Mandibular dental arch dimensional changes following prematurely lost deciduous molars

Dunia A. AL-Dulayme, MSc.*
Mohammad Rafid AL-Khannaq, MSc**
*Al-Mustansiria University, College of dentistry, department of pedodontics, orthodontic and preventive dentistry, Iraq.
**Al-Mustansiria University, College of dentistry, department of pedodontics, orthodontic and preventive dentistry, Iraq.
Phone: 009647812742945
E-mail: drduniaahmed13@yahoo.com

Abstract
Background: The aim of the study was to evaluate the changes in the mandibular dental arch width and length after the unilateral premature loss of deciduous molars at the mixed dentition stage.
Methods: The sample consists of (50) Iraqi children aged (8-9) years with unilateral prematurely extracted mandibular first or second deciduous molars, each child have a dental study models prepared by taking alginate hydrocolloid impressions, then the measurements were done on the Auto sketch program after scanning of the occlusal surface of the study casts.
Results: Reveals that in case of unilateral premature loss of mandibular primary molars at the mixed dentition stage lead to changes in most of the vertical and horizontal distances of the dental arch.
Conclusion: The findings of the present study indicate the importance of space maintainer construction following the premature loss of mandibular primary molars at the mixed dentition stage.

Key Words: Mandibular dimensions, Premature loss, Primary molars

Introduction
The changes from primary dentition to the permanent dentition consist of a complex phenomenon, which is composed of a variety of physiological adaptations of occlusion during this period. The exfoliation of the primary teeth, the permanent teeth eruption and the occlusion are independent; however, they occur in a harmonious sequence (Salzman 1938, David 1959, Rao and Sarkar 1999). When the normal physiological process of primary-tooth exfoliation and eruption of its successor is disrupted, a series of changes are observed in the dental arches (Seward 1965). Such disruption is the premature loss of primary molars. Salzman (1938) found that the edentulous space of prematurely extracted tooth closed in 67.6% of the children, due to the movement of the adjacent teeth resulting in malocclusion (Northway et al. 1984). The premature loss of primary molars, which results in mesial positioning of the first permanent molars is of a great concern during the mixed dentition period. Many studies have emphasized the harmful effects following the premature loss of primary molars on space problems such as tipping of the first permanent molar, crowding of the dental arches, and impaction of the permanent predecessor (David 1959, Lin and Chang 1998, Rao and Sarkar 1999). The pattern of space loss is of interest for many researchers, some of these researches found a greater percentage of space loss by mesial migration of the posterior teeth (love and Adams 1971, Northway et al. 1984, Rao and Sarkar 1999). However other researchers agreed that the space was lost by both mesial migration of the posterior teeth and distal movement of the anterior teeth, especially in the mandible (Cuoghi et al. 1998). More and more workers today are of the consensus that irregularities of the primary dentition are often harbinger of disorders of the developing permanent dentition. In general the premature loss of primary molars was capable of causing permanent changes in the amount of space available and changes in the sagittal molar relationships in the permanent dentition (Hoffding and Kisling 1978). Overall, the prevalence of malocclusion was significantly higher in the groups who had suffered from pre-
mature loss of primary teeth (Helm 1970), therefore the maintenance of arch length during the mixed dentition period is of a great significance in the normal development of a functionally well aligned and balanced adult occlusion (Al-Dulayme 2002). The sample of the present study carried out on Iraqi children at (8-9) years of age at the mixed dentition stage and the purpose was to assess the amount of changes in the mandibular horizontal and vertical dental arch dimensions following the unilateral premature loss of first or second primary molars and these assessments were done by comparing the mean values of the present study with the mean values of a control group collected from previous Iraqi study (Al-Dulayme, 2010) that were conducted on normal healthy Iraqi children (25 males and 25 females) at the same age group (8-9) years at the mixed dentition stage having a complete set of dentition, both measurements were carried out by the investigators blindly and at a long time intervals between them. Since no previous Iraqi study was conducted to measure the mandibular dental arch dimensions at the mixed dentition stage, therefore the data collected from this study considered as a baseline data of this age group for the horizontal and vertical dimensions using plaster study models (Al-Dulayme, 2010).

Material and Methods
The sample of the present study consists of 50 Iraqi healthy children ranging in age between 8-9 years, at the mixed dentition stage, belonging to a mixed socioeconomic status selected from different primary schools from Baghdad city. First the names of those children who fulfilled the requirements of the research were recorded and a special consent form was prepared to be given to the parents of each child who was candidates for participation in the research. Then in the subsequent visits the consent forms were collected after being signed with agreement of parents. The selected studied children were divided into two groups:

Group (1): include 25 children (13 male and 12 female) have unilateral premature loss of mandibular first primary molars figure (1).

Group (2): include 25 children (13 male and 12 female) have unilateral premature loss of mandibular second primary molars figure (2).

Both groups had the period of absence of prematurely extracted primary molars between 6-12 months. The remaining dentitions are healthy with no extensive caries or malformation and had no history of space maintainer therapy or orthodontic treatment.

Dental study models were prepared by taking alginate hydrocolloid impressions for each child with perforated metal trays, pouring it with dental stone according to the manufacturing instructions, then for every dental cast a proper plaster base was made and trimmed then labeled with certain number (Morris and Khanz1985, Al-Dulayme 2002, Al-Dulayme 2010).

Study Models Measurements:
Figures 3 (A) and (B) shows the mandibular dental arch widths “horizontal” measurements which include:

1. (IC): inter-canine distance which extends between the cusp tips of right and left primary canines (and / or the centers of the facets of the worn primary canines).
2. (IM): inter-molars distances which are represented by 4 distances:
   (MB): the distance between the mesiobuccal cusp tips of right and left mandibular first permanent molars.
   (ML): the distance between the mesiolingual cusp tips of right and left mandibular first permanent molars.

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   (ML): the distance between the mesiolingual cusp tips of right and left mandibular first permanent molars.
(DB): the distance between the distobuccal cusp tips of right and left mandibular first permanent molars.
(DL): the distance between the distolingual cusp tips of right and left mandibular first permanent molars.
While figures 4 (A) and (B) shows the mandibular dental arch length “vertical” measurements include four distances which are:-
1- (A) the distance between the contact points of the mandibular permanent central incisors to the line tangent to the cusp tip of the mandibular primary canines (or when worn, to the centers of resulting facets).
2- (B) The distance between the contact points of the mandibular permanent central incisors to the line tangent to the distal surfaces of the mandibular primary molars.
3- (C) The distance between the contact points of the mandibular permanent central incisors to the line tangent to the distal surfaces of the mandibular primary molars (Rao and Sarkar, 1999).
In the present study a computer analyzing method was introduced for measuring the dental arch dimensions so, we used the Auto sketch (Germany) software which provides a complete set of CAD tools for creating professional-quality precision drawing, such software program were accurately used in many other dental measurements (Al-Azzawi 2005).
Each study casts were marked with certain landmarks by a sharp lead pencil to facilitate accurate recognition. Then the occlusal surface of study casts were facing the glass window of the scanner directly, then accurate and exact image of the casts were saved and transferred to the Auto sketch program on Pentium 4 computer according to the instruction read from that software program.
Later on the measurements obtained from the present study were compared with same measurements on a control group collected from previous Iraqi study (Al-Dulayme 2010), because the age of the studied sample was the same and no other study has been done in Iraq to measure such dimensions.
Statistical Analysis:
Statistical Analysis used in this study was under statistical package SPSS program loaded on Pentium 4. The suitable statistical methods were used in order to analyze and assess the results, these include:-
1- Descriptive statistics for the mandibular dental arch dimensions of the studied sample for both genders (mean, minimum, maximum, and standard deviation).
2- Two tailed t-test was applied to test the significance difference between the means of the groups.
(P > 0.05: non-significant, P > 0.01: highly significant, 0.05>P> 0.01: significant).

Results
Table (1) demonstrates the descriptive statistics of the mandibular dental arch dimensions in millimeters for the control group that obtained from previous Iraqi study and shows that the mean values of the mandibular dental arch widths at IC were (27.17)mm and the MB, ML, DB and DL distances were (44.48), (34.63), (46.82)mm and (36.45)mm respectively, while the mandibular dental arch lengths measurements shows that the mean values at A,B,C and D were (4.8)mm, (15.19), (24.56)mm and (34.82)mm respectively.
Table (2) demonstrates the descriptive statistics of the mandibular dental arch dimensionsin millimeters for group (1), which shows that the mean values of the mandibular dental arch widths at IC were (26.69)mm and the MB, ML, DB and DL distances were (42.70), (33.67), (45.45)mm and (34.85)mm respectively, while the mandibular dental arch lengths measurements for group (1) shows that the mean values at A,B,C and D were (5.08)mm, (22.92)mm and (33.03)mm respectively. The (B) distance has been excluded because of the loss first primary molars.
In table (3) by applying two tailed t-test to test the significance difference between the means of the groups, the P value shows a highly significant difference in the C and D distances, while the IC and DB shows a significant difference statistically.
Table (4) demonstrates the descriptive statistics of the mandibular dental arch dimensions for group (2), which shows that the mean values of the mandibular dental arch widths at IC were (27.008)mm and the MB, ML, DB and DL distances were (42.70), (33.67), (45.95)mm and (36.21)mm respectively. While the mandibular dental arch...
lengths measurements for group (2) shows that the mean values at A, B and D were (3.8) mm, (14.53) mm, and (30.62) respectively. The (C) distance has been excluded because of the loss second primary molars.

Table (5) two tailed t-test was applied to test the significance difference between the means of the groups and revealed that the P value shows a highly significant difference in the A and D distances and the MB distance shows a significant difference.

Discussion

Research dealing with space changes of the dental arch was difficult to perform because of the multifactorial variance that might influence the results (Northway et al. 1984). The present study was carried out to evaluate the scientific evidence concerning space changes in the mixed dentition stage following unilateral premature loss of mandibular primary molars with a period of absence of the prematurely extracted primary molars between 6-12 months, because the observations period for space loss after the extraction has still provoked some disagreement, according to Richardson, 1965 and McDonald, 2006 whom they consider the first 6 months are crucial to verify future space loss. Other studies recommend observation until the twelve months after extraction (Northway et al, 1984).

Most studies shows that the actual mechanism of tooth drifting is not clearly understood, the factors which may produce this drifting are occlusal force, ligament contraction and soft tissue pressure (Tencate 2006). In the sample studied it was observed that in case of unilateral premature loss of mandibular first primary molars, the changes that occur in the arch length and width are follows:

A distance: although there is no statistical significant
difference when compared with the control group but there is an increase in the A distance from (4.8) to (5.08)mm. Indicating the distal movement of the primary canines toward the space created by the loss of first primary molars, this finding is in accordance with other studies who concluded that space closure occur by distal migration of canines in the mandible following the premature loss of first primary molars (Liu 1949, Seward 1965, Helm 1970, Love and Adams 1971, Owen 1971, Ten cate 1989, Kumari and Kumari 2006). The possible explanation is that the erupting anterior incisors pushed the primary cuspid toward the distal more than the erupting first permanent molar did on the second primary molar towards the mesial. The findings of the present study support the findings of other studies who found that the space changes occurred mainly by the distal migration of primary cuspsids in the initial stage (Liu 1949, Hoffding and Kis ling 1978, Osmar et al. 1998, Kumari and Kumari 2006).

C and D distances: following the premature loss of mandibular first primary molars, there is about 2mm. reduction, the C distance from (24.6) to (22.9) and the D distance from (34.9) to (33.03) with a statistical significant difference when compared with the control group. The result of the present study confirm with the conclusion of other studies (Liu 1949, Owen 1971, Lin and Chang 1998). The space loss was more common in the mandibular arch after the premature loss of first primary molar, this explained by the mesial forward movement of second primary molars and first permanent molars toward the extraction space (Liu 1949, Hinrichsen 1962, Love and Adams 1971, Northway et al. 1984, Lin and Chang 1998, Rao and Sarkar 1999, Kumari and Kumari 2006) and disagree with a study who concluded that the premature loss of lower first primary molar in the mixed dentition resulted in more space loss at the extraction site than arch length loss (Titjana et al. 2008).

IC and IM distances: Inter-canine width (IC) was decreased from (27.2) to become (26.7) without any statistical significant difference from the control group, indicating that when the lower first primary molar prematurely extracted there’s no or slight changes in the (IC) width (Lin and Chang 1998) and this information is so valid to pedodontist and orthodontist during their routine work.

While the decrease in the (IM) distance in all parameters with a significant difference statistically when comparing with the control group except the ML parameter, indicating that whenever the first primary molar is lost the second primary molar moved in mesial direction toward the space followed by the mesial migration of the first permanent molars with a lingual tipping. The results of the present study partly support the conclusions that space in the mandible is lost predominantly by mesial migration of posterior teeth (Titjana et al. 2008).

The second primary molar is most often prone to caries, because of its morphology and the early loss tooth in primary dentition in our subjects as well as in all subjects in general (Ash and Nelson 2003). Its early loss in the period of mixed dentition and even later may result in mesial movement of the first permanent molar (Titjana et al. 2008), because these teeth serve as a guide for the erupting permanent first molars.

The present study shows that; the changes in the arch length and width in case of unilateral premature loss of mandibular second primary molars was as follows:

A distance: there’s decrease in A distance from (4.8) to (3.8) mm. with significant difference statistically when compared with the control, this explained either because of the action of lower lip, or by the distal movement of permanent incisors and canines following the distal movement of the first primary molar toward the second primary molar space, and this come in accordance with many studies who found that space closure following premature loss of second primary molars occur by distal migration of canines in the mandible (Sowden 1941, Liu 1949, Hoffding and Kisling 1978, Northway et al. 1984, Lin and Chang 1998, Rao and Sarkar 1999).

B and D distances: although there is no significant difference statistically when compared with the control group but there is decrease in (B) distance from (15.2) to (14.5) mm. Explained by the distal movement of the first primary molars (Titjana et al. 2008). While the reduction in (D) distance from (34.87) to (30.6) mm. with significant difference statistically when compared with the control group indicating the strong mesial forward movement of the first permanent molars toward the second primary molar extraction spaces (Liu 1949, Love and Adams 1971, Northway et al. 1984, Lin and Chang 1998, Rao and Sarkar 1991, Titjana et al. 2008).

IC and IM distances: the (IC) decrease from (27.18) to (27.7) mm. without any significant difference. The (IM) distances decreased with a significant difference statistically only in MB distance leading to a fact that, the premature loss of mandibular second primary molars has an effect on the inter molar distances more than the inter canine distance leading to the fact that whenever second primary molars lost prematurely there is mesial forward movement of first permanent molars with lingual tipping (Macena et al. 2011). The main goal in this research is the relative position of the mandibular permanent first molars after the unilateral premature loss of each of the mandibular primary molars, in which we design to take 6 parameters, for
this reason these parameter are illustrated in table (3) and they are (C) and (D); both are vertical dimensions that measure the relative position of the mandibular permanent first molars antero-posteriorly (length) in the arch. While the (MB), (ML), (DB) and (DL) all of them are horizontal dimensions that measure the relative position of the mandibular permanent first molars laterally or horizontally.

The loss of lower first primary molars appeared to have greater influence on crowding than did the loss of second primary molars (Hoffding and Kisling1978).

On the basis of these findings, we must point to the fact, that maintaining of a high standard of dental service for preschool children to reduce the need for premature extractions of primary molars because, one of the important services that a pediatrician can render to a pediatric patient is that of maintaining the arch length prior to the eruption of the succeeding permanent tooth. So the main target in our study is the prevention of loss of primary molars during childhood years to preserve the space for the permanent successors.

Conclusion
Premature loss of mandibular primary molars result in a changes in the mandibular arch length and width as follows:
1- The unilateral premature loss of mandibular primary first molars cause a reduction in the (C and D) distances with a statistical significant difference when compared with the control group, at the same time there will be a reduction in the (IC and IM) distances with a significant difference statistically in the (IM) only.
2- Premature Loss of mandibular second primary molar there will be a reduction in the (A and D) distances with a significant difference when compared with the control group.

At the same time there’s a decrease in the (1M) distance with significant difference when compared with the control group; i.e. the effects mainly on the first permanent molars, the first permanent molars drift mesially and tipped lingually as observed from the change in in the size of extraction site and the horizontal inter molar disturbances.

3- All the vertical and horizontal parameters related to the relative position of the first permanent molars exhibit a decrease in length and width, causing crowding in the future which greatly make the work of orthodontist more difficult.

4- The present study show the importance of space maintenance following premature loss of mandibular primary molars at the mixed dentition stage for preventing space loss.

References


Liu WA (1949). A study of the closure of space following premature


Richardson ME (1965). The relationship between the relative amount of space present in the deciduous dental arch and the rate and degree of space closure subsequent to the extraction of a deciduous molars. Dent Pract Bristol 16:111-118.


