Natural Closure Of Deciduous Molar Extraction Spaces

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Most people who are interested in the mouth possess opinions concerning the effects of dental extractions on the occlusion. Many orthodontists (Brauer[1]) consider that premature extraction of deciduous molars is an important factor in the etiology of malocclusion while others (Seipel)[2] do not. In the present study an attempt was made to determine if the spaces left by the premature extraction of deciduous molars closed. Closure was noted in the majority of the spaces and, for these particular spaces, the amount, rate, timing and manner of closure were examined. Investigations were made of possible associations between the behaviour of the space and the teeth extracted, extractions from the opposing arch, and the classification of the occlusion.

Review of the Literature

Much has been written about the orthodontic consequences of the premature extraction of deciduous molars, but most authors have concerned themselves with the effects on the permanent dentition rather than the manner in which these effects have arisen.

The majority of authors agree that in most cases the premature extraction of deciduous molars will cause crowding associated with either rotation, tipping or bodily movement of teeth. The percentage of malocclusions due to the premature extraction of deciduous molars has been stated by Brandhorst[3], Willett[4] and Lyons[5] as twenty, twenty-eight and sixty-five respectively. Linders[6], on the other hand, denied that there was any causal relationship between the premature extraction of deciduous molars and crowding in the permanent dentition despite his own statement that, "The series, however, is too small to permit definite conclusions".

Ungar[7], after reviewing the serial records (annual examination and periodic models) of 292 children, stated that "Abnormal occlusion cases definitely show a higher percentage of premature loss than do cases of normal occlusion", but "In all cases where space retainers were used, the permanent teeth erupted normally". This is contrary to the report by Seipel[2] that in only eighteen per cent of cases in which he used a space retainer did this device prevent crowding.

Seipel[8] calculated the amount of closure subsequent to the unilateral extraction of deciduous teeth by measuring the differences between the space occupied by the bicuspids on the nonextraction side and the space occupied by the bicuspids on the extraction side. He stated that, in fifty cases, the average space loss during ten years on the extraction side compared with the nonextraction side was 1.9 mm ± 0.30 mm. He stated also that in "A large amount of cases, about seventy percent, the decrease of space value is fairly insignificant and must play a minor role in the production of malocclusion". One must understand that Seipel's technique would be un-

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satisfactory if midline shifts occurred after extraction. In children in whom midline shifts occurred, crowding would be increased on one side and decreased on the other. Linders claimed, however, that such shifts do not occur. On the other hand, Pringle[9] has stated that, in all nine cases of unilateral deciduous extractions he examined, there was a midline shift towards the extraction side.

Breakspear[10], in a clinical study of one hundred cases of unilateral, early deciduous extractions, measured the size of the extraction space and deduced the amount of space loss, using the corresponding tooth on the opposite side as a measure of the original space. Whereas the mean amounts of space loss in his sample were approximately 1.3 mm less than those found by Seipel, the distribution of space loss was similar. However, Breakspear's final records were taken at an earlier age than those of Seipel[8], and he (Breakspear) concluded that the difference in space loss could be due to Seipel's children regaining space as the bicuspids erupted.

Once it has been established that space can be lost subsequent to the extraction of deciduous molars, it becomes very important to determine the tooth movements involved in this loss so that preventive measures can be introduced. Most authors (Clinch and Healy[11]) when writing about space loss in the maxilla do not mention the possibility of distal movement of the anterior teeth, and, by inference, one assumes that the space loss in the maxilla occurs always by mesial movement of the teeth distal to the space. Pringle[9], however, has written "In cases of normal anteroposterior arch relationship, the early extraction of upper temporary molars or canines allows, at first, the crowns of the upper laterals to drift distally and, relative to the lowers, backwards, if the bite allows this", and that "The centrals also tend to follow the same course".

In the mandible, distal movement of anterior teeth has been observed by McBride[12] who wrote "When the first deciduous molar is lost, the mesial drifting of the first permanent molar is not always evident, although there is nearly always a distal drifting of the anterior segment carrying the incisors and cuspids on that side".

Friel[13], on the other hand, stated "Teeth do not move distally", "All teeth move forward and none backward"[14] and "As far as I know, there is no evidence, experimental or clinical, that teeth move distally, except that they look as if they did". In 1949 he showed three cases "where it is generally claimed that teeth had moved distally". Of these he wrote "In all these cases I ask you to believe that the teeth anterior to the gap have not moved distally at all, but have remained to a greater or less extent in the positions occupied at the same time of the extraction, and that the teeth posterior to the gap have moved forward during growth, and also the teeth on the other side". These conclusions of Friel were deduced from his own superimpositions of tracings published by Broadbent. He made conclusions about the movement of teeth in the maxilla by registering on the R point and about the movement of teeth in the mandible by registering on the anterior border of the ramus. Tooth movement within a bone cannot be examined by registering successive tracings on points which have movement independent of the bone or a transient existence without obtaining misleading results. Despite the unsatisfactory nature of Friel's evidence, his statements are quoted fully, without comment, by

Clinch and Healy[11] and by Smyth[15] and have presumably influenced these workers. Clinch and Healy concluded that in the mandible there was "greater tendency to space loss due to lack of forward growth of the teeth anterior to the extraction". Similarly, Smyth has stated that "The roots may tilt medially, and give the appearance of the crowns tilting distally". Both Clinch and Healy and Smyth had available study models only and did not have serial radiographic records. Consequently, their conclusions regarding the direction of tooth movement may be incorrect.

Noyes[16] stated that "It is obviously impossible to diagnose mesial drift from a plaster cast which is not oriented to facial or cranial anatomical landmarks", and he made the request that "loose and careless thinking upon the subject of mesial drift be corrected, not alone because of the spreading confusion upon the pages of our literature, that is rapidly becoming history, but primarily in the interests of the patients who suffer through the consequent orthodontic practice".

Material and Methods

The material for this investigation was drawn from Australian children of British ancestry attending the Melbourne University Child Growth Study[17]. They consisted of eight year-old children some of whose deciduous molars had been extracted before the age of six years. The extraction spaces were observed, from their inception, for periods ranging from two years to five years. These children were examined first at the age of two years. Between the ages of two years and four years, they were examined every three months, and subsequent to their fourth birthday they were examined every six months. In the maxilla, 12 spaces in nine children involving the loss of 18 teeth, were studied. In the mandible, 24 spaces in 16 children involving the loss of 41 teeth were studied. These children were not treated orthodontically.

Serial casts were made of all the children, but in only 22 of the 36 spaces was a "pre-extraction" cast included in the series. These casts were used principally to determine the mesiodistal dimension of extracted teeth. Thus, if a second deciduous molar was extracted before the first permanent molar had erupted, the space lost, if any, could be determined after the eruption of the first permanent molar because the size of the extracted tooth was known. The mesiodistal diameters of the extraction spaces were recorded directly from the mouth with fine-pointed dividers at each visit. These dividers were stamped gently into the child's examination record. Later the distance between the marks was measured with a vernier caliper. By a series of repeated measurements it has been shown that, using this method, an accuracy to 0.1 mm is achieved by the present investigator. In the 14 spaces for which a "pre-extraction" cast was not available, the dimensions of the spaces were studied by using the routine measurements made on each child's arches at every visit. The most useful of these measurements was the distance between the tip of the cusp of the deciduous cuspid and the distal of the second deciduous molar (mesial of first permanent molar). This measurement is accurate to half a millimeter, with a cooperative child and a well-shaped cuspid. In adverse circumstances, however, the measurement was accurate to the nearest millimeter only. Changes in the size of the space left by the deciduous molar extraction would be reflected in this measurement.

The rate of closure was calculated

for each child in mm per year. A study of the serial measurements of the space revealed that the timing of the closure varied. This variation in timing of closure was expressed as an opinion only. Thus closures were described as being "only early", "mainly early", "continuous", "mainly late", "only late" or "no comment".

An extraction space may close by a mesial movement of the tooth or teeth distal to it, by a distal movement of the tooth or teeth mesial to it or by a combination of these. The serial cephalometric radiographs were used to determine, in each case, which of these mechanisms was operating.

The radiographs were taken using a Broadbent-Bolton cephalometer. The difficulties of obtaining good radiographs of young children were appreciated, and almost all the radiographs were taken by the same technician to give the young children confidence. They were attempted every three months in the young child. Consequently, if an examination was missed or the child was uncooperative, the gap in the records was less serious than it would otherwise have been.

Tooth movement in the maxilla was detected by superimposition of tracings on the palatal plane with ANS, point A or the shadow of the incisive canal (canalis incisivus, P.N.A.) registered. Tooth movement in the mandible was detected by superimposition on the mandibular plane with the anterior outline of the symphysis registered. The radiographs were not used quantitatively.

Findings

In the maxilla all the spaces left by the extraction of one or more deciduous molars closed to some extent. The amount of closure varied from 2.0 mm to 7.3 mm. The average closure in eight boys was 3.9 mm and in three girls was 3.3 mm (Table I).

In the mandible all except two of the spaces left by the extraction of deciduous molars closed. The maximum closure recorded was 7.0 mm. The average closure in thirteen boys was 2.2 mm and in six girls was 3.4 mm.

TABLE I
MAXILLA

Child	Sex	Amount of closure (mm)	Period of observation (years)	Rate of closure (mm/year)	Time of closure
J. H.	F	2.0*	2.0	1.0	C.
T. R.	M	2.2	2.0	1.1	N.C.
P. G.	M	2.4	5.0	0.48	N.C.
L. D.	M	2.5*	2.0	1.25	C.
G. B.	M	2.9	2.5	1.16	C.
J. H.	F	3.5*	2.0	1.75	C.
G. B.	M	3.7	2.5	1.48	C.
P. G.	M	3.9	5.0	0.78	N.C.
J. G.	F	4.5	3.5	1.29	C.
R. R.	M	6.0*	2.5	2.4	N.C.
I. R.	M	6.5*	2.0	3.25	C.
P. S.	M	7.3	3.5	2.09	C.

M = male; F = female; * = accurate to 0.5 mm only;
C = continuous; N.C. = no comment.

The findings indicate a possibility that maxillary spaces close more than mandibular spaces (Table II).

In the maxilla the rate of closure varied from 0.48 mm/year to 3.25 mm/year (1.50 mm mean, 0.77 s.d.). In the mandible the rate of closure varied from 0.0 mm/year to 2.15 mm/year (0.98 mm mean, 0.62 s.d.). In the maxilla all eight spaces, for which an opinion could be expressed, closed by a continuous movement. Closure was observed in twenty-two of the twenty-four spaces in the mandible and for eighteen of these an opinion is expressed concerning the time of closure. Two spaces closed "only early", three closed "mainly early", nine closed by "continuous" movement, three closed "mainly late" and one closed "only late".

In the maxilla the predominant tooth movement in all except one space was a mesial movement of the teeth distal to the space. In nine of the twelve spaces more than three quarters of the space lost was due to mesial movement. In one space only was the amount of closure due to mesial movement exceeded by that due to distal movement (Table III).

In the mandible distal movement

TABLE II
MANDIBLE

Child	Sex	Amount of closure (mm)	Period of observation (years)	Rate of closure (mm/year)	Time of closure
M. S.	M	0.0	2.0	0.0	—
M. S.	M	0.0	2.0	0.0	—
M. F.	F	1.5*	2.0	0.75	M. E.
R. R.	M	1.5	2.5	0.6	N. C.
P. H.	M	1.5	3.5	0.43	C.
D. L.	M	1.5*	3.0	0.5	M. E.
P. H.	M	2.0*	3.5	0.57	C.
W. R.	M	2.0	2.5	0.8	N. C.
M. F.	F	2.0	2.0	1.0	M. E.
P. M.	M	2.0*	4.0	0.5	O. L.
J. P.	F	2.0*	2.0	1.0	O. E.
G. B.	M	2.4	2.5	1.14	M. L.
J. P.	F	2.5*	2.0	1.25	O. E.
L. R.	F	2.5*	3.5	0.71	M. L.
L. R.	F	3.0*	3.5	0.86	M. L.
R. T.	F	3.0	3.5	0.86	C.
P. G.	M	3.2	5.0	0.64	C.
R. T.	F	3.3	2.5	1.32	C.
P. G.	M	3.8	5.0	0.76	C.
T. R.	M	4.3	2.0	2.15	N. C.
I. R.	M	4.6	2.0	2.3	C.
K. M.	F	4.5	3.5	1.29	N. C.
S. N.	F	5.9	3.0	1.97	C.
K. M.	F	7.0	3.5	2.0	C.

M = male; F = female; * = accurate to 0.5 mm only;
O. E. = only early; M. E. = mainly early; C. = continuous;
M. L. = mainly late; O. L. = only late; N. C. = no comment.

TABLE III
MAXILLA

Child	Sex	Manner of closure*	Teeth Extracted Original	Teeth Extracted Additional**	Extractions from Opposing arch**	Classification
J. H.	F	3+:1	D	—	Nil	crossbite
T. R.	M	3+:1	D	—	Nil	normal
P. G.	M	3+:1	DE	—	DE (5.0)	normal
L. D.	M	3+:1	D	E (0.5)	Nil	normal
G. B.	M	3:1	DE	—	Nil	crossbite side
J. H.	F	3+:1	D	—	Nil	crossbite
G. B.	M	3:1	DE	—	DE	crossbite
P. G.	M	3+:1	DE	—	DE (5.0)	normal
J. G.	F	2:3	E	—	D (3.5)	I
R. R.	M	3+:1	E	D (0.5)	E (2.5)	normal
I. R.	M	3+:1	D	—	Nil	normal
P. S.	M	3+:1	D	—	D (1.0)	normal

M = male; F = female; * = mesial migration: distal migration;
** = period of observation in years is recorded in brackets.

TABLE IV
MANDIBLE

Child	Sex	Manner of closure*	Teeth Extracted Original	Teeth Extracted Additional**	Extractions from Opposing arch**	Classification
M. S.	M	—	D	E (1.5)	Nil	normal
M. S.	M	—	D	E (0.5)	Nil	normal
M. F.	F	1:1	E	—	Nil	normal
R. R.	M	1:1	D	E (0.5)	DE (0.5)	normal
P. H.	M	3+:1	D	E (1.5)	Nil	normal
D. L.	M	3+:1	D	E (1.0)	Nil	III
P. H.	M	3+:1	D	E (0.5)	Nil	normal
W. R.	M	3+:1	D	E (1.5)	DE (1.5)	II div. 1
M. F.	F	1:1	DE	—	Nil	normal
P. M.	M	1:3+	E	—	Nil	normal
J. P.	F	1:3	DE	—	Nil	normal
G. B.	M	2:3	DE	—	DE (2.5)	crossbite
J. P.	F	1:3	DE	—	Nil	normal
L. R.	F	1:3	D	E (2.0)	Nil	normal
L. R.	F	1:3	D	E (1.5)	Nil	normal
R. T.	F	1:1	D	E (3.0)	Nil	normal
P. G.	M	1:3+	DE	—	DE (2.0)	normal
R. T.	F	1:1	D	E (0.5)	Nil	normal
P. G.	M	1:3+	DE	—	DE (2.0)	normal
T. R.	M	1:3	D	—	Nil	normal
I. R.	M	1:3	D	—	Nil	normal
K. M.	F	1:3	D	—	D (1.0)	I
S. N.	F	1:3	D	—	Nil	normal
K. M.	F	1:3	E	—	Nil	II

M = male; F = female; * = mesial migration: distal migration;
** = period of observation in years is recorded in brackets.

accounted for half or more than half of the closure observed in each of those spaces in which the closure exceeded 2.0 mm (Table IV). In eleven of thirteen spaces in which closure exceeded 2.0 mm, three quarters or more of the closure was due to distal movement. This occurred even when second deciduous molars had been extracted. There were nine spaces in which some closure occurred but the amount was less than 2.0 mm. In these spaces closure occurred by equal mesial and distal movement in three, predominantly mesial in four, and predominantly distal in two spaces.

Consideration of Possible Influences

A relationship was not noted between either the amount, rate or the timing of closure and the particular tooth or teeth extracted.

Concerning the manner of space closure in the maxilla, irrespective of whether the first or both deciduous molars had been extracted, the extraction spaces closed more by mesial movement than by distal movement. The only space that closed by a greater distal than mesial movement of teeth was the only one that had resulted from the extraction of a second deciduous molar alone from the jaw considered. However, no conclusion should be drawn from one case, particularly when it is noted that in another child who was observed for two and one half years the second deciduous molar was the only tooth missing for two of these years.

In the mandible no pattern could be seen relating the manner of closure to the particular tooth or teeth extracted.

In the maxilla the smaller amounts of closure seemed to be coupled with an intact opposing arch. Five of the six intact opposing arches were associated with the six spaces that closed least. Paradoxically, the sixth intact opposing arch was associated with the space showing the second greatest closure. There was no clear relationship between either the timing or the rate of closure and the condition of the opposing arch.

No conclusion could be drawn concerning the closure of mandibular spaces and the condition of the opposing arch, because in only three of the twenty-four cases was the opposing arch broken for a period of two years or more.

In the maxilla seven of the twelve spaces examined were in children with normal occlusion. Included in these seven spaces are the three that closed most and three of the four that closed least. The remaining five spaces occurred in children with Class I malocclusion. One had an excessive overjet. The remaining four spaces occurred in two children: one had a bilateral crossbite and the other had a unilateral crossbite, the space on the "normal" side closing least.

In the mandible nineteen of the twenty-four spaces were in children with a normal occlusion. One child had a Class III malocclusion and his space closed only 1.5 mm in three years. Two children had Class II malocclusions. One of these closed 2 mm in two years, six months. The greatest change recorded (7.0 mm) was observed in the other. The remaining two spaces occurred in children with Class I malocclusions. A crossbite case appears in the middle of the list showing a closure of 2.4 mm, and the second showed the third highest closure of 4.5 mm and was actually the Class I side of the Class II subdivision case that showed the greatest closure of all.

These data do not allow definite conclusions concerning the influence of the classification of the occlusion upon space closure. However, it is clear that, both in the maxilla and in the mandible, wide variations in the amount of closure occurred in children with normal occlusion.

Discussion

The spaces left by the extraction of deciduous molars closed in every child except one. The exception was a boy who lost deciduous molars from both sides of his mandible. He had a normal (i.e., ideal) occlusion at the time of extraction. He had a convex, mesiognathic facial type, tending to a dental prognathism. His facial soft tissues were in harmony with his hard tissues, and no abnormal habits were present, conditions obligatory for a classification of "normal occlusion". No explanation for the absence of space loss in this case is advanced.

There was no relationship between the particular tooth or teeth extracted and either the amount or the rate of space loss. This draws attention to the fact that in each jaw the teeth are arranged in and function as an arch in which each tooth is merely a unit in the arch. The results suggest that it does not matter if the arch is broken at the first or second or over both deciduous molars, it still behaves as a broken arch. It emphasizes the importance of the mechanical strength of an intact arch to oppose the potentially destructive crushing force of the labial and buccal musculature.

It was noted with particular interest that, in the maxilla, smaller amounts of closure seemed to be associated with an intact mandibular arch. The strong mandibular arch was able to support, to a degree, the broken maxillary arch, and was able to prevent what would otherwise have been a more serious collapse.

Mesial migration of the upper molar teeth to reduce extraction spaces has been reported previously but the cause of this migration is not completely understood. The mesial force in these children could have been due to the inclination of the permanent molar, but this is not the only factor, because space can be lost before the eruption of the first permanent molar. In addition, maxillary teeth receive a mesial force from the buccinator muscle which extends distally to the last erupted molar tooth which could well account for the mesial migration of maxillary teeth. On the other hand, the occlusion with the mandibular teeth would help to prevent a lingual and distal collapse of the maxillary incisors and cuspids. The support lent to the maxillary denture by an intact mandibular arch was noted in the present study.

Distal migration of the anterior teeth accounted for most space loss in the lower jaw. The buccinator is less closely related to the distal of the last erupted mandibular molar than it is to the distal of the last erupted maxillary molar. This difference in relationship occurs because the maxillary molars overhang the mandibular molars to the buccal and to the distal. In addition, the muscle passes completely around the distal of the last maxillary molar to reach the pterygomandibular ligament which is actually lingual to the maxillary arch but not to the mandibular. Therefore the mesial component thrust of the buccinator is greater on the last maxillary molar than on the last mandibular molar. On the other hand, the mandibular arch, particularly over the extent of its six anterior teeth, is subject to a strong lingual force produced by its maxillary antagonist. The lingual force on the incisors has a distal component at the cuspids. When the distal component is no longer resisted by a first or second

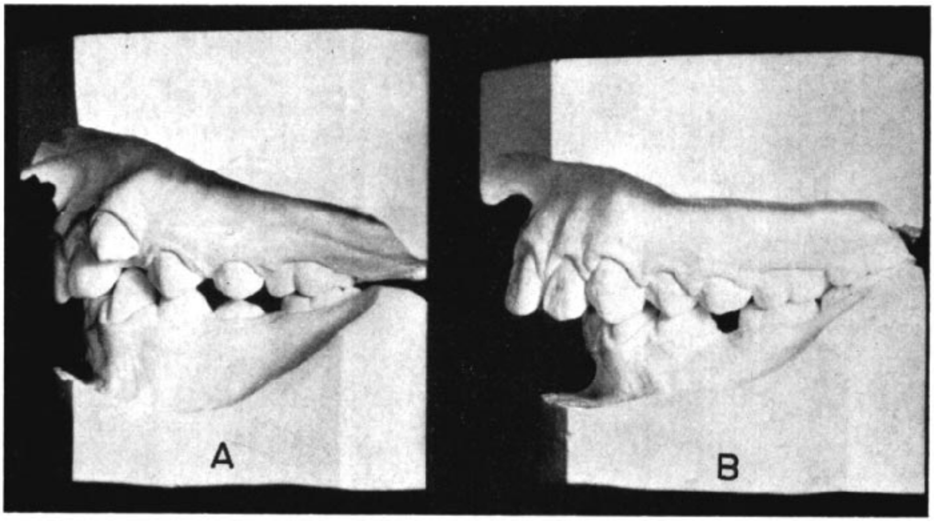

Fig. 1 Sequelae of premature deciduous molar extractions in the maxilla (A) and mandible (B).

deciduous molar, the cuspid will move distally, the lower midline drifts to the side of the extraction and the incisors collapse lingually. When these changes occur, spaces will not appear between the anterior teeth even though one cuspid has moved distally.

The manner of space closure becomes most important when considering the design of space retainers. The major requirement of maxillary space retainers is to prevent the mesial migration of the teeth distal to the extraction space. On the other hand, the distal migration of the teeth mesial to the space is the movement against which one has to guard in the mandible. Thus the deciduous cuspids must be prevented from moving distally and incisors must be supported from the lingual to prevent lingual collapse.

It will be very interesting to watch the future development of the dentition of these children. In some, the extraction spaces may open when the bicuspids force their way into occlusion. Other children may develop the typical malocclusions illustrated in Figure 1. Premature extraction of deciduous molars from the maxilla has allowed mesial drifting of the first permanent molar teeth with subsequent blocking out of the upper cuspids (Figure 1A). Premature extraction of deciduous molars from the mandible has allowed distal drifting of the anterior teeth resulting in a Class II cuspid relation and impacted second bicuspids (Figure 1B).

Summary

Intraoral measurements, measurements from models and cephalometric radiographs were used to study the behaviour of 12 spaces caused by the extraction of maxillary deciduous molars from 9 children, and 24 spaces caused by the extraction of mandibular deciduous molars from 16 children. The spaces were observed from their inception for periods ranging from two to five years. The children were observed from the age of two years to eight years.

In the maxilla all extraction spaces closed. All, save one, closed by mesial

migration of the teeth distal to the extraction space. Space loss ranged from 2.0 to 7.3 millimeters. In the mandible all except two extraction spaces closed. The manner of the space closure of the smaller spaces varied. All space losses greater than 2.0 millimeters were brought about mainly by a distal movement of the teeth mesial to the space. In the design of space retainers these directions of tooth movement must be considered.

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