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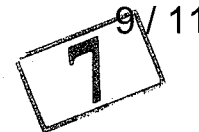
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# Results of 310 cases of rapid maxillary expansion selected for medical reasons\*

By LINDSAY P. GRAY (Perth, W. Australia)

FROM birth the normal method of respiration is by the nose and any interference producing mouth breathing causes considerable local or general impairment of function. The interference is caused by a combination of factors, such as narrowness of the nose often associated with maxillary compression, allergic mucosal swelling, deviated septum, infection, and at times obstructing adenoids. Rapid maxillary expansion is a simple, conservative, but very efficient method of converting mouth breathing back to normal nasal respiration in a high proportion of cases.

Rapid maxillary expansion (referred to as R.M.E. for this paper) is performed by applying strong pressure to the back teeth over a relatively short period of time causing the maxillae to separate down the intermaxillary suture, without the teeth moving in the bone. This not only changes the dental occlusion, but also widens the nasal cavity.

## Historical

The first record of work on R.M.E. was that of Angell in 1860, who performed it to provide space for the canines. Since about 1900 there have been many reports (as well listed by Wertz, 1970; McCracken, 1970) of associated medical results, such as improvement in nasal airway, nasal allergy and asthma. The reported results have been very good and quite challenging. For example, Griffiths (1958) and Braun (1966) reported improvement in asthma cases, and Stockfish (1969) reported the following results in a series of 150 cases aged 6-32 years, 5-15 years after R.M.E.

82% Now nose breathing.

45% Marked increase in concentration at school.

20% Had had previous adenotonsillectomy without improvement.

10% Still mouth breathing.

8% Partial improvement in nose breathing.

The present investigation was commenced in 1968, and has given very similar excellent results. This paper presents the results of 310 consecutive cases selected for medical reasons and followed up for at least six months.

\*Based on a paper presented at the Combined Meeting of the Otolaryngologica Societies of Australia and New Zealand 1973.

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**Regarding the method**

In an orthodontic movement produced by prolonged gentle pressure, the teeth move in the bone. In an orthopaedic movement (as in R.M.E.) the teeth do not move in the bone. In R.M.E. the large pressures up to 20lb. (Isaacson *et al.*, 1964) which can be developed, fix or lock the teeth in the bone, and the maxillae separate down the intermaxillary suture. It has been shown that little if any trouble is caused to the teeth (Rinderer, 1966). The method used in this series has previously been reported by Gray and Brogan (1970, 1972).

There are several types of appliance in use, and the one used in this series which has been developed in the Princess Margaret Hospital, is particularly suited to the younger age group. It is applied directly to the teeth, as any extension over the gums has been found to be unnecessary (see Fig. 1). It comprises individual silver castings for the posterior 3-4

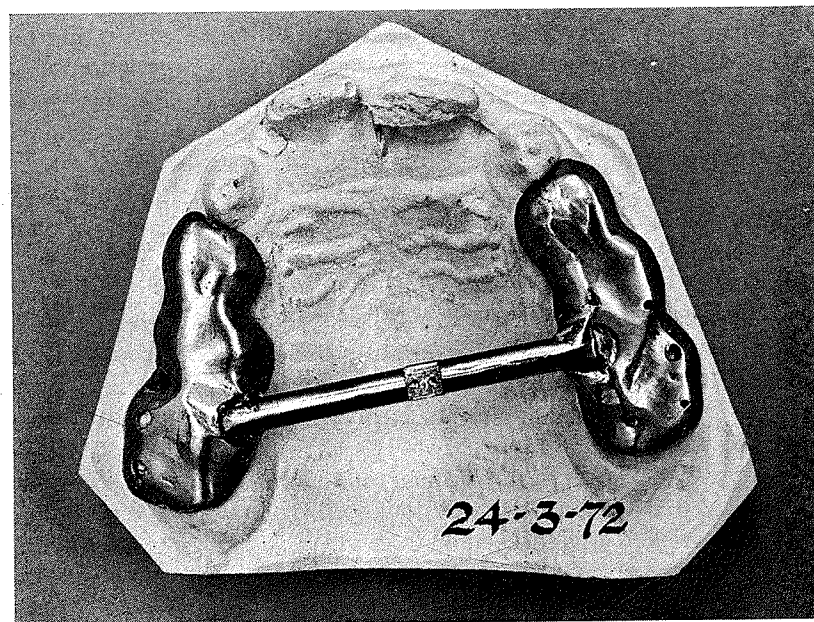


FIG. 1.

Expanding device and Spanner: The 4-sided central turning nut is marked on each side to enable progressive identification. Note the cast base is at an angle, but the bar is in the coronal plane.

teeth which are connected by a stainless steel expansion screw. The screw is turned a quarter turn night and morning by the parents, using a small spanner, until the required expansion is attained. This usually takes about 3 weeks. The screw is then locked and the appliance removed 6-8 weeks later. About 7-8 mm expansion is usually produced, and it retracts down to

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5-6 mm on removal. (One mother failed to report in 3 weeks, and continued screwing, producing an expansion of 12 mm which was simply reduced by unscrewing.) The intermaxillary space becomes filled in (see Fig. 2). The central incisors, which obviously spread in 3 weeks, usually have rotated back to their original appearance by the time the appliance is removed (see Fig. 2). The teeth usually stay expanded, but if signs of relapse occur then a retention appliance is fitted. This is used in about 50 per cent of cases. There is very little discomfort and then only for the first 24 hours.

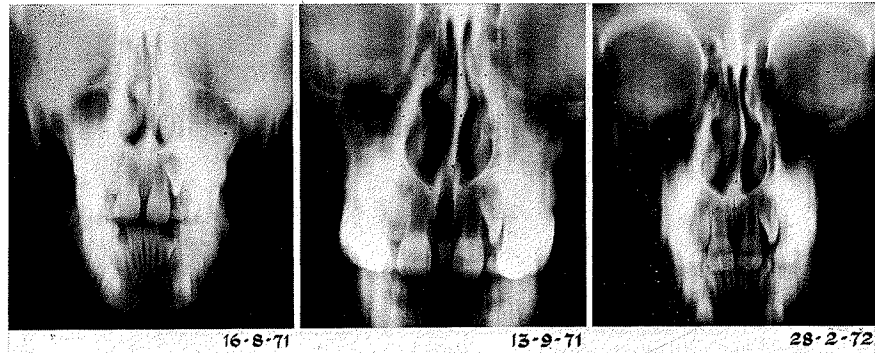


FIG. 2.

Filling in of Intermaxillary Space: Anterior tomographs taken before (16/8/71), during (13/9/71) and 6 months after (28/2/72) R.M.E. Note after 6 months the roots of the central incisors are kept separated by new bone formation, and that the tips of these teeth have rotated medially enabling the crowns to meet in the mid line.

The maxillae separate from each other and also from the vomer (see Figs. 2 & 4). At times the vomer may stay attached to one side (see Fig. 3), as demonstrated by Derichsweiler (1953). The diastasis between the maxillae is practically parallel, with the opening the same anteriorly and posteriorly.

The nasal cavity expands in 3 dimensions, horizontally, vertically and forwards, and the result is a combination of these different movements. The maximal expansion is always at the level of the inferior turbinates, with a variable degree of expansion superiorly. The main lateral nasal movement can be described as triangular, with minimal expansion high up opposite the ethmoids, as if the whole maxilla has rotated. In a small percentage, there is considerable expansion high up giving a parallel type of movement, as if the whole maxilla has moved laterally. In most there is also a varying degree of rotation of the lower part of the maxilla in which the teeth are imbedded. This part not only moves laterally but appears to rotate on a fulcrum just above the origin of the inferior turbinates. This causes the medial edge next to the vomer, to move both laterally and

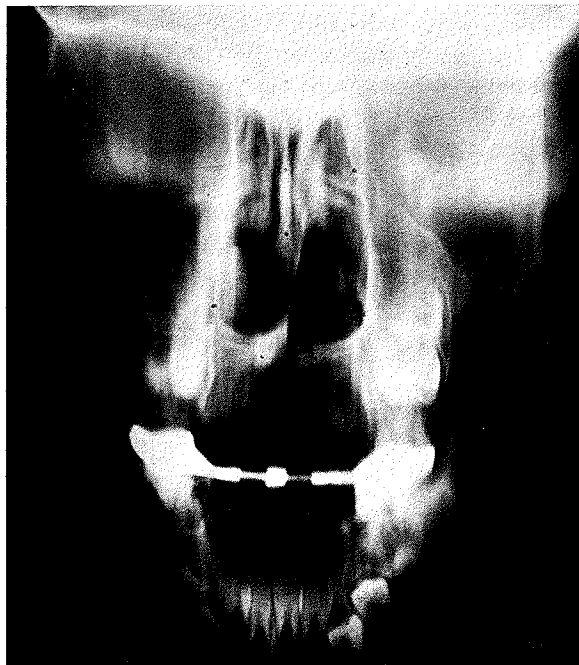


FIG. 3.  
Unilateral Separation. Note separation from the vomer on the left, while the right maxilla together with the attached vomer has rotated without widening the right side of the nose.



FIG. 4.  
Rotation and downward movement: Posterior tomographs before (10/1/73) and at end (16/2/73) of R.M.E. Note the rotation of the lower part of the maxilla and palate with increase in vertical height of the nose, more marked on the left side. Note the pencil dots placed for measuring purposes.

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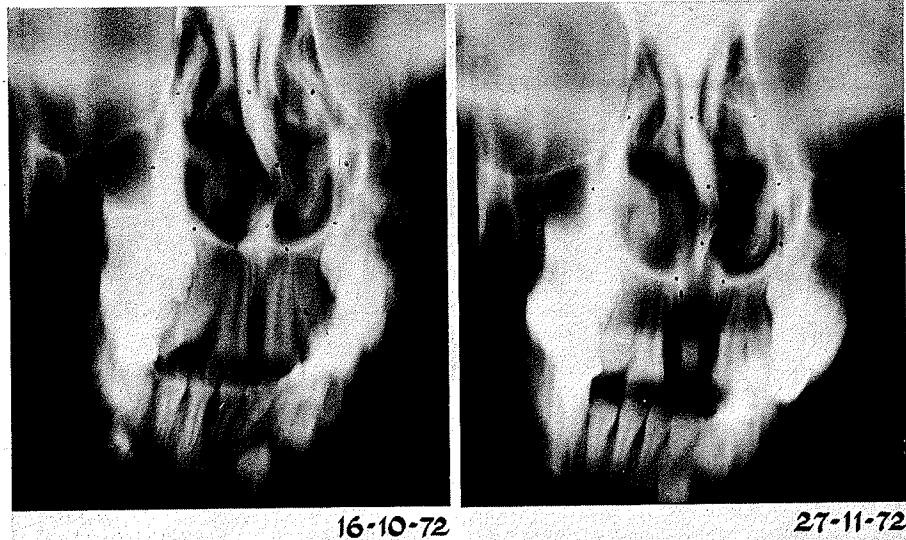


FIG. 5.  
Straightening the Septum. Anterior tomographs before (16/10/72) and at the end (27/11/72) of R.M.E. Note the straightening of the septum which was also apparent on clinical observation.

downward (see Figs. 4 & 5), thus increasing the vertical dimensions of the nose (1-3 mm), and also tending to straighten the septum (see Fig. 5). If the vomer stays attached to one side, then it also may rotate, and there may be only unilateral improvement in the airway. (See Fig. 3).

We have been unable to correlate the X-ray appearances and the amount of expansion, with the clinical results. As Post (1966) observed, one is unable to assess the nasal airway from the dried skull—i.e., the soft tissue reaction is most important. In some cases of R.M.E. there is dramatic improvement in nasal airway in one week when only minimal expansion has occurred.

The amount of expansion is governed mainly by clinical improvement, but also by the combination of the fact that the greater the expansion the less likely for relapse to occur (Stockfisch, 1969), the type of malocclusion, and the final assessment of the occlusion. The eventual expansion achieved, is governed by the necessity of keeping the upper and lower teeth in adequate occlusion. Stability is governed by the length of retention. Some cases stabilize after 7 weeks' retention, others require up to two years.

The expansion must be reinforced by a positive effort by the child. When awake, a nose blowing programme and deep breathing through the nose is performed at least night and morning. By one month snoring usually ceases, i.e. normal respiratory cycle is established when asleep. In some, this is established in a week, demonstrating the importance of the naso-

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sensory reflexes (Simmonds *et al.*, 1965; Ogura *et al.*, 1966; Whicker and Kern, 1973). Speech therapy for treatment of aberrant tongue thrust or reversed swallow syndrome may be required.

### Age

Ages ranged from 4 years to 24 years, but mainly under the age of 12 years. The younger the patient the more likely that the teeth (both upper and lower) will grow into normal occlusion, while the nasal cavity will grow wider with normal growth due to the wider angle of the maxillae. By the age of 4 years the deformity is obvious, and the child is old enough to be co-operative and appreciate what is being done and why. European writers quote doing R.M.E. on 30 year olds or even more. The age distribution groups are shown in Table I.

TABLE I  
AGE DISTRIBUTION 310 CASES

4-8 years	9-12 years	13-16 years	16-24 years
129	139	35	7

### Results of R.M.E.

The results have been assessed by personal review and by means of (1) a questionnaire sent to all parents about six months after completion of R.M.E., (2) in 70 cases by measuring X-rays at beginning and end of treatment, of tomograms of the anterior and posterior ends of the palate, and of anterior and lateral cephalostats (see Fig. 6) and (3) repeated plaster casts of maxilla and mandible (see Fig. 7).

The tomograms were taken 1 cm and 2.5 cms posteriorly to the incisor teeth. It is only by paying particular attention to details of technique that a series of comparable films from each case can be produced. A special retention apparatus is used with the cephalostats enabling the easy production of comparable films. The use of an aluminium wedge on the lateral films (see Fig. 5) enables the soft tissue shadow to be demonstrated as well.

### Anatomical and physiological results of R.M.E.

1. The palate is widened—as obviously demonstrated by the teeth (see Fig. 2).
2. There is a tendency for flattening of the arch of the palate, and the septum clinically and radiologically often appears to have been pulled straighter (see Figs. 4 & 5). This observation has been reported as far back as 1898 by Monson.
3. The maxilla is displaced downwards 1-3 mm and at times may be displaced forward 1-5 mm (see Fig. 4).
4. Change in alignment of the mandible.

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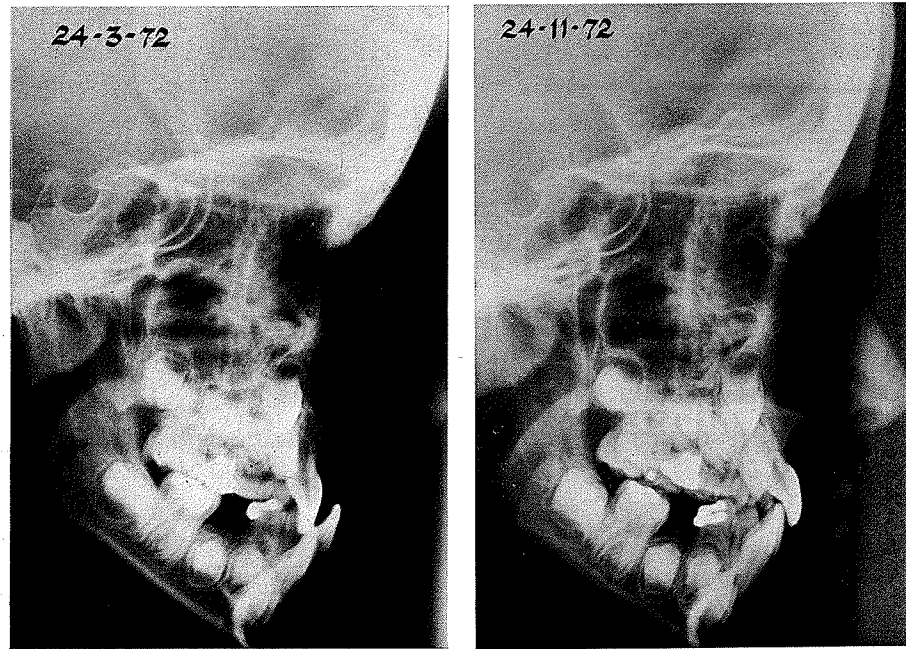


FIG. 6.

Lateral cephalostats: Before (24/3/72) and after (24/11/72) R.M.E. Note in this case the change from prognathoid class III bite to as good as normal class I bite. Note the soft tissue shadow produced by shielding with an aluminium wedge.

- (i) change from prognathoid class III to normal class I position (see Figs. 6 & 7) is due to a combination of
  - (a) improvement in airway, allowing the tongue to assume normal position (as observed by Ricketts, 1968),
  - (b) the movement forward of the maxilla,
  - (c) the change in alignment of cusps.
- (ii) swing to normal alignment on acquiring normal occlusion, for there is frequently a swing or twist of the mandible to one side with maxillary compression. (Gray and Brogan, 1970, 1972).
5. Change in facial contour. This is mainly with class III cases.
6. Improvement in chewing and relief of temporomandibular joint dysfunction due to better occlusion of the teeth.
7. Improvement in nasal airflow. Wertz (1967) objectively demonstrated improved airflow with exercise.
8. Changes in blood chemistry and chest physiology. Numerous writers have demonstrated these changes associated with poor nasal airway, and improvement with relief of the obstruction. For example, Ogura *et al.* (1966) and Whicker and Kern (1973) reported on the nasopulmonary reflex, Liese *et al.* (1973) on humidification of respired



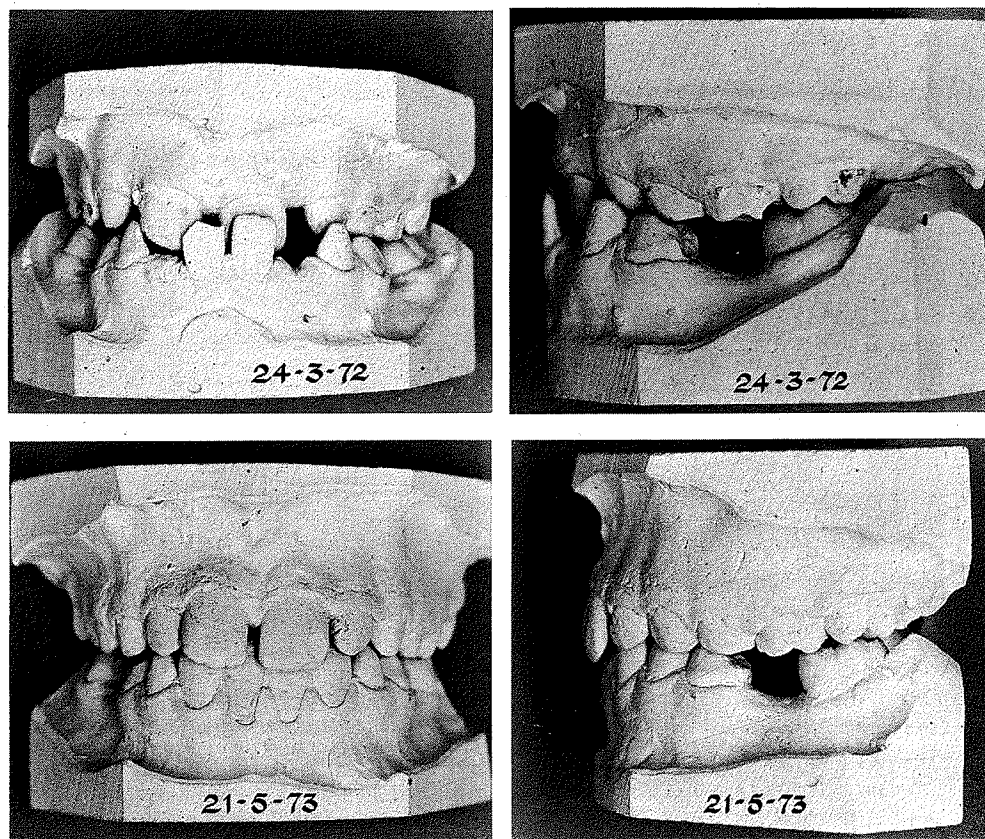


FIG. 7.  
Plaster casts of same case as Fig. 6 demonstrating the change in occlusion following R.M.E. Note the improvement in the alignment of the mandible, the increase in room of the maxilla for the eruption of the upper lateral incisors, relief of the bilateral cross bite and the change from prognathoid class III occlusion to as good as normal occlusion.

gas, and Simmons *et al.* (1965), Kressner (1966) and Cook and Komorn (1973) reported changes in blood chemistry. Ogura *et al.* (1966) demonstrated that (a) unnatural mouth breathing due to obstructed nose, caused acid/alkali imbalance and decrease in alkali reserve in the blood, due to disturbance in pulmonary ventilation and (b) with nasal obstruction pulmonary compliance is decreased, and pulmonary resistance increased due to some reflex action from the upper respiratory tract.

#### Change in symptoms with R.M.E.

The following questions were asked by questionnaire sent to the parents about 6 months after removal of the expansion device. Over 92 per cent returned the form, and personal interrogation of numerous cases confirmed

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the accuracy of the replies. They were asked to state any change in the following:

1. Nasal respiration and mouth breathing.
2. Sleep pattern and snoring.
3. Respiratory infections, colds, sore throats, ear troubles.
4. Sniffing and itching of the nose (allergic rhinitis).
5. Asthma and wheezing.
6. Eating.
7. Speech clarity.
8. They were also asked to make any comments.

The following are the results (see Table II) of 310 consecutive cases which had been selected on their medical indications—basically on poor nose breathing.

TABLE II  
MEDICAL RESULTS 310 CASES R.M.E.

AIRWAY		INFECTIONS		SNIFFING ITCHING		WHEEZING ASTHMA		PSYCHO- LOGICAL	
No.	Good result	No.	Good result	No.	Good result	No.	Good result	No.	Good result
310	270	212	128	174	162	133	88	310	94
(100%)	(87%)	(70%)	(60%)	(56%)	(93%)	(43%)	(66%)	(100%)	(30%)

Although improvement in the airway has been the major object of treatment, the other changes have been very pleasing. Eighty-seven per cent changed from mouth to nose breathing and ceased to be noisy sleepers. Of the remainder, 9 per cent had fair improvement and 4 per cent had little change, due to combination of big septal deformities and severe allergic rhinitis.

The improvement in upper respiratory infections in 60 per cent of 212 cases was mainly in fewer colds and to a lesser extent in fewer sore ears and sore throats.

With allergic reactions the decrease in sniffing in 93 per cent of 174 cases was most marked, but not so much in itching and rubbing. Out of 54 cases with asthma, 31 or 57 per cent showed considerable improvement. Of these 31 cases, 12 or 38 per cent dramatically improved from having considerable disability and almost continual medication, to no disability, normal activities and no medication. Seventy-two per cent of the 79 cases of intermittent wheezing were greatly improved.

Improvement in well-being, confidence and concentration occurred in most cases, and was of such a degree as to be especially mentioned by 94 parents or 30 per cent of cases. This change had been commented on by Stockfish (1969).

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In cleft palate cases the diastasis is always along the cleft, giving unilateral expansion, and as the nasal and septal deformities are always severe, the improvement in symptoms is likely to be small. Thus these cases could be used as a control group. In an assessment of 28 cases of cleft palate who had R.M.E. for dental reasons, the improvement in airway was good in only 35 per cent (10 cases), fair in 3 cases and poor or no change in 54 per cent (15 cases).

*Dental Results.* These were:

1. Change to normal occlusion.
2. Change of one type of malocclusion to another.
3. Change in alignment of the mandible.

The change from Class III (prognathoid type of bite), to fairly normal class I occlusion occurred in a high proportion of the 35 class III cases (see Figs. 6 & 7).

*The medical indications of R.M.E.* are a combination of the following:

1. Poor nasal airway.
2. Septal deformity.
3. Recurrent ear, nasal or sinus infections.
4. Allergic rhinitis.
5. Asthma.
6. Prior to septoplasty. In the narrow compressed nose, R.M.E. widens the nose enabling septoplasty to become a reasonable proposition.

*The Dental Indications for R.M.E. are:*

1. Unilateral or bilateral crossbite.
2. Class III malocclusion.
3. Some narrowing of the maxilla, particularly with a high vaulted palate.
4. Cleft palate cases with associated cross bite.

*The Dental Contra-indications are:*

1. Normal occlusion in the permanent dentition.
2. To a less degree, severe class II occlusion and a micro mandible.

It has been found that the maxilla can be a little over-expanded in the very young and then, apparently due to the relief from abnormal restraining forces, the mandible may grow and teeth become realigned into fairly normal occlusion as observed by Derichsweiler (1953).

### Discussion

The rationale of R.M.E. is the close relationship between septal deformity and malocclusion (Gray and Brogan, 1970, 1972), for one can very accurately predict the type of malocclusion by inspecting the nose, or the type of septal deformity by inspecting the teeth. Considerable evidence has been put forward by Gray (1965, 1972, 1974) of a maxillary moulding theory of compression of the maxilla during pregnancy or

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parturition, causing compression and narrowing of the maxilla, elevation of the palate and septal deformity. The expansion by R.M.E. would reduce all these deformities.

The degree of general impaired function due to mouth breathing is difficult to appreciate, but may be demonstrated quite dramatically following the sudden change to normal respiration with R.M.E. The change to nose breathing in over 80 per cent of cases is similar to other reports. Improvement in exercise tolerance and athletic ability may be quite marked. This is helped by the associated increase in confidence.

The increase in confidence and feeling of wellbeing was not anticipated, although Wachsberger (1942) clearly stated that this may occur following improvement of nasal airway after septoplasty. Many parents (30 per cent of the total) made special mention of this change. The following are typical reports. 'He has turned from a tired and listless little boy into a happy brighter mischievous one', or 'He is a different child, stronger, with weight gain, better appetite and less asthma by a mile', or 'It is wonderful not to have her in tears because she cannot breathe at night'. Four children could now swim under water, and three eleven-year-olds ceased bed wetting. This improvement is mentioned in the editorial of the *Orthodontist* (Spring 1972). Stockfisch (1969) quoted that 45 per cent showed marked increase in confidence at school. In a number of cases there was marked decrease in the incidence of headache and migraine. There is no doubt that this improvement frequently occurs with change to nasal respiration, and demonstrates its importance. The adenoids rarely seem to be a real factor, but if suspected, a lateral X-ray of the post nasal space will demonstrate any obstruction. The X-ray often shows allergic enlargement of the posterior ends of the inferior turbinates (see Fig. 6).

The decrease in colds, sore throats and ear infections has been particularly pleasing. This is considered to be due mainly to the cessation of undue drying of the pharyngeal mucosa, and improvement in airflow and air pressures in the nose, with improvement in nasal physiology.

The symptoms of nasal allergy, sniffing and itching, were complained of by over half the cases, and there was a tremendous relief of symptoms (over 80 per cent). It is difficult to appreciate the worry (i.e. the 'Observer Disease') that this sniffing and itching may cause to the parents. As one mother said: 'He is allowed to have dinner with his father now, since he ceased sniffing.' The chest symptoms of wheezing and asthma also were considerably improved from almost weekly to 1 or 2 a year, and in quite a number the asthma attacks as good as ceased. This had been reported by Griffiths (1958), and Braun (1966) who strongly advocated R.M.E. for treatment of asthma cases. One felt very sceptical with the initial cases, but as their improvement continued and further cases appeared, one realised that R.M.E. was a very real help to a lot of allergic patients.

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This improvement in allergic rhinitis and asthma is considered to be due to a combination of:

1. Improvement in nasal airflow, with evaporation of the excess moisture enabling the cilia to function more efficiently.
2. Decrease in naso-respiratory and naso-central reflexes. Increased nasal reflexes could be due to local stimulation of the septal spur on the lateral wall during the normal nasal physiological cycle (Stocksted, 1952). This cycle is more marked in infection or allergic rhinitis. With the normal straight septum there would be a diffuse, and not a localised stimulus, and widening the nose and straightening the septum could reduce this stimulation.
3. Increase in confidence.

These changes are not just a psychological reaction, for the improvement in airway in cleft palate cases is poor (35 per cent of 28 cases), as were the changes in the other symptoms, but the dental expansion was considerable.

As the improvement in the nasal airway allows respiration to continue while masticating, there is frequently considerable improvement in the appetite and comfort in eating. Similarly, the improved nasal airway allows better resonance of the voice, and this was noticed in about 25 per cent of the cases.

My clinical impression is that the shape of the palate is a familial tendency and has no close relation with the shape of the septum, for one sees flat palates with bent septa and high arched palates with straight septa, and vice versa. However, it does seem that the high arched palate is more likely to have bilateral compression with 'S' shaped septal deformity, than unilateral compression with kinking.

It is difficult to forecast the results from the shape of the septum. A gross deformity may be helped, but septoplasty may also be required. The spur with unilateral cross bite and the bilateral compressed maxilla with the vertical 'S' shaped deviation have good prognosis. The nasal allergic reaction is a very big factor, for it is so variable. All severe cases were referred to the allergist.

### Summary

1. Rapid Maxillary Expansion is a comparatively simple, conservative method of treating impaired nasal respiration.
2. It can be used from 4 years to 25 or 30 years of age, but the younger the patient the better the long term results.
3. The medical indications are a combination of poor nasal airway, septal deformity, recurrent ear or nasal infection, allergic rhinitis and asthma, and prior to septoplasty.

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4. The dental indications are mainly unilateral or bilateral cross bite, class III (prognathoid) malocclusion, maxillary compression, and cleft palate.
5. The dental contra-indications are normal occlusion in the permanent dentition and to a lesser degree severe class II occlusion and micro-mandible.
6. In selected cases, it produces a change of over 80 per cent from mouth to nose breathing. In this series of 310 consecutive cases 87 per cent were greatly improved, 9 per cent had a fair result and 4 per cent a poor result.
7. It also gives considerable improvement in colds and respiratory infection, nasal allergy and many cases of asthma. The improvement in health and confidence and concentration in over 30 per cent of cases is particularly pleasing.
8. The rationale of Rapid Maxillary Expansion can be explained by the maxillary moulding theory of production of septal and facial deformities.

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