Extraction Choice: In the Era of Evidence Based Orthodontics

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Abstract:

Extraction of first premolars has been the most favorable extraction choice. However, the superiority of first premolar over second premolar extraction is not supported by recent evidence**.** Second premolar extraction is in harmony with Mother Nature's Rules. Mother Nature ruled in many instances to eliminate second premolars from the dentition. The high incidence of agenesis of second premolars is the proof. Therefore, the guide for extraction should be the natural occurring hypodontia. This article advocates the extraction of second premolars in average extraction cases on the grounds of simulating Mother Nature, and shows that in light of recent evidence, extraction of second premolars does not jeopardize treatment outcomes.

Introduction

The extraction/non-extraction ideology had received a great deal of attention in orthodontics. The "no extractions under any circumstances" Angle's ideology had been defeated by "extractions when necessary" Case's ideology. [1] The history of this battle continues to reverberate to this day. On the other hand, which tooth to extract? Is a question that is overlooked in many instances. It had been generally thought that extraction is synonymous with the removal of the four first premolars. Augmenting anchorage, maximum lip

retraction, better contact between the canines and second premolars, and the fact that first premolars are nearer to anterior crowding are some of the reasons behind favoring their extraction. However, in the era of evidence-based orthodontics, every treatment decision made should be supported by evidence. The superiority of first premolar over second premolar extraction is not supported by recent evidence.

Nance in 1949 [2] was one of the first to draw attention to the extraction of second premolars in mild discrepancy cases. Later, the extraction of second premolars has been advocated by many authors in borderline cases. [3-5] Logan [6] listed advantages of second premolar extractions: the maxillary first premolar is more esthetic than the second; the contact point of mandibular first molar and first premolar tended to stay closed; and rapid space closure reduces the possibility of buccal or lingual bone furrows in the extraction site. Newton De Castro in 1974 [7] was the first to advocate the removal of second premolars in average extraction cases. He based his ideology on the anatomy of the mammalian dentition. He considered the dentition as an arrangement of three independent segments. There is an anterior segment, ending at the two canines and two posterior segments. When a second premolar is extracted in the middle of the posterior segment, only this segment is affected and shortened. However, the first premolar is the point where the anterior and posterior segments meet. Removal of first premolars not only affects the posterior segment but also disturbs the transitional area between the anterior and posterior segment.

Although the literature is rich in the merits of extraction of second premolars, orthodontists still favor first premolar extractions. This article advocates the extraction of second premolars in average extraction cases on the grounds of simulating Mother Nature, and shows that, in light of recent evidence, extraction of second premolars does not jeopardize treatment outcomes.

Extraction of second premolar simulates Mother Nature

Orthodontic treatment objectives are to simulate Mother Nature by achieving the different normal values that are derived from the natural occurring dentition. Andrews's six keys of occlusion, cephalometric values, and tooth size ratios are all derived from the best occlusions occurring in nature. Extraction ideology itself is based on simulating Mother Nature. When “Begg” advocated extraction, his shield from criticism was that extraction of teeth compensate for the lack of natural tooth attrition in civilized man. Stone Age man exhibited proximal and occlusal tooth attrition that compensates for the mesial and vertical tooth migration. Begg, therefore, concluded that orthodontists have a well-founded precedent for reducing dental arches by tooth extraction.[8]

As long as orthodontic treatment tries to simulate Mother Nature, by attaining results similar to the best occlusions occurring naturally, we should also respect it and simulate it in our extraction choice. In order to respect this rule we strongly believe that the guide for extraction should be the natural occurring hypodontia. Since second premolars have a higher incidence of congenital absence than first premolars [9], we believe that their removal should be recommended in the average extraction case.

Second premolar extraction not only respects Mother Nature’s rules but also is a better choice from a functional point of view. Second premolars complement the grinding function of molars during mastication. First premolars complement the tearing function of the canines. [10] Since we only have one canine we need to keep first premolars to enhance tearing during mastication. Whereas, we have three molars to grind the second premolars could be sacrificed.

Clinical Differences between extraction sequences

The clinical differences between extraction of first premolars and second premolars are highly debatable. It will be discussed from the following aspects:

1. Effect of extraction site on anchorage.
2. Effect of extraction site on the amount of lip retraction.
3. Effect of extraction site on the amount of tooth size arch length discrepancy.
4. Effect of extraction site on the vertical facial dimension.
5. Clinical considerations.

Anchorage:

Over the years, anchorage needs geared the choice of extraction. First premolars are extracted in maximum anchorage situations; second premolars are usually extracted in borderline cases. These choices are based on William's Hypothesis in1969; which stated that by a change in the location of the extraction site, there would be a change in the relative root surface areas between the anterior and posterior segments, enough to influence the potential for incisor retractions. [11] Creekmore in 1997 quantified this clinically; when mandibular first premolars are extracted, the posterior teeth move forward about one-third of the space, leaving two-thirds of the space for correction of crowding and for incisor retraction. On the other hand, when mandibular second premolars are extracted, the posterior teeth move forward about half the extraction space. [12]

Augmenting anchorage through increasing the number of teeth in the anchorage unit depends on the differential force theory. Increasing the number of teeth disperses the force over a greater root surface area. This decreases the strain of the periodontal structures within the anchorage unit. Presuming that decreasing the load will result in decreased rate of tooth movement, the anchorage unit will then be more stable.

Many studies investigated the relationship between the magnitude of pressure in the periodontal ligament and the rate of tooth movement. The hypothesis most accepted is that tooth movement is produced after forces reach a threshold, i.e. the lower limit of the force that will produce tooth movement. A linear relationship may then exist between tooth movement and pressure in the periodontal ligament up to a point. When that point is reached, the amount of tooth movement becomes more or less independent of the magnitude of the pressure. "Fig 1". [13] Therefore, the best anchorage from a biological point is when the force acting on the periodontal ligaments and the surrounding bone is below the threshold that leads to tooth movement. However, the magnitude of the threshold is not fully known. Kvam[14] has shown that even the seating of a band is enough to produce an activation of the cells of the periodontal ligaments. Brudvik and Rygh [15, 16] have shown that even low forces may correspond to the amount of force needed for the displacement of anchorage units.

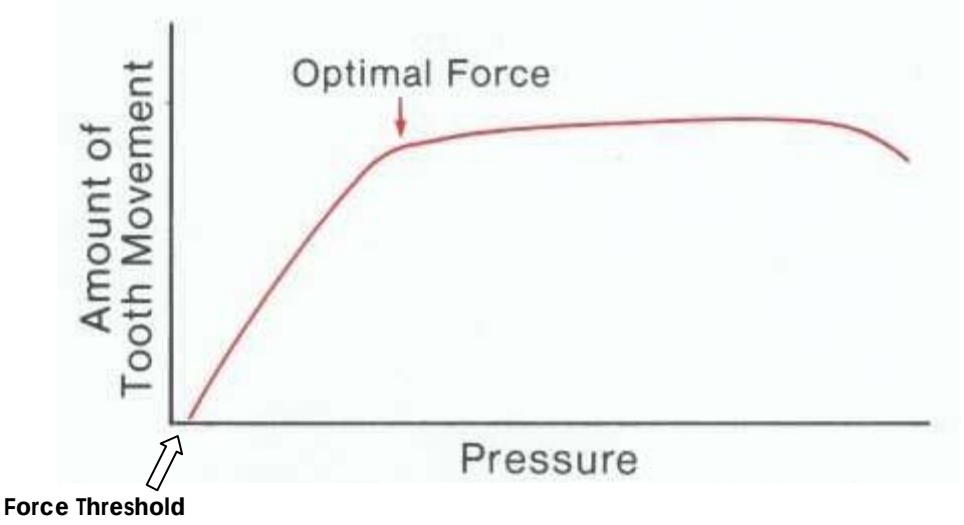

Figure 1: Theoretic representation of the relationship of pressure within the periodontal ligament to the amount of tooth movement.

In 1996 Pilon et al [17] placed serious doubts on the differential force theory in its entirety. They showed that in Beagle dogs the rate of tooth movement and the amount of anchorage loss were not significantly different for forces ranging from 50gm to 200gm. It was concluded that the magnitude of force is not decisive in determining the rate of bodily tooth movement. Later, Von Bohl et al, [18] confirmed the poor correlation between force level and tooth movement. Geron et al in 2004 [19] found that crowding and mechanics are primary factors in anchorage loss, whereas age, extraction site and overjet are secondary factors. Anchorage loss was only 0.5 mm greater with second premolar extractions when compared to first premolar extractions, and this was statistically insignificant.

The long-held dogma that greater anchorage loss occurs when second rather than first premolars are extracted is weakly supported in recent literature. The ever-increasing effectiveness of modern fixed appliances to conserve anchorage is clinically apparent. In many extraction cases with high anchorage needs, overjet and overbite are reduced to normal, leveling and alignment is completed without losing anchorage. Extraction spaces may still be available. The following case is an example; 11 year old female patient "Fig 2". Class II canine and molar relation "Fig 3". She has a 7mm overjet, a deep bite and 5mm tooth-size arch-length discrepancy in the upper arch "Fig 4". The treatment objectives were to align teeth, reduce overjet, achieve a class I canine relation and accept a class II molar relation.

Figure 2: 11-year-old patient

Figure 3: Class II molar and canine relation

Figure 4: overjet 7mm

Extraction of upper second premolars was carried out. Upper and lower 0.022 fixed appliance (MBT prescription) placed. Light forces were used throughout the treatment. Initial archwires were upper 0.014 and lower 0.016 nickel titanium archwires. Lace backs (0.09 ligature wire extending from the upper molars to the canines) to move the canines distally while aligning "Fig 5". Lace-backs are known to conserve anchorage in the aligning stage.[20] After leveling and alignment was completed, an upper and lower 0.019 x 0.025 stainless steel wires were inserted, and en-masse retraction using the MBT active tie backs started "Fig 6". Overjet and overbite are reduced to normal, and alignment achieved. However, around 3mm of the upper extraction spaces were still available "Fig 7 and Fig 8". Active tie backs were continued. The patient missed two appointments, she came back with and edge to edge occlusion "Fig 9". Arches were removed to allow the arches to relapse

Figure 5: Lace Backs

Figure 6: Upper and lower 0.019 x0.025

stainless steel archwires.

Figure 7: overbite and overjet reduced.

Figure 8: 3mm of upper extraction space is still available.

Figure 9: overcorrection.

Closing the remaining extraction space came from burning anchorage and moving upper molars mesially. Case finished with a class II molar relation, which was anticipated "Fig 10 and Fig 11".

Figure 10: Class II molar, Class I canine relation.

Figure 11: anterior view.

Cephalometric measurements in (Table 01) show the degree of retraction of the upper anterior and lower anterior teeth. Most of the overjet reduction was from the upper incisor retraction. Table (02) Shows the seven points MBT uses from Arnett soft tissue analysis.

Table 01 Cephalometric measurements

Measurement	Norm	Beginning	End
Upper 1 to Pal	108	119	112
Lower 1 to mand	90	105	108
Interincisal angle	130	113	111
U 1 to Apog	+4 mm	9	3.5
L 1 to Apog	+2 mm	2	0
Pal/ Mand plane	25	23	20
Sn/ Mand plane	34	29	28

Table 02 Arnett soft tissue analysis

Measurement	Mean ±SD Females	Mean±S.D Males	Reading 1	Reading 2
Soft tissue A point (A'- TVL)	-0.1 ± 1.0	-0.3 ± 1.0	-2	-2
U lip anterior (ULA-TVL)	3.7 ± 1.2	3.3 ± 1.7	2	0
L lip anterior (LLA-TVL)	1.9 ± 1.4	1.0 ± 2.2	-1	-3
Soft tissue B point (B'- TVL)	-5.3 ± 1.5	-7.1 ±1.6	-10	-11
Soft tissue Pog (Pog '- TVL)	-2.6 ± 1.9	-3.5 ± 1.8	-4	-9
Mx1 inclination (Mx1-MxOP)	56.8 ± 2.5	57.8 ± 3.0	50	60
Md 1 inclination (Md1-MdOP)	64.3 ± 3.2	64.0 ± 4.0	57	58

Lip Retraction

There are anecdotally based expectations of the esthetic benefit of one premolar extraction sequence over another. In 1949, Nance promoted extraction of upper and lower second premolars to limit the amount of incisor retraction during space closure, in order to prevent the lateral lip profile from flattening. [2] These recommendations are largely derived from clinical observations with little scientific evidence to support the choice of one sequence over another. [21, 22] For example Proffit [23] sought to quantify differences in incisor retraction and mesial molar movement with different extraction patterns through *clinical observation*. He stated that "…all other things being equal, the amount of incisor retraction will be less, the further posteriorly in the arch an extraction is located".

To verify the validity of this clinical notion, two questions must be answered. How much does the location of the extraction site affect the amount of incisor retraction? And, how will incisor retraction change soft tissue morphology? These questions have been answered by numerous studies in the recent literature.

Shearn and Woods in 2000, Ong and Woods in 2001, answered the first question. Their study showed that there is considerable individual variation in incisor and molar movements with any premolar extraction sequence. A specific extraction sequence does not necessarily guarantee that certain amounts of incisor retraction or molar protraction will occur. [21, 22]

The second question has been answered by Steyn et al. Their results showed that whether four first premolars or four second premolars are extracted, the soft tissue appearance of the patient after orthodontic treatment will virtually be the same.[24] Moreover, in 2003 Wholley and Woods showed that a similar range of changes in depths of upper and lower lip curves occur, regardless of the chosen

premolar extraction sequence. The depth of lip curvature was influenced by the pretreatment thickness of the upper and lower lips, at the level of the vermilion tissue. [25]

Tooth Size Discrepancy:

Tooth size discrepancy between the maxillary and mandibular dental arches may produce deviations from an ideal occlusion at the end of orthodontic treatment. Spaces between the teeth, an excessive overjet and an increased overbite are some of the problems encountered. [26, 27] The distal tooth in each morphological group has a greater coefficient of variation in mesiodistal crown diameter than the mesial tooth. Maxillary lateral incisors, maxillary second premolars, and all four third molars are the most variable in crown size. [28]The effects of relatively small lateral incisors on the final occlusion are well appreciated, probably because of their high visibility to both patient and orthodontist.

In extraction cases, premolar size discrepancies can have a profound effect on the final occlusion. [29] Saatçi, Yukay in 1997, showed that the removal of the four 1st premolars created the most severe tooth-size discrepancy, whereas the extraction of all four 2nd premolars created fewer discrepancies. In his study, the mandibular second premolar showed the largest mean mesiodistal dimension. It appeared that, because most discrepancies created by extraction occurred as a mandibular excess, removal of the mandibular second premolars, which usually had wider mesiodistal dimensions, was likely to create discrepancies of a smaller size than the mandibular first premolars. [30] This result is in agreement with the opinion expressed by Bolton in 1962, that the removal of mandibular 2nd premolars often creates the potential for a better occlusion than the removal of the 1st premolars. [31]

Facial Vertical Dimension:

It is hypothesized that second premolar extraction permits the molar to move more mesially than first premolar extraction therefore limiting the wedge effect. Mesial movement of the molars leads to anti-clock wise rotation of the mandible and a decrease in the vertical facial dimension. Therefore, in orthodivergent and hypodivergent patients, first premolar extractions are selected and hyperdivergent patients are treated with extraction of second premolars. However, as recent as 2005, Kim et al, showed that the wedge effect concept is invalid. Facial vertical dimension is virtually the same whether first or second premolars are extracted. [32]

Clinical Considerations:

Extraction of second premolars positively reflects on the clinical aspects of the case. Among the clinical advantages of extracting second premolars, is the easier bracket bonding to the first premolars when compared to bonding brackets to second premolars. Moreover, second premolars have the highest incidence of bracket bond failure. Another clinical advantage is in case of furrow formation due to extraction (knife edge alveolus). Furrows impede space closure and may lead to space re-opening. Furrows, in the area of the first premolars, show much more than in the area of second premolars during smiling "Fig 12 ". Clinically, it is easier to extract second premolars since the anatomy of maxillary first premolars makes it more liable to fracture. Maxillary first premolars have a narrow neck, variable furcation, and they have thin roots. [10] Second premolar anatomy is less variable. Therefore, their liability to fracture is less.

Figure 12: furrow after extraction of first premolar.

Extraction of first premolars becomes a more favorable extraction option in just a handful of cases. For example, when the extraction is near the crowding site, "Fig 13" or, if their presence is impacting the second premolars "Fig 14".

Figure 13: first premolar extraction is favored.

Figure 14: second premolars are impacted against the first premolar.

Conclusion:

The accepted merits of the effects of different extraction sequences have been largely derived from clinical observations, with little scientific evidence to support the choice of one sequence over another. In light of recent evidence, anchorage, lip retraction, and facial vertical dimension is virtually the same whether second or first premolars are extracted. Therefore, the decision of which premolar to extract should be based on simulation of Mother Nature. Reviewing the literature showed the highly debatable comparison between the two extraction options, but none has mentioned that the guide for extraction should be the natural occurring Hypodontia. Since second premolars have a higher incidence of congenital absence they should be the most favorable extraction choice.

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