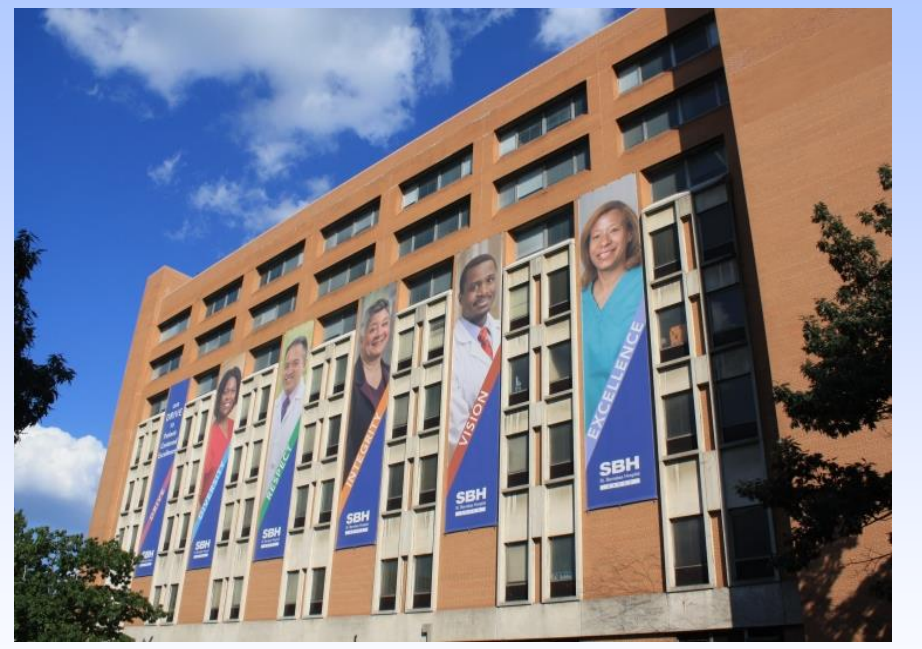


Determining Predictive Factors of Successful Maxillary Permanent Second Molar Substitution

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Introduction

Permanent first molars (PFMs) are the most caries-prone teeth due to their anatomy and early eruption into the mouth.¹ Furthermore, PFMs may be affected during their development by systemic or environmental factors that compromise their structural integrity, such as in the case of molar-incisor hypomineralization (MIH). PFMs affected by MIH tend to be more sensitive, more prone to rapid caries progression, more difficult to achieve anesthesia, and if restored, more likely to have marginal breakdown of restorations.² Research has shown that children with MIH will need lifelong, repeated restorations that will eventually fail.³ The behavior and cooperation of a pediatric patient must also be taken into consideration when determining if a permanent tooth can be predictably restored and/or endodontically treated. With these factors taken into consideration, extraction of PFMs with the possibility of permanent second molar (PSM) substitution is one of the treatment options for pediatric patients with PFMs that have questionable or no restorability. Extraction of the PFM in such cases presents challenges in managing the resulting edentulous space, especially considering that most restorative options (e.g. implants and fixed partial dentures) are typically indicated for adult patients.^{4,5} The eruption of the PSM into the extraction site of the PFM is influenced by various factors, including the chronology of dental development and the impact of adjacent teeth.⁶ However, the success of this natural space closure remains uncertain and often necessitates orthodontic intervention.⁷

This retrospective chart review is modeled after previous research conducted in London with the aim to investigate the predictive factors influencing the successful eruption of the PSM into the extraction site of the PFM in patients aged 5 to 13 in the Bronx, New York.⁷ Maxillary molars were analyzed in this particular study. This study seeks to contribute to the existing knowledge base and validate the findings of the previous study, examining variables such as age, gender, angulation of the PSM and second premolar adjacent to the extracted PFM, developmental stage of the PSM at the time of extraction, and presence or absence of third molars to determine their influence on eruption outcomes. The null hypothesis states that these factors have no effect on the ultimate eruption position of the PSM.

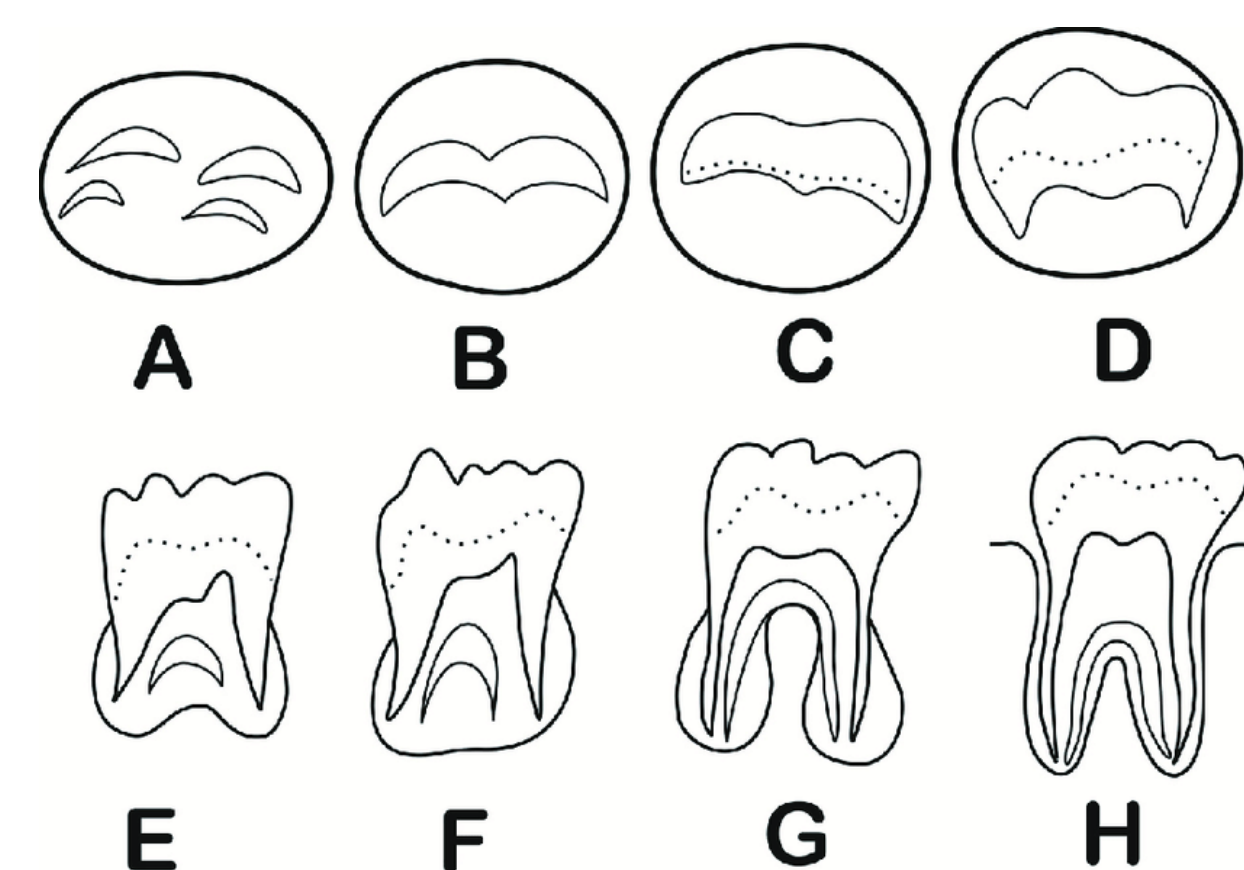


Figure 1. Demerjian Stage of Tooth Development⁸
Permanent molar tooth development, as classified by the Demerjian stages, from crown calcification (stage A) to apical closure of the roots (stage H)

Methods

Subjects

One hundred and seventy-seven patients of record between the ages of 5 and 13, who had extraction of tooth #3 and/or #14 from the years of 2005 to 2021, were analyzed. Thirty-six maxillary PFMs (from 32 patients) met the study criteria.

Patient Selection

Inclusion Criteria: Patients with at least one maxillary PFM extracted between the ages of 5 and 13; pre-extraction panoramic radiograph of adequate quality within six months prior to extraction; bitewing, periapical, or panoramic radiographs post-extraction that show angulation and eruption of the PSM and presence/absence of third molars

Exclusion Criteria: Patients congenitally missing PSMs or premolar tooth in the same quadrant; patients with non-diagnostic panoramic, periapical, or bitewing radiographs; patients with systemic disease or syndromes known to affect dental development, bone metabolism, or general facial growth/development; patients who previously had PSM extraction at any point prior to extraction of PFM; patients who had orthodontic treatment to close space

Data Collection

After applying the inclusion/exclusion criteria, 36 maxillary PFM extractions qualified for the study; 16 patients had tooth #3 extracted and 20 patients had tooth #14 extracted.

Measurements: Qualifying panoramic radiographs prior to extraction of the PFM were uploaded to Dolphin Imaging Software (2021 Patterson Dental Holdings), and a three-point angle measurement tool was used to measure the angulation of the second premolar and second molar against the occlusal table (Figure 2). The angulations were categorized as mesial (>95°), upright (85-95°), or distal (<95°) inclinations. Demerjian stages of tooth development (Figure 1) of the PSM and presence/absence of third molars were also evaluated using the panoramic radiographs.⁸ The measurements and developmental stages were recorded. After a two-week interval, the measurements and developmental stages were evaluated again to ensure reproducibility. Eight panoramic radiographs were randomly chosen from the data for calibration.

Calibration: The calibration was completed with Intraclass Correlation Coefficient (ICC) to examine reproducibility. The ICC test results were 0.98 for the calibration of the premolar and molar measurements, indicating excellent reliability.

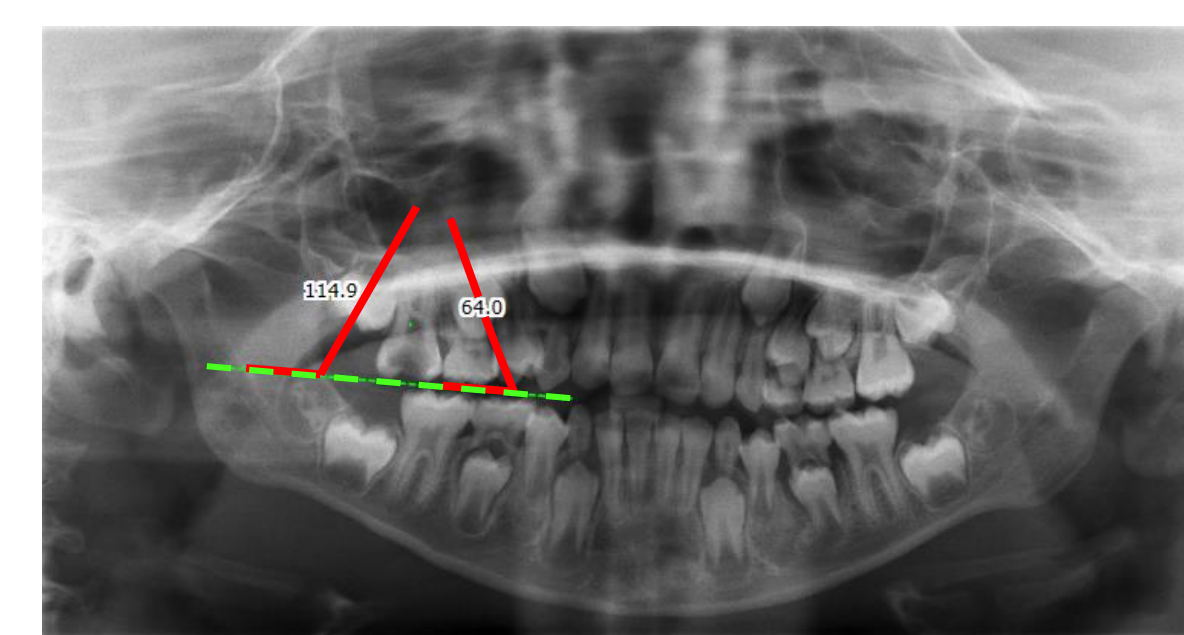
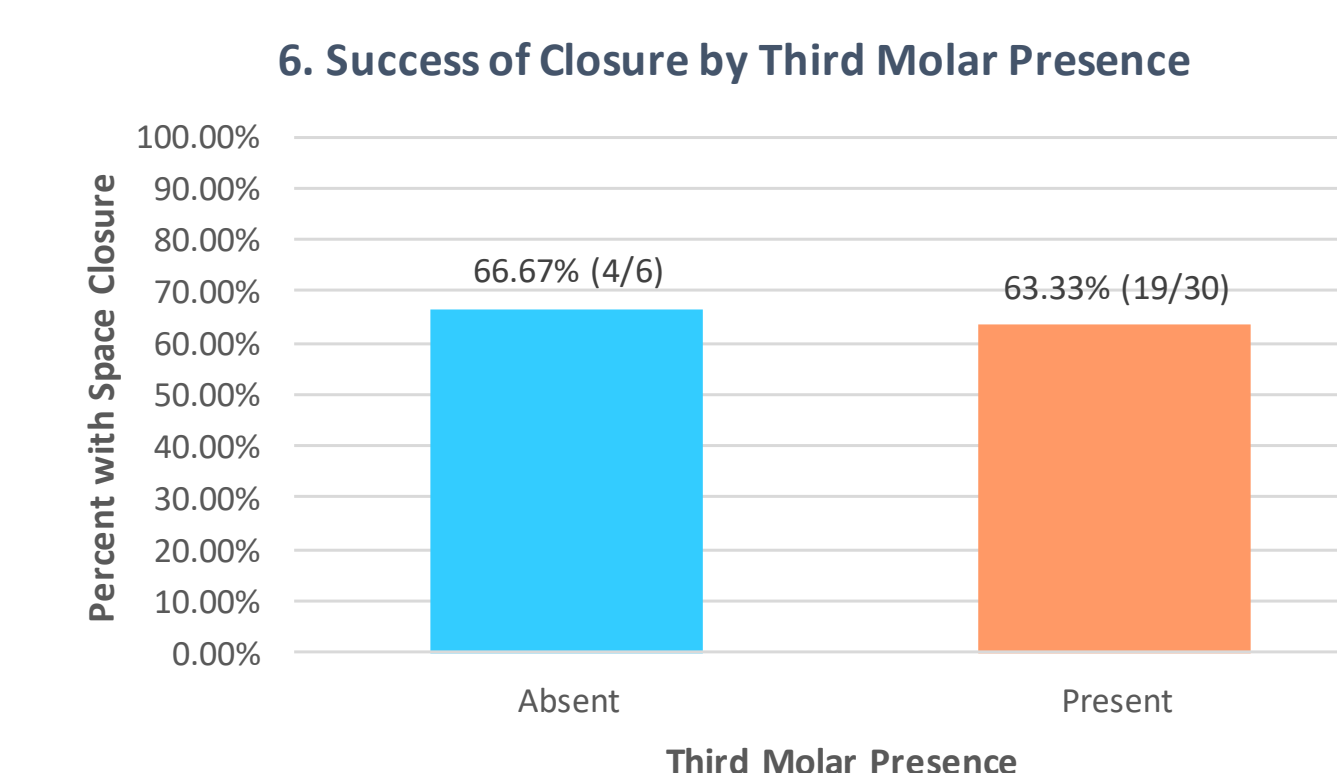
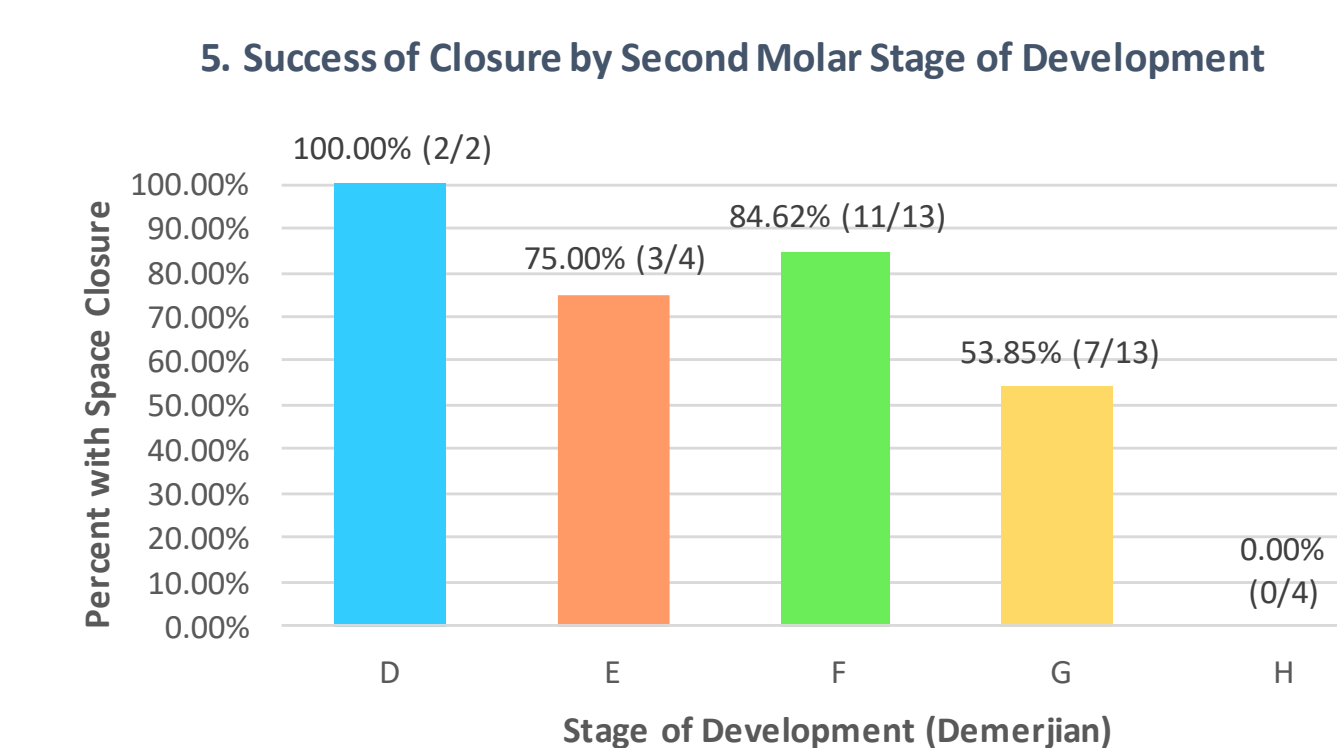
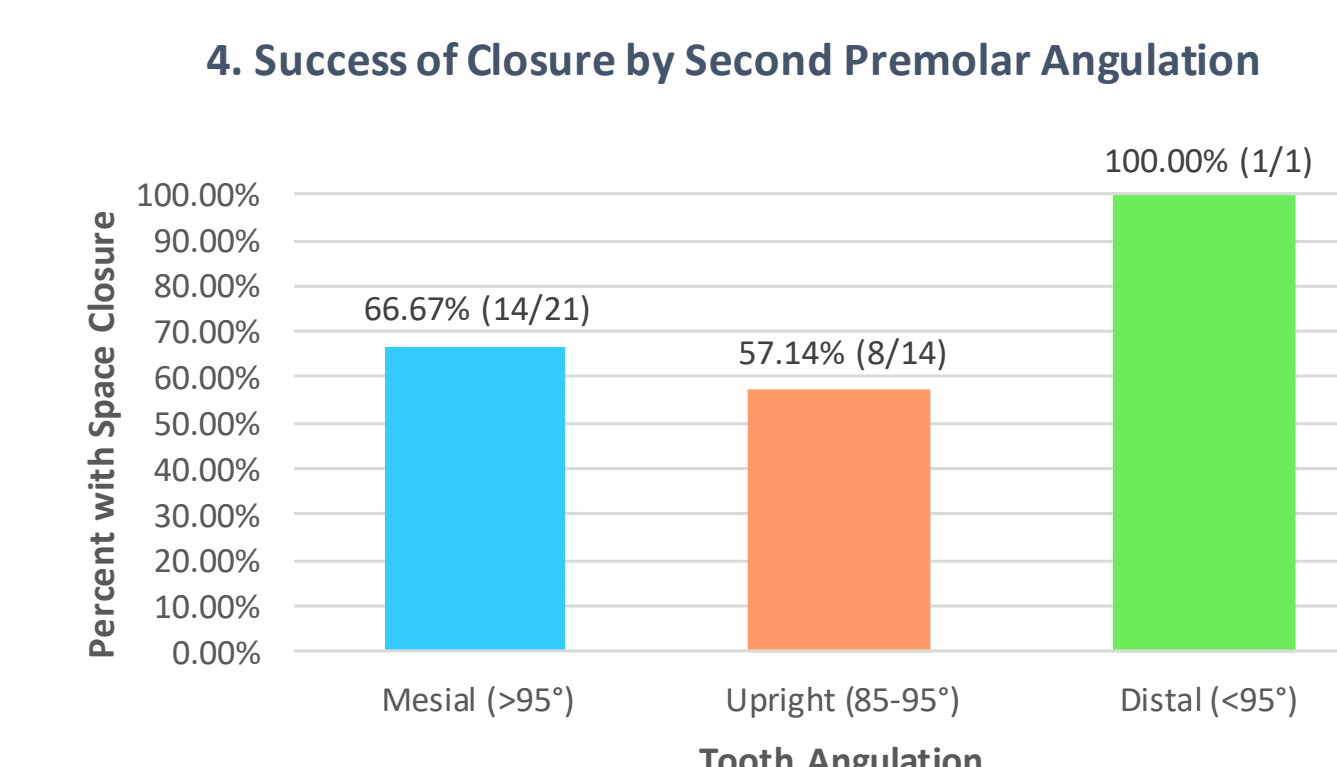
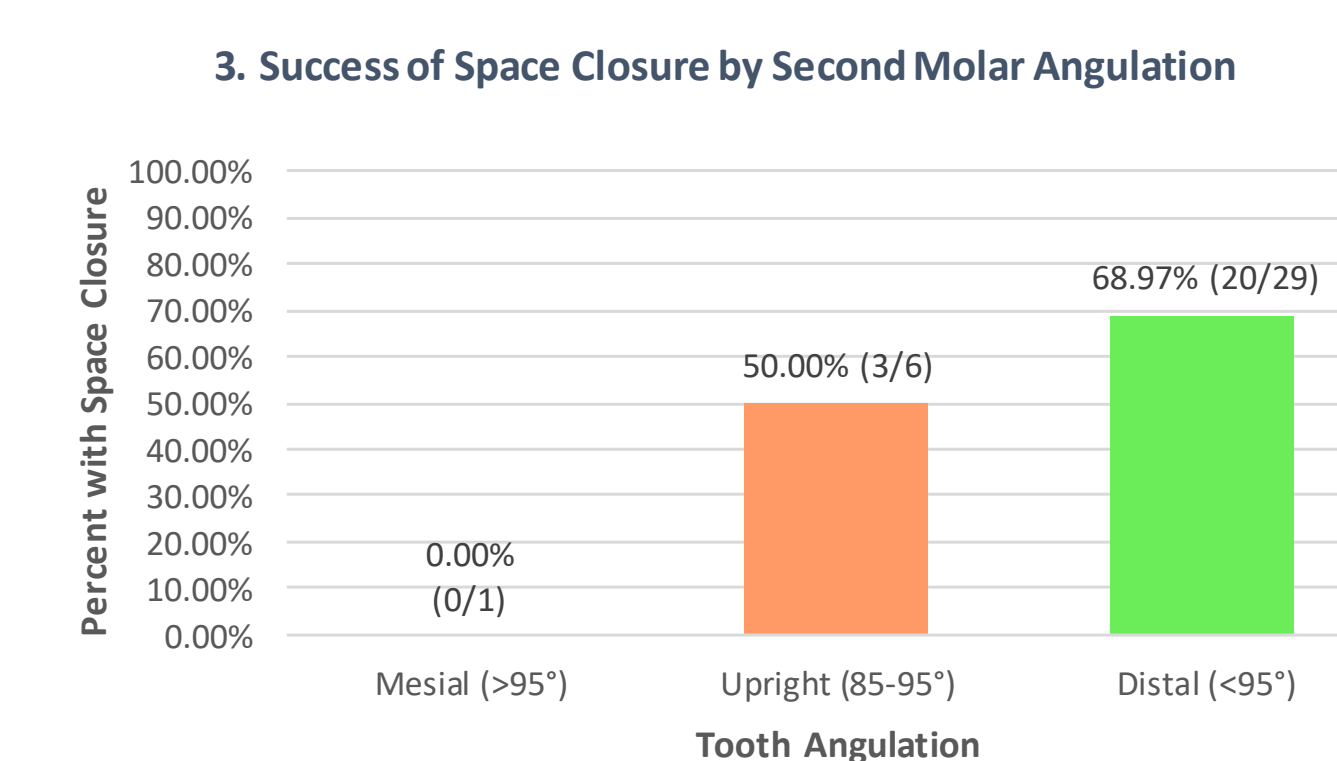
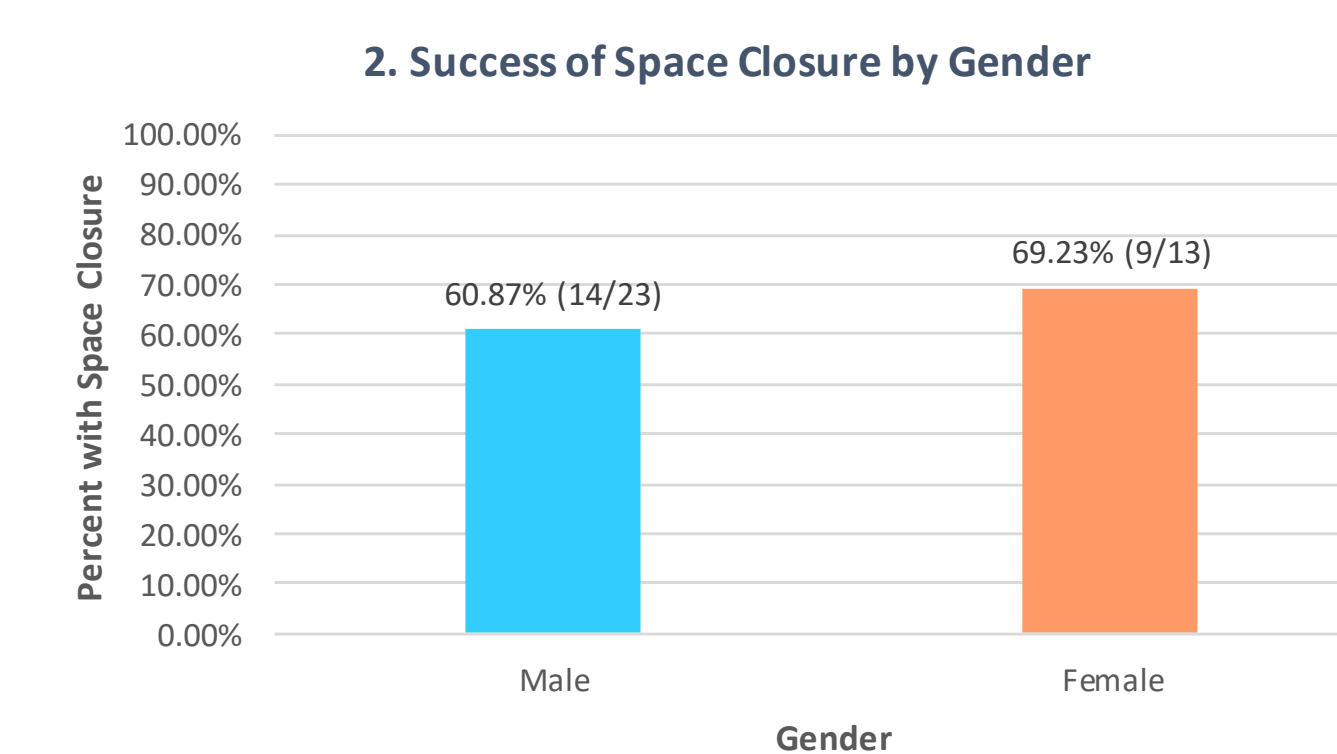
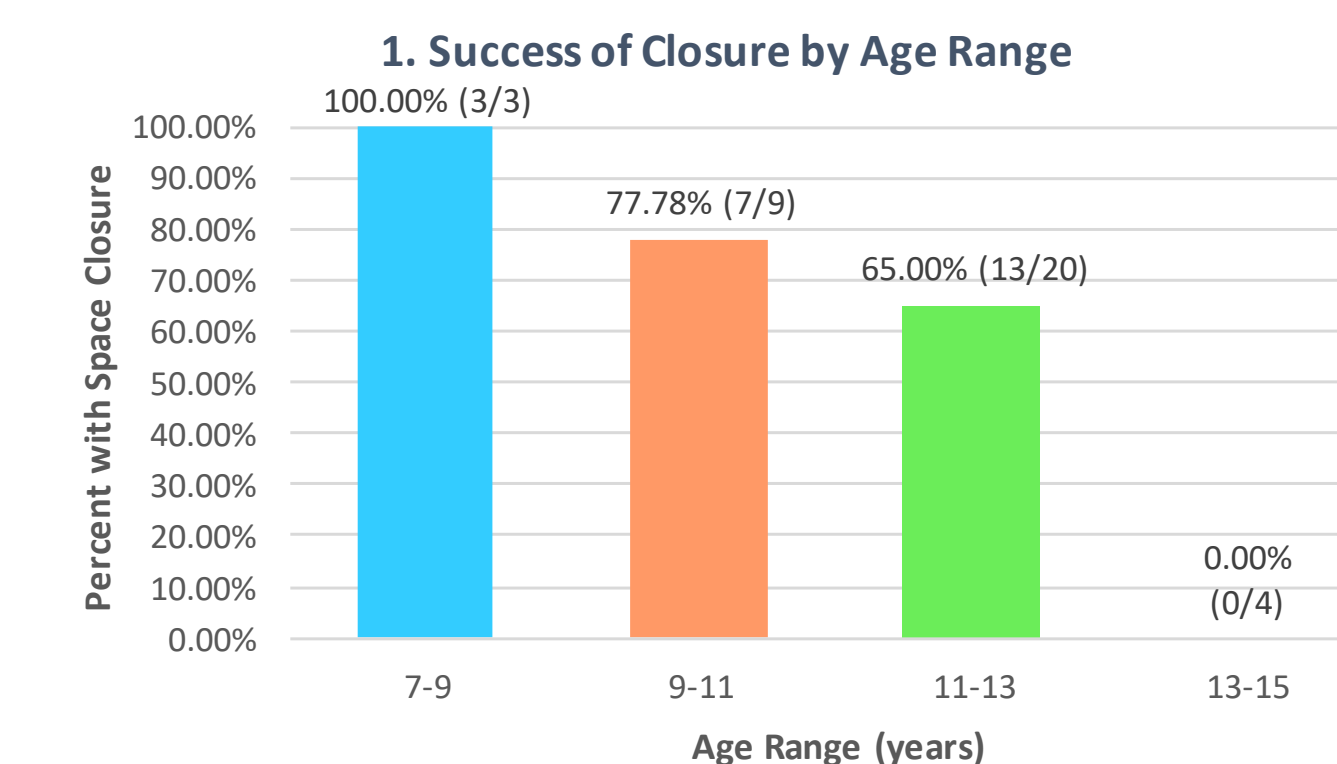


Figure 2. Panoramic Radiograph Measurements
Three-point angle measurements (red lines) were taken of the permanent second molar and second premolar against the occlusal table (green dashed line) in the quadrant of the extracted PFM. Presence/absence of the third molar crypt and stage of development of the permanent second molar were also noted on each radiograph.

Statistical Analyses

Logistic regression model analyses were run to determine whether age, gender, PSM angulation, second premolar angulation, developmental stage of the PSM, and presence or absence of third molars affected the likelihood of space closure.

Results



Discussion

- The only statistically significant factor in predicting closure of space was the developmental stage of the maxillary PSM at time of extraction of PFM ($P=.045$). The less developed the roots/furcation are (e.g. Demerjian stages D, E, F), the higher the percentage of success of space closure.
- The age of patients at the time of extraction ranged from 7.56 to 13.7 years with a mean of 11.31 years. Younger patients appeared to have higher rates of space closure than older patients, however there was no statistical significance.
- Of the 36 teeth analyzed, 13 belonged to female patients and 23 belonged to male patients. Out of the 13 females, 69.23% achieved space closure while out of the 23 males, 60.87% achieved space closure. Gender was not a statistically significant factor.
- Twenty-nine of the maxillary PSMs were distally inclined, 6 were upright, and 1 was mesially inclined. Of the patients with distally inclined PSMs, 68.97% achieved space closure while 50% of those with upright PSMs and 0% of those with mesially inclined PSMs achieved closure. This result was not statistically significant.
- Twenty-one of the maxillary second premolars were mesially inclined, while 14 were upright, and 1 was distally inclined. Of the patients with mesially inclined second premolars, 66.67% achieved space closure while 57.14% of those with upright second premolars and 100% of those with distally inclined second premolars achieved closure. This result was not statistically significant.
- Thirty patients had third molars present in the quadrant of extraction while 6 patients did not. Of the 30, 63.3% achieved space closure while of the 6, 66.7% achieved space closure. This result was not statistically significant.

Conclusions

- The only statistically significant predictor of space closure was the developmental stage of the PSM. This differs from the previous study that showed dental age as the only statistically significant factor in predicting maxillary space closure.
- All other factors (age, gender, angulation of PSM and second premolar, and presence or absence of third molar) show no relationship with success of space closure in the maxillary arch.
- Patients should follow-up with an orthodontist for evaluation and guidance of space closure.

Study Limitations

- Limited sample size with limited follow-up
- Absence of control group, so cannot definitively determine what factors caused space closure
- Can only determine radiographic closure of space; clinical closure of space is unclear

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