformities by suitable osteotomies is not difficult, but necessitates careful pre-operative orthodontic treatment. The segments of the maxillary study model are cut free and accurately placed in correct occlusion on the mandibular model. Separate cap splints are then prepared for each maxillary segment and locking bars fashioned which will hold the segments in their corrected positions by means of appropriate screw plates. A cap splint is also made for the mandible and suitable retention hooks or screw plates incorporated to allow intermaxillary fixation. The expansion splint is removed on the day of operation and the separate splints are cemented to the maxillary segments and to the mandible. In a unilateral case, the maxillary splint is in two parts and in a bilateral case in three (Figure 4).

At operation an ectopic premaxilla is freed from the septum as already described in the technique for freeing the nasal tip and lowered into correct occlusion. A displaced lateral segment is freed along the lower border of the nasal aperture after separating the antral lining to avoid injuring it; the osteotomy is safely performed, like the premaxillary separation, with a dental drill. The locking bars are then set in place and

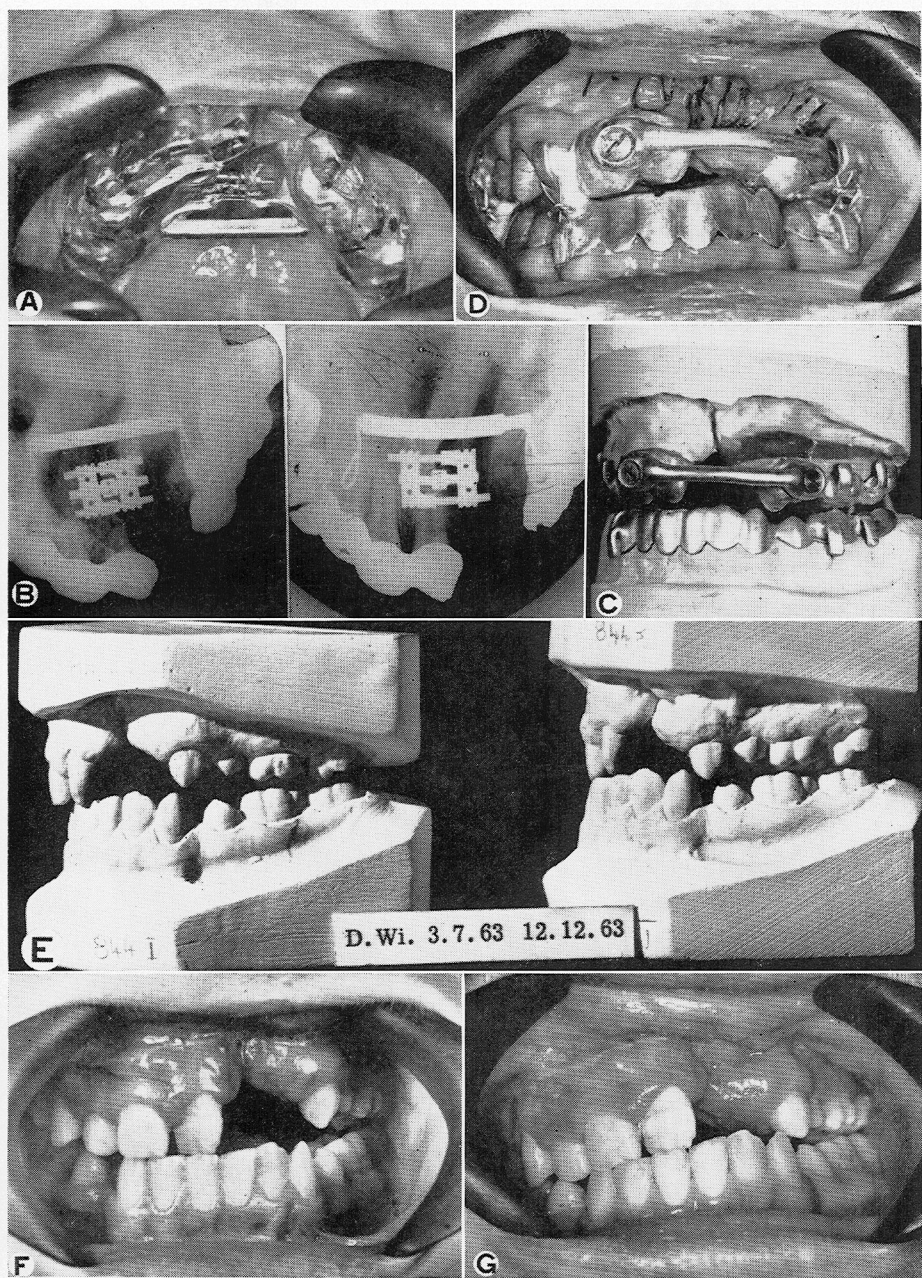


FIGURE 4. Case IV: lateral open bite. Correction of open bite as well as expansion in unilateral case. (a) Expansion splint in situ. (b) X-ray films before and during expansion. (c) Sectional maxillary splint and locking bar prepared on model together with mandibular splint. (d) Fixation immediately after correction of lateral open bite and insertion of bone graft. (e) Articulated models after expansion, and after correction of lateral open bite and insertion of bone grafts. (f) Bite after expansion but before correction of lateral open bite. (g) Bite after expansion and correction of lateral open bite and insertion of bone grafts.

intermaxillary fixation secured. The bony gaps opened up by aligning the segments are filled with bone grafts which are additional to the grafts inserted to close the main clefts.

Post-operative maxillary fixation is maintained until the whole maxilla is clinically stable; this is easily tested by loosening the locking bars. The premaxilla sometimes takes three months to stabilize, while the lateral maxillary segments stabilize in seven weeks. Intermaxillary fixation need only be maintained for about a fortnight.

Summary

Twenty-four cases of complete clefts of the palate (unilateral and bilateral) have been treated over the past three years by rapid maxillary expansion. The expanded position has been maintained by using iliac bone grafts. Treatment is undertaken with either mixed or permanent dentition and takes the brief span of three weeks or less. Improvement in the nasal airway, the facial contour, and the dental occlusion have been achieved and there have been no relapses, cases of infection, loss of the grafts, or increase in the size of existing fistulae.

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