Factors Affecting Spontaneous Space Closure After The Extraction of First Permanent Molars

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AIM

The aim of this retrospective study was to determine the factors affecting spontaneous space closure and resultant occlusion following planned lower first permanent molar extractions conducted 5 years ago at a London dental hospital.

INTRODUCTION

First permanent molars (FPMs) are the most caries-prone teeth in the permanent dentition of children (figure 1). This is often exacerbated by the fact that FPMs are also susceptible to coronal defects such as molar-incisal hypomineralisation (figure 2) arising from physiological or metabolic disturbances during early infancy.

Figure 1. FPM with extensive caries

Figure 2. FPM with molar incisor hypomineralisation

In the UK, such FPMs of poor prognosis are routinely planned for extraction so as to avoid long-term dental treatment. If the FPM is extracted at the "ideal time", the second permanent molar (SPM) may spontaneously erupt to take its place, with minimal disruption to the resultant occlusion. This "ideal time" is defined in the UK national guidelines as between the ages 8 to 10 when there is radiographic evidence of early dentine calcification within the SPM root bifurcation[1] (figure 3). While upper FPM extractions usually result in spontaneous closure, there is little evidence to show that lower FPM extractions are as predictable. Other than the stage of SPM development at the time of extraction, it has been suggested that three other factors may be associated with a favourable resultant occlusion[2].

As numbered in figure 3, the radiographic factors are:

Factor 1: If the second premolar is engaged in the bifurcation of the second primary molar.

Factor 2: If the position of the SPM is mesially angulated in relation to the FPM.

Factor 3: If the permanent third molar is present.

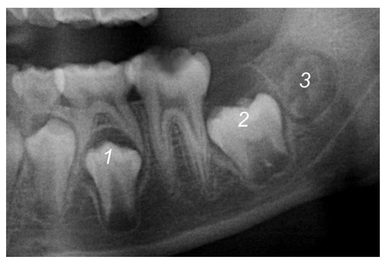

Figure 3. Radiographic factors affecting space closure

HYPOTHESES

Hypothesis 1: FPM extraction at the "ideal time" is significantly associated with spontaneous space closure and a favourable occlusion in the majority of cases, more so than FPM extraction earlier or later than this.

Hypothesis 2: The presence of one or more of the other three factors explained in figure 3 is significantly associated with spontaneous space closure and a favourable occlusion following FPM extraction in the majority of cases.

Hypothesis 3: The interaction between hypotheses 1 and 2 is significantly associated with spontaneous space closure and a favourable occlusion following FPM extraction in the majority of cases.

DESIGN

Sample: 127 lower SPMs from 66 patients ages 11 to 17 were included in the study, which was conducted at the Eastman Dental Institute in London, UK.

Inclusion Criteria: All patients had one or two lower FPMs extracted under general anaesthesia 5 years prior. They were subsequently discharged with no orthodontic treatment carried out in the following years.

Radiographic assessment: Every patient's dento-pantomogram taken at the time of FPM extraction was assessed for stage of SPM development (Demirjian dental development stage D – late crown, stage E – "ideal time", stage F – early root, stage G – late root)[3], and the presence of the other three radiographic factors described in figure 3.

Clinical Assessment: Each patient was recalled and examined. Spontaneous space closure and malocclusion in the posterior arch was recorded on a scale of 1 to 4, adapted from the dental health component of the Index of Orthodontic Treatment Need[4] or IOTN (table 1). IOTN 1 represented the most favourable outcome (figure 4), and IOTN 4 the least favourable (figure 5), also taking into account the presence of posterior cross-bites, open-bites and impactions.

Statistical Analysis: Results were analysed using ordered logistic regression.

IOTN Grade	Criteria
1	Extremely minor malocclusions including displacements less than 1 mm.
2	Contact point displacements greater than 1 mm but less then or equal to 2 mm.
3	Contact point displacements greater than 2 mm but less than or equal to 4 mm.
4	Severe contact point displacements greater than 4mm.

Table 1. Clinical assessment of SPM space closure adapted from IOTN

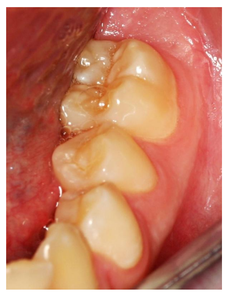

Figure 4. IOTN 1 space closure

Figure 5. IOTN 4 space closure

RESULTS

Hypothesis 1: IOTN 1 space closure was found in 57.8% of resultant occlusions when FPMs were extracted at the "ideal" time (SPM development stage E). Statistical analysis of the data in Figure 6 demonstrated that FPM extraction at SPM stages D (late crown development), E and F (early root development) was significantly associated with better space closure only when compared to SPM stage G (late root development).

Hypothesis 2: IOTN 1 space closure was found in 83.3% of the cases with all three radiographic factors present. Statistical analysis of the results confirmed the visual impression of three levels (figure 7). Poor outcomes were associated with FPM extractions performed when none of the three radiographic factors were present. The presence of one or more of the three factors were associated with significantly better space closure. Lastly, the combined presence of the second and third radiographic factors (SPM mesially angulated in relation to the FPM, and the presence of the permanent third molar) were associated with the most favourable outcomes.

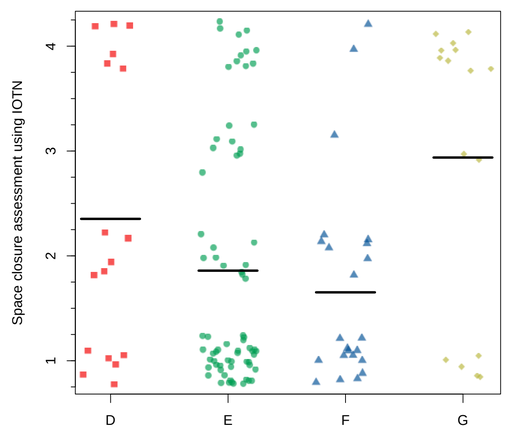

Figure 6. Jittered scatterplot comparing space closure assessment using IOTN and SPM development stage

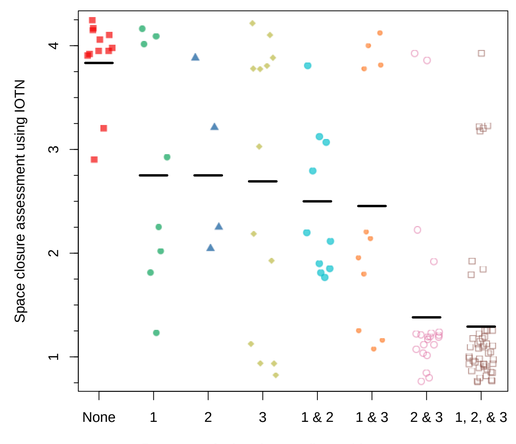

Figure 7. Jittered scatterplot comparing space closure assessment using IOTN and the presence or absence of the other three radiographic parameters

Hypothesis 3: Likelihood ratio comparisons showed that the three radiographic factors accounted for more of the variability in space closure than SPM development stage (LR stat = 64.93, $p(\chi) = <0.001$). However, the model that compared space closure with both SPM development stage and the three radiographic factors accounted for the most variability (for SPM vs. both: LR stat = 84.85, $p< 0.001$; for the other three measures vs. both: LR stat = 19.92, $p<0.001$). Interactions between SPM development stage and the three radiographic factors did not converge. The best-fit model is shown in Table 2. An SPM development stage not equal to G, combined with the SPM mesially angulated in relation to the FPM, and the presence of the permanent third molar, were associated with the best outcomes. In these cases 88.1% of the occlusions had IOTN 1 spontaneous space closure.

Comparison	t value	p value	level
1 vs. none	-2.27	* 0.024	2
2 vs. none	-1.62	0.11	1
3 vs. none	-2.28	* 0.026	2
1 & 2 vs. none	-2.32	* 0.021	2
1 & 3 vs. none	-3.01	* 0.0026	2
2 & 3 vs. none	-5.13	* < 0.001	3
1, 2, & 3 vs. none	-5.97	* < 0.001	3
SPM D vs. F	1.26	0.20	1
SPM E vs. F	0.00	1.00	1
SPM G vs. F	3.64	* < 0.001	2

Table 2. Ordinal Logistic Regression comparing space closure assessment using IOTN with SPM development stage plus the other three radiographic factors (* = significant, alpha = 0.05)

DISCUSSION

The acceptance of planned FPM extraction as a treatment modality in the UK rests mostly on the assumption that resultant space closure and occlusion will be satisfactory, as long as precise extraction timing is observed. Consequently, most children who undergo this treatment are not followed up upon. Here the assumption is challenged by employing the dental health component of the IOTN (a validated and repeatable assessment scale) to categorize the degree of lower arch malocclusion 5 years post-extraction, and correlate this to orthodontic treatment need. Because the parameters for IOTN 5 grading were not applicable, it was not included in the assessment. Nonetheless it is widely accepted that IOTN 1 indicates no treatment necessary, and IOTN 4 indicates a strong need for treatment. Therefore:

Hypothesis 1: The results only partially support this hypothesis. Extraction at the "ideal time" of SPM development stage E, although associated with spontaneous space closure, only resulted in a satisfactory outcome in slightly over half the cases. Moreover, the results do not demonstrate that extraction at SPM development stage E is itself ideal over stage D, which is considered too early, or stage F which is considered too late.

Hypothesis 2: The results strongly support this hypothesis, and provide compelling evidence that the presence of factors 2 and 3 are a better indicator of spontaneous space closure than SPM development stage.

Hypothesis 3: The results demonstrate that both SPM development stage and the presence of the other three radiographic factors should be examined in tandem to ensure the best possible outcomes and resultant occlusion.

CONCLUSION

The study demonstrates that timing alone based on the stage of SPM development is insufficient to ensure predictable spontaneous space closure following lower FPM extractions. Consideration must also be given to the presence of the third molar and the angulation of the SPM in order to properly select the cases more suitable for planned FPM extraction, and these patients should be reviewed closely.

References:
1.Cobourne M, Williams A, McMullen RA. Guideline for First Permanent Molar Extraction in Children. 2004 (updated 2009) *http://www.rcseng.ac.uk/fds/publications-clinical-guidelines/clinical_guidelines/index.html*
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