



Orthodontic Treatment Strategies and Prescription of Extractions

Farid Bourzgui¹ , Kenza Khamlich^{2*} , Yasmine Haddad³, Zineb Serhier⁴ 

¹Orthodontics Department, Faculty of Dentistry, University Hassan II, Casablanca, Morocco

²Orthodontics Department, Faculty of Dentistry, University Hassan II, Casablanca, Morocco

³Private Practice, Casablanca, Morocco

⁴Laboratory of Medical Informatics, Faculty of Medicine & Pharmacy, University Hassan II, Casablanca, Morocco

Email: faridbourzgui@gmail.com, kenza.khamlich94@gmail.com, yasmine.haddad68@gmail.com, zineb.serhier@etu.univh2c.ma

How to cite this paper: Bourzgui, F., Khamlich, K., Haddad, Y. and Serhier, Z. (2024) Orthodontic Treatment Strategies and Prescription of Extractions. *Open Access Library Journal*, **11**: e10953. <https://doi.org/10.4236/oalib.1110953>

Received: November 1, 2023

Accepted: February 25, 2024

Published: February 28, 2024

Copyright © 2024 by author(s) and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

The aim was to assess possible trends in the prescription of extractions for therapeutic purposes over the last 5 - 10 years and to focus on changes in treatment goals, facial aesthetics and the smile. A cross-sectional study was carried out. A total sample of 107 participants was selected. The questionnaire used in this study was inspired by that of Fleming PS *et al.*, 2018 (1). A 17-item questionnaire was distributed to participants for completion, 15 of them were close-ended questions while 2 were open-ended questions. 107 responses were obtained out of 190. 73.8% reported reduced extraction prescription over the last 5 - 10 years with the majority reporting a decrease in adults 53.3%. Overall, 54.4% and 51.9% respondents were comfortable treating 8 mm or more with extractions; this figure decreased to 38% and 41.8% for 6 - 8 mm in adolescents and adults, respectively. Facial and smile aesthetics (97.5%), increased use of inter-proximal reduction (95%) and periodontal implications (86%) were the factors most frequently reported as having either a moderate or major influence on this approach. In conclusion, over the past 5 - 10 years, there has been a reduction in the prescription of orthodontic extractions among Moroccan orthodontists.

Subject Areas

Orthodontics

Keywords

Extraction, Bicuspid, Treatment Outcome, Orthodontic, Morocco

1. Introduction

Nowadays, facial aesthetics, occlusion and functions are strongly valued. Thus,

orthodontic treatment is receiving increasing attention, not only from orthodontists, but also from the population seeking treatment. With any orthodontic patient, the diagnosis requires a careful analysis of the face, skeletal pattern, and dentition so that the treatment plan and subsequent treatment will yield long-term esthetic and functional benefits and stability.

The effect of orthodontic treatment on the balance and aesthetics of the face has become an ongoing research topic, originating from the extraction - non-extraction dilemma which is a classic one in the history of orthodontics. The previous extraction of teeth (especially bicuspid) is a common treatment modality in orthodontics. Controversies over whether to extract or not which have taken place over many years were often related to personal preferences and beliefs, as well as intimate convictions, rather than scientific and factual criteria [1].

In the early 20th century, to Edward Angle and his followers, extraction was anathema. In their concept, extraction destroyed the possibility of ideal occlusion or ideal esthetics, both of which required the presence of all teeth [2]. However, the increase in extractions that took place in the mid-1940s was largely due to the influence of Charles Tweed, whose teaching became widely accepted. He advocated positioning the mandibular incisors vertically on the basal bone (approximately 90° to the angle of the mandibular plane) and argued that the expansion of dental units from this bone resulted in instability [3].

Extractions into the permanent dentition quickly became the most common treatment strategy for the correction of Class I and II malocclusions and, as Allan Brodie regrettably noted, “the air quickly filled with bicuspid”. The prevalence of extractions rose from a modest 30% in 1953 to 76% in 1968 [4].

In recent decades, the debate has been reframed with new non-extractionists trends based on new treatment philosophies or mechanics. In this new scenario, it seems pertinent to redefine the classic and new protocols with a critical perspective in order to find a potential consensus on the parameters that set up the indication for extraction in orthodontics [5].

Is this supposed to mean that nonextraction treatment is always better than extractions, more stable, and healthier for the periodontal tissues, and improves the profile and facial appearance?

By observing these changing trends in decision making regarding the definition of orthodontic treatment goals, what is the situation of Moroccan orthodontists during this last decade? In order to bring elements of answers to this question, this study aimed to evaluate: First, the perception of Moroccan orthodontists regarding their tendency to prescribe extractions for orthodontic purposes over the last 5/10 years; then, the decision-making criteria such as facial and smile aesthetics, as well as the treatment strategies and techniques chosen.

2. Methods

A cross-sectional study was carried out at Casablanca dental school in the first

semester of 2019/2020 academic year. The target population included all Society members involved in public and private practice: Exclusive orthodontists, general practitioners (GP) practicing orthodontics. Data was collected during the congress of the College of alumnis Orthodontists of the Faculty of Dentistry of Casablanca (COLFMDC) which took place in Casablanca from 13 to 16 February 2019. A total sample of 107 participants was selected.

The questionnaire used in this study was inspired by that of Fleming PS *et al.*, 2018 [1]. A 17-item questionnaire was distributed to participants for completion, 15 of them were close-ended questions while 2 were open-ended questions. The questionnaire consisted of 2 sections:

The first concerned practitioner demographics gender, years of experience, university of education and treatment philosophy. Respondents were then asked if there is any change of the proportion of patients, they treated with extractions in the last 5 to 10 years. If they reported that this was unchanged, the survey was complete. If, however, they reported a change in extraction frequency, they were asked specific follow-up questions in relation to tooth type and patient maturity; use of alternative methods of creating space; and factors influencing tendency to suggest extractions as part of an orthodontic treatment plan. The degree of influence associated of the following factors was considered:

- Facial and smile aesthetics,
- Temporo-mandibular joint (TMJ) health,
- Appliance and anchorage systems used,
- Use of inter-proximal reduction (IPR) and reliance on transverse expansion and incisor proclination,
- Periodontal and treatment duration implications,
- Retention and stability.

Further information in relation to answers open-ended questions could be given in free text boxes.

Data were analyzed using the statistical SPSS software (version 16.0, SPSS Inc.; Chicago, IL, USA). Ordinal logistical regression analysis was used to investigate the association between estimated threshold space requirement prompting extractions according to clinical setting. Ethical clearance was obtained from the college of departments, of the Faculty of Dentistry, University Hassan II of Casablanca which acts as the Ethics Committee. All the participants were informed that the questionnaire was anonymous Consent of the participants was obtained after the pertinent information about the purpose of the study and its content were presented.

3. Results

In total, 190 questionnaires were distributed, of which 107 were usable, yielding a response rate of 56.31%. Our sample includes 107 participants distributed as follows: 42 participants were male (39.3%), 65 were female (60.7%). The sex ratio was 1.5.

Our population was represented by participants whose ages were distributed as follows: 17 participants belonging to the age group (25 - 30) years/15.9%; 39 participants belonging to the age group (30 - 40) years/36.4%; 51 participants belonging to the age group (>40) years/47.7%.

Regarding, years since qualification: 24 participants had 2 - 5 years experience 22.4%; 25 participants had 5 - 10 years experience 23.4%; 58 participants had above 10 years experience 54.2%.

Concerning the type of degree obtained in orthodontics: 64 participants obtained a university diploma 59.8%; 17 participants obtained a diploma of national specialization in orthodontics 15.9%; 3 participants obtained CECSMO (French national diploma in orthodontics) 2.8%; 23 obtained an improvement certificate in orthodontics 21.5%.

For the Clinical settings, most of participants worked in private practice as mentioned below: 90 participants worked in private practice/84.1%; 10 participants worked in public practice/9.3%; Only 7 participants worked in the university hospital/6.5%. The majority of respondents worked in specialist practice with a percentage of 64.5% whereas 35.5% worked in general dental practice.

The demographic characteristics of the respondents are represented in **Figure 1**.

For the orthodontic appliances used, the majority of respondents used an “Adjusted appliance (Straight wire)” routinely (n = 82; 76.6%), with 63.6% (n = 68) using Self Ligating Brackets (SLB) most commonly.

Most respondents trained with Aligner (n = 63; 58.9%), although some trained with standard conventional, edgewise (Zero information) (n = 44; 41.1%) (**Figure 2**).

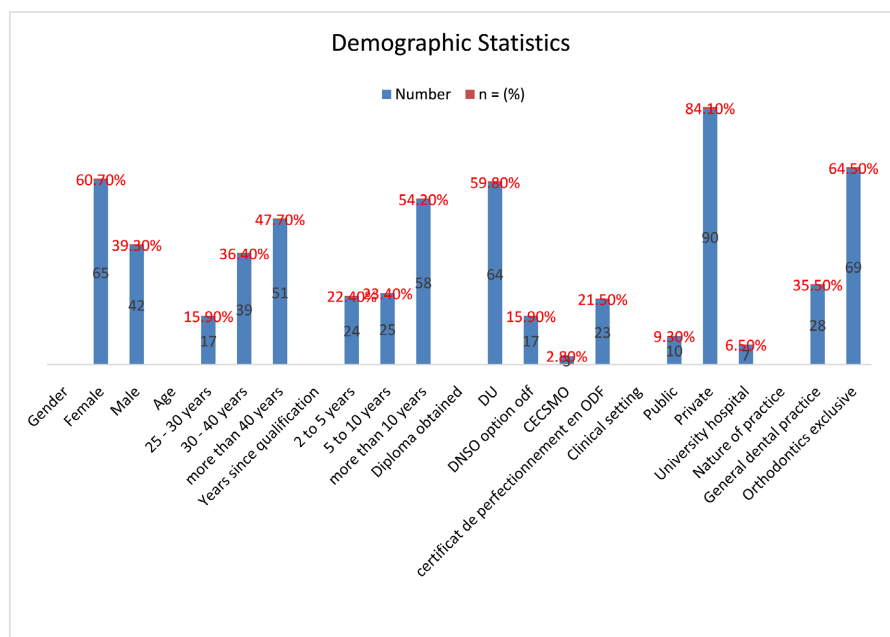


Figure 1. Demographic characteristics of the respondents (n = 107).

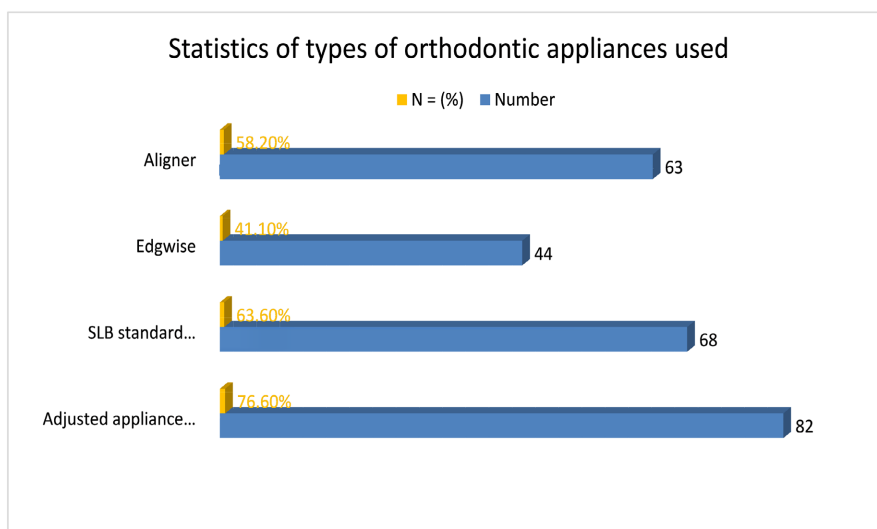


Figure 2. Types of orthodontic appliances used.

Overall, 73.8% (n = 79) reported reduced extraction prescription over the last 5 - 10 years with the majority reporting a decrease in adults 53.3% (n = 57).

In terms of threshold levels of crowding which might be treated without extractions, 43 respondents were comfortable treating 8 mm or more with extractions; this figure decreased to 38% (n = 30) for 6 - 8 mm, whereas, only 6 respondents (7.6%) for 4 - 6 mm agreed to suggest non-extraction approaches for crowding of more than 4 mm (**Table 1**).

Among the possible factors explaining the reduced prescription of extractions (**Table 2**):

- Facial and smile aesthetics which takes the lead with a percentage of 97.5%.
- The use of transverse expansion with a percentage of 95%.
- The use of IPR: most of respondents were frequently reported as having either a moderate or major influence (93.7%).
- Periodontal implications with a percentage of 86%.
- With regard to answers concerning the treatment of moderate Class I crowding (4 - 7 mm) in adolescents. The majority (82.3%) likely prescribed interproximal reduction (IPR). Transverse expansion (n = 131; 63%), expansion (n = 115; 55.3%), incisor advancement (n = 130; 62.5%) and a combination of arch lengthening and IPR (n = 110; 52.9%) were all considered more likely approaches than 5 to 10 years previously. Distal movement of posterior teeth with temporary anchorage devices was reported to have some effect, with 26.4% (n = 55) relating their use to changes in extraction frequency (**Figure 3**).
- Ordinal logistical regression analyses did not find any significant relationship between threshold for extractions and level of orthodontic experience or bracket type (SLB vs conventional brackets and both conventional and

SLB vs conventional brackets). An association was found between setting (Private practice vs University and public practice) and the threshold amount of crowding before choosing to extract. Most practitioners who were selected in this survey worked in private practice, thus outside of university and hospital clinics (Table 3, Table 4).

Table 1. Reported upper threshold for non-extraction approach to treatment.

Estimated space requirement prompting decision to extract	Respondents n = (%)	
	Child patients	Adult patients
Above 8 mm	43 (54.4%)	41 (51.9%)
Up to 6 - 8 mm	30 (38.0%)	33 (41.8%)
Up to 4 - 6 mm	6 (7.6%)	4 (5.1%)
Up to 4 mm	0	1 (1.3%)

Table 2. Degree of influence of various factors on extraction decisions.

	Totally agree	Agree	Disagree	Totally disagree	Without opinion
Facial and smile aesthetics	89.9%	7.6%	0.0%	1.3%	1.3%
TMJ symptoms	12.7%	41.8%	17.7%	8.9%	19.0%
Appliances used	22.8%	45.6%	16.5%	11.4%	3.8%
Increased use of IPR	41.8%	51.9%	1.3%	2.5%	2.5%
Increased use of Transverse expansion	49.4%	45.6%	1.3%	0.0%	3.8%
Increased use of antero posterior expansion	21.5%	50.6%	10.1%	12.7%	5.1%
Periodontal Implications	54.4%	31.6%	7.6%	5.1%	1.3%
Treatment duration	25.3%	26.6%	31.6%	7.6%	8.9%
Stability due to effect of extractions	30.4%	36.7%	13.9%	11.4%	7.6%

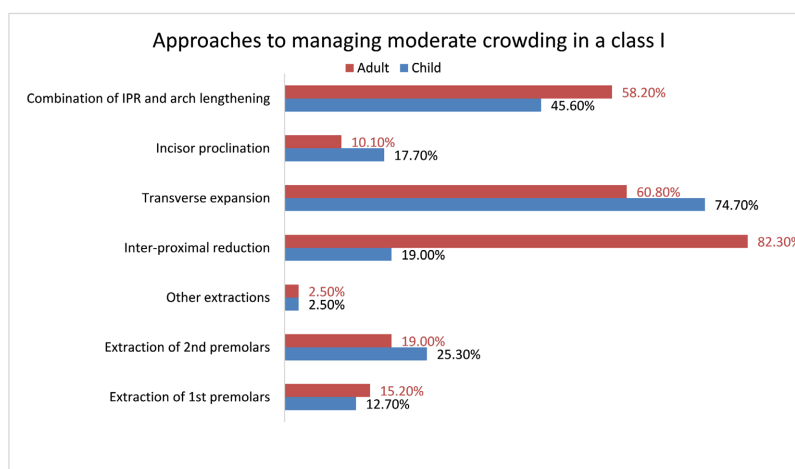


Figure 3. Managing moderate crowding in a Class I.

Table 3. Ordinal logistic regression analysis of likelihood of suggesting extraction for low (0 - 4 mm), moderate (4 - 6 mm) or high (>6 mm) space requirements (Raw data).

Predictor	Odds ratio	<i>p</i> value	95% CI
Experience			
5 to 10 years vs 2 to 5 years	1.18	0.851	0.214; 6.93
More than 10 years vs 2 to 5 years	1.51	0.579	0.368; 7.06
Private practice vs University and public practice	6.65	0.036	1.334; 51.99
Appliance			
SLB vs conventional brackets	1.42	0.701	0.265; 10.94
Both conventional and SLB vs conventional brackets	5.10	0.085	0.905; 42.02

Table 4. Ordinal logistic regression analysis of likelihood of suggesting extraction for low (0 - 4 mm), moderate (4 - 6 mm) or high (>6 mm) space requirements (variable data).

Predictor	Odds ratio	<i>p</i> value	95% CI
Experience			
5 to 10 years vs 2 to 5 years	0.772	0.714	0.190; 3.15
More than 10 years vs 2 to 5 years	1.322	0.643	0.413; 4.50
Private practice vs University and public practice	4.64	0.060	1.11; 31.8
Appliance			
SLB vs conventional brackets	1.77	0.514	0.358; 13.2
Both conventional and SLB vs conventional brackets	4.04	0.120	0.786; 31.0

4. Discussion

This is an investigation aiming to assess the degree to which extractions are prescribed and the factors thought to influence this decision. The aim of this study was, the evaluation of the perception of Moroccan orthodontists regarding any changes in their tendency to prescribe extractions for orthodontic purposes over the last 5/10 years.

The main result of this study was: 79 out of 107 decisions lead to non extractional treatments during the past 5 to 10 years, with the tendency to reduce extractions for adults. The reasons given by the surveyed orthodontists for this reduced extraction rate was the development of new techniques, such as adjusted appliance, self-ligating brackets, transverse expansion and the use of inter proximal reduction. Orthodontists were asked to score the parameters influencing their decision-making process towards extraction or non extraction. Crowding was

confirmed to be an important parameter in their decision, but unexpectedly, it did not reach the highest score. The major factors dictating extractions was the periodontal implication, the soft tissue profile highlighting orthodontists' concern about facial and smile esthetic appearance.

The prevalence of extractions of first and second premolars was of less importance. These results are quite similar to the previous data from international surveys, based on archived data in the U.S. and Brazil [6]. Non extraction has become more popular with clinicians over the past few years. Extraction rates of four premolars were around 10% in the 1950s, increasing to about 50% in the 1960s, then gradually declining to approximately 10% in the 90 s. The frequency of extractions in orthodontics has since increased to 27% - 30% [7] [8]. As indicated in the results of the current study, 73.8% of the participants believed that the extraction rate in their practice had decreased over the past 5/10 years. Most clinicians attributed this to a change in treatment philosophy, or in aesthetic beliefs. It is difficult to identify the reasons behind the reduced pattern in extractions, however, we might deduce that several factors can be related to it, such as:

- Psychological: Patients feeling anxiety and discomfort related to extractions.
- Marketing: Practitioners finding it hard to convince patients to get extractions.
- Unproven side effects of extractions.

In this study, patient's facial and smile aesthetics, periodontal implications were among the top reasons chosen by both the clinicians who preferred extractions and those who chose non extraction. Dickins S *et al.* also discovered that extraction treatment results in narrower dental arches which, in turn, are associated with a less esthetic smile [9]. Arch width reduction creates unaesthetic triangles at corners of the mouth with "negative" spaces lateral to the buccal segments (corridors). According to Dickins, appearance of unesthetic black triangles at the corners of the mouth during smiling are expected sequelae of 4first-premolarextraction treatment. Premolar extraction treatment narrows the width of the dental arches and shrinks the arches, resulting in a dentition that is too small to fill the oral slit during a smile [9]. Because arch width appears to be a determinant of smile esthetics, Eunkoo Kim [10], compared arch width changes in the anterior and posterior parts of the arches as well as smile esthetics in patients treated by extraction and non extraction procedures. This study concluded that the average arch width of both arches was significantly wider in the extraction sample (1.8 mm wider in the mandible and 1.7 mm wider in the maxilla). Arch width is not decrease data constant arch depth because of extraction treatment, and smile esthetics are the same in both groups of patients [10].

Based on the data of our study, it is clearly identified that the participants rely more on the IPR for adults to resolve space problems. With an increasing number of patients using removable, aesthetic, orthodontic appliances, for whom extractions are often not advocated, the use of IPR as an alternative to gain space is becoming more popular [11] [12]. The benefit of using IPR rather than extrac-

tion therapy to gain space is that it decreases overall treatment time, since the amount of stripping corresponds exactly with the amount of crowding [13]. Performing IPR when treating a case without any extractions also means that excessive advancement of the mandibular incisors can be avoided, [14] as well as overexpansion of the dental arches, while at the same time satisfactory alignment is still achieved [12] [13] [14]. Moreover, it was debated whether reduction of tooth size did any harm to the dental and periodontal tissues. As it was clearly stated on the 10-year follow-up Zachrisson *et al.* (2007) [15], interdental enamel reduction did not result in iatrogenic damage. Dental caries, gingival problems, or alveolar bone loss did not increase, and the distances between the roots of the teeth in the mandibular anterior region were not reduced.

Generally, crowding of 5 to 9 mm may be treated with or without extractions depending on the characteristics of the case; however, in patients in whom there is an arch length discrepancy of 10 mm or more, extractions are almost always indicated, despite the reported amounts of space that can be created by the use of IPR [12] [16]. However, there are potential dangers related with this method and due care and consideration is required in order to avoid introduction of inter-proximal ledges, which may risk plaque accumulation and sensitivity.

Also, a growing acceptance of Transverse expansion occurred for both adults and children. Expansion has been promoted since long to treat posterior cross-bite. In the 1980s, it became popular as a substitute to extraction treatment to resolve crowding even without the presence of posterior crossbite. Advocates of rapid maxillary expansion (RME) claim resolving of borderline crowding of 3 - 6 mm in the mandible in patients with narrow transpalatal widths. They contend that RME will result in reciprocal mandibular expansion because the mandibular arch form is dictated by the maxillary arch form. McNamara Jr. *et al.* reported [17] that a favorable change in the sagittal occlusal relationships between maxillary and mandibular teeth can be facilitated by RME. Fields cautioned that “to date, there is no credible long-term post retention evidence that early intervention to prepare, develop, balance, or expand arches by any other name has any efficacy in providing a less crowded permanent dentition later”. Stability of expansion, particularly in the mandible, has little evidence demonstrating the same. Many authors support the contention that intercanine expansion is unstable. A study by Housley *et al.* in 2003 concluded that in patients who underwent mandibular expansion, intercanine widths were maintained in only 8% of patients, for six years and three months after fixed retention [18]. The study conducted by Housley *et al.* in 2003, however, was in contradiction the philosophy of the study, Maltagliati *et al.* [19] which highlights the fact that expansion is not accepted by orthodontists because of the alveolar limitation of this procedure, being reduced to only cases with very mild crowding or that permit a buccal tipping effect, especially on the anterior segment. Orthodontics understand that cases with crowding, which require space in the arch for correct alignment, should be treated by the extraction of teeth, as it is believed that, proceeding in this manner, the original arch shape is preserved, making the obtained occlusion

more stable [20]. A study of U.S. orthodontists outlined that clinical decision-making is influenced by a run of variables, including clinical encounter and research findings [21].

In the present study, practitioners used almost all different types of orthodontic appliances, but a big percentage preferred using SLB instead of conventional brackets. There have been assertions that the efficacy and affectivity of SLB is better than conventional brackets. It reduces treatment time and avoids the need for extractions in most cases. From an evidence-based standpoint, self-ligating brackets are as beneficial as conventional brackets except for two advantages they offer: reduced chair side time (insertion and removal of wire is easy), and control of mandibular incisor proclination [22] [23].

In a separate survey Prettyman *et al.* (2012) [24], US orthodontists chose to extract using conventional brackets. The choice of brackets depended on many factors including:

- Time management: Orthodontists indicated that SLB yielded a shorter overall treatment time.
- Discomfort during adjustments: 27% reported less discomfort using SLB.
- Oral hygiene: 42% reported better oral hygiene in patients with SLB.
- Assistants preferred working with SLB.
- The cost: Conventional brackets were found to be the most cost-effective bracket systems.

Based on the Scott *et al.* (2008) [25] and Fleming *et al.* 2013 [26] studies, there was no significant difference in initial rate of alignment for either bracket system.

The management of hypothetical cases was explored in relation to possible threshold levels of space requiring extractions: 92.4% of respondents were comfortable advocating non-extraction approaches for children and 93.7% for adults with crowding in excess of 6 mm of space requirement. Based on the Proffit WR study [27], Contemporary extraction guidelines are as follows:

- <4 mm arch length discrepancy: extraction rarely indicated.
- 5 - 9 mm arch length discrepancy: non-extraction (posterior expansion).
- /extraction.
- 10 mm or more arch length discrepancy: extraction almost always required to obtain enough space.

These results observed in adolescent and adult cases were different from those obtained in the study of Fleming and al (2018) article [1]. Additionally, the extraction of the first premolars was slightly less remarkable in adolescents than in adults. It's quite the opposite for the removal of the second premolars, as it was prescribed more for adolescents than adults.

Based on studies about different types of treatment to alleviate crowding, one of the routine procedures for Class I malocclusion and bimaxillary protrusion is the extraction of the first premolars. These teeth are usually chosen because of their position and size, which are compatible with most types of discrepancies in cases that require the retraction of anterior teeth. However, tooth-size discre-

pancies may also be found in the same case, which will require not only extractions, but also interproximal stripping [28]. Proffit WR. (1994) [6], has determined that, with appropriate orthodontic mechanics, patients with Class I crowding can be treated satisfactorily with or without premolar extraction. Likewise, in the study Janson *et al.* (2014) [28], the non-extraction protocol frequency increased gradually with consequent reduction of extraction treatments. The four premolar extraction protocol frequencies decreased gradually while the two maxillary premolar extraction protocol has maintained the same frequency of indications throughout time.

Our study was based on practitioners' recollection rather than on objective data, but appears to suggest that these findings are mirrored in this Casablanca sample, containing both hospital- and practice-based practitioners. No specific extraction trend in relation to extractions was noted with respect to place of work. The results of the current survey suggest that Orthodontists in Casablanca prefer the non-extraction based approaches.

The decision to extract was influenced by three factors:

- Differences in relation to facial and smile aesthetics,
- Space conditions,
- Andocclusal factors.

The majority of research studies are not randomized, and statistical procedures such as discriminant analysis have been used to offset these difficulties [29]. Distinctly, equipoise is required for random assignment to treatment interventions; however, the current study suggests that equipoise in relation to extractions may exist in some cases, and that the use of focused selection criteria may facilitate random assignment in a comparison of extraction and non-extraction approaches. On the other hand, in light of apparent reluctance among practitioners and patients to adopt random allocation to extraction-based treatment, a prospective cohort trial should be considered. Known confounders would need to be thoroughly recorded with extensive follow-up to determine the relative merits of each technique in the short and medium term, especially given the potential for third molar impaction in participants who did not undergo mid-arch extractions.

As it was clearly stated on the Brezulier *et al.* 2017 study [30], premolar extraction significantly improves the chances of third molar's eruption, but the level of evidence of comparative retrospective studies is low, therefore, clinicians must rely on a case-by-case basis until the evidence is stronger. However, in another study conducted by M. Sebbar and F. Bourzgui [31] which studied the prognosis of upper and lower third molar evolution, it was concluded that the extraction of premolars has little influence on the variation of the retromolar space; conversely first molar extraction increases that space. Seventy-eight patients were included after a clinical examination, dental casts, panoramic and lateral cephalometric radiographs on inclusion (T1) and two years after (T2). Five parameters were studied: retromolar space (RMS) between the third molar (M3) and the

anterior ridge of the ramus; RMS/M3 crown diameter ratio, distances (PTV-M1) and (Xi-Mi2); and third molar angle with occlusal plane. The results showed that they were noted at T1 and T2. The gain of retromolar space from T1 to T2 reached:

- 1.2 to 2.2 mm without extraction,
- 2 to 2.7 mm with PM extraction,
- And 4.5 to 6.8 mm with M1 extraction.

The “RMS/M3 diameter” ratio increased in the maxilla from 0.6 to 0.8 and from 0.5 to 0.8 in the mandible ($p = 0.01$) between T1 and T2. PTV-M1 increased significantly from 17.1 to 19.9 mm ($p < 0.001$), and Xi-M2i increased significantly from 18.5 to 22.4 mm ($p < 0.001$) between T1 and T2.

We had some difficulties obtaining full information through the paper-based questionnaire. Our study was limited by a relatively low response thus the results are likely to be credible, also there have been lack of time from orthodontists’ side which decreased the chance to gather more answers.

Furthermore, there is no reason to suppose that non-response is linked to any type of extraction prescription bias. Besides, a diverse range of viewpoints was gathered in relation to:

- Geographic spread,
- Level of experience,
- And location of employment.

Another potential issue, as previously mentioned, is the reliance on recall of extraction frequency. The current data could be supplemented with objective quantification of extraction frequency, but this would almost certainly have reduced the percentage response even more. However, findings from comparable worldwide research Proffit 1994 [6]; Janson *et al.* (2014) [28]; Jackson *et al.* (2017) [8] suggest to decreased extraction frequency among Casablanca-based practitioners, which cannot be reliably attributed to altering treatment mechanics or adjuncts.

5. Conclusion

Over the last 5 - 10 years, members had become less likely to prescribe orthodontic extractions; orthodontists relied more on the inter-proximal reduction for adults; there was a growing acceptance of transverse expansion for both adults and children; a big percentage of practitioners preferred using self-ligating brackets instead of conventional brackets. More controlled clinical research with long follow-up and extensive examination of associated variables could be considered to compare the relative merits of extraction versus non-extraction techniques.

Conflicts of Interest

Ethical clearance was obtained from the Ethics Committee of the Faculty of Dentistry, University of Hassan II University, and all participants and their respective teachers were informed about the aims of the study. Access to schools

was granted by the Casablanca Regional Academy of Education and training. The parental consent and authorization of all students was also obtained. All authors stated that no conflict could influence their participation in this study.

References

- [1] Fleming, P.S., Cunningham, S.J., Benson, P.E., Jauhar, P. and Millett, D. (2018) Extraction of Premolars for Orthodontic Reasons on the Decline? A Cross-Sectional Survey of BOS Members. *Journal of Orthodontics*, **45**, 283-288. <https://doi.org/10.1080/14653125.2018.1517470>
- [2] Angle, E.H. (1907) Treatment of Malocclusion of the Teeth: Angle's System. 7th edition, S. S. White, Philadelphia.
- [3] Vaden, J.L. (2015) Charles, H. Tweed, 1895-1970. *American Journal of Orthodontics and Dentofacial Orthopedics*, **147**, S171-S179. <https://doi.org/10.1016/j.ajodo.2015.02.004>
- [4] Phulari, B.S. (2013) History of Orthodontics. JP Medical Publishers, London. <https://doi.org/10.5005/jp/books/12065>
- [5] Ganguly, R., Suri, L. and Patel, F. (2016) A Literature Review of t Extraction Decision and Outcomes in Orthodontic Treatment. *Journal of the Massachusetts Dental Society*, **65**, 28-31.
- [6] Proffit, W.R. (1994) Forty-Year Review of Extraction Frequencies at a University Orthodontic Clinic. *The Angle Orthodontist*, **64**, 407-414.
- [7] Konstantonis, D. (2012) The Impact of Extraction vs Nonextraction Treatment on Soft Tissue Changes in Class I Borderline Malocclusions. *The Angle Orthodontist*, **82**, 209-217. <https://doi.org/10.2319/051911-339.1>
- [8] Jackson, T.H., Guez, C., Lin, F.C., Proffit, W.R. and Ko, C.C. (2017) Extraction Frequencies at a University Orthodontic Clinic in the 21st Century: Demographic and Diagnostic Factors Affecting the Likelihood of Extraction. *American Journal of Orthodontics and Dentofacial Orthopedics*, **151**, 456-462. <https://doi.org/10.1016/j.ajodo.2016.08.021>
- [9] Dickens, S., Sarver, D.M. and Proffit, W.R. (2002) The Dynamics of the Maxillary Incisor and the Upper Lip: A Cross-Sectional Study of Resting and Smile Hard Tissue Characteristics. *World Journal of Orthodontics*, **3**, 313-320.
- [10] Kim, E. and Gianelly, A.A. (2033) Extraction vs Nonextraction: Arch Widths and Smile Esthetics. *The Angle Orthodontist*, **73**, 354-358.
- [11] Lapenaite, E. and Lopatiene, K. (2014) Interproximal Enamel Reduction as a Part of Orthodontic Treatment. *Stomatologija*, **16**, 19-24.
- [12] Yitschaky, O., Neuhof, M.S., Yitschaky, M. and Zini, A. (2016) Relationship between Dental Crowding and Mandibular Incisor Proclination during Orthodontic Treatment without Extraction of Permanent Mandibular Teeth. *The Angle Orthodontist*, **86**, 727-733. <https://doi.org/10.2319/080815-536.1>
- [13] Jarjoura, K., Gagnon, G. and Nieberg, L. (2006) Caries Risk after Interproximal Enamel Reduction. *The American Journal of Orthodontics and Dentofacial Orthopedics*, **130**, 26-30. <https://doi.org/10.1016/j.ajodo.2004.08.024>
- [14] Chenin, D.A., Trosien, A.H., Fong, P.F., Miller, R.A. and Lee, R.S. (2003) Orthodontic Treatment with a Series of Removable Appliances. *The Journal of the American Dental Association*, **134**, 1232-1239. <https://doi.org/10.14219/jada.archive.2003.0358>

- [15] Zachrisson, B.U., Nyøygaard, L. and Mobarak, K. (2007) Dental Health Assessed More than 10 Years after Interproximal Enamel Reduction of Mandibular Anterior Teeth. *American Journal of Orthodontics and Dentofacial Orthopedics*, **131**, 162-169. <https://doi.org/10.1016/j.ajodo.2006.10.001>
- [16] Travess, H., Roberts-Harry, D. and Sandy, J. (2004) Orthodontics. Part 8: Extractions in Orthodontics. *British Dental Journal*, **196**, 195-203. <https://doi.org/10.1038/sj.bdj.4810979>
- [17] McNamara, J.A., Sigler, L.M., Franchi, L., Guest, S.S. and Baccetti, T. (2010) Changes in Occlusal Relationships in Mixed Dentition Patients Treated with Rapid Maxillary Expansion. A Prospective Clinical Study. *The Angle Orthodontist*, **80**, 230-238. <https://doi.org/10.2319/040309-192.1>
- [18] Housley, J.A., Nanda, R.S., Currier, G.F. and McCune, D.E. (2003) Stability of Transverse Expansion in the Mandibular Arch. *American Journal of Orthodontics and Dentofacial Orthopedics*, **124**, 288-293. [https://doi.org/10.1016/S0889-5406\(03\)00450-5](https://doi.org/10.1016/S0889-5406(03)00450-5)
- [19] Maltagliati, L.A., Myiahira, Y.I., Fattori, L., Capelozza Filho, L. and Cardoso, M. (2013) Transversal Changes in Dental Arches from Non-Extraction Treatment with Self-Ligating Brackets. *Dental Press Journal of Orthodontics*, **18**, 39-45. <https://doi.org/10.1590/S2176-94512013000300008>
- [20] Strang, R.H. (1949) The Fallacy of Denture Expansion as a Treatment Procedure. *The Angle Orthodontist*, **14**, 12-22.
- [21] Madhavji, A., Araujo, E.A., Kim, K.B. and Buschang, P.H. (2011) Attitudes, Awareness, and Barriers toward Evidence-Based Practice in Orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, **140**, 309-316.e2. <https://doi.org/10.1016/j.ajodo.2010.05.023>
- [22] Chen, S.S.H., Greenlee, G.M., Kim, J.E., Smith, C.L. and Huang, G.J. (2010) Systematic Review of Self-Ligating Brackets. *American Journal of Orthodontics and Dentofacial Orthopedics*, **137**, 726.e1-726.e18. <https://doi.org/10.1016/j.ajodo.2009.11.009>
- [23] Marshall, S.D., Currier, G.F., Hatch, N.E., Huang, G.J., Nah, H.D., Owens, S.E., et al. (2010) Self-Ligating Bracket Claims. *American Journal of Orthodontics and Dentofacial Orthopedics*, **138**, 128-131. <https://doi.org/10.1016/j.ajodo.2010.04.019>
- [24] Prettyman, C., Best, A.M., Lindauer, S.J. and Tufekci, E. (2012) Self-Ligating vs Conventional Brackets as Perceived by Orthodontists. *The Angle Orthodontist*, **82**, 1060-1066. <https://doi.org/10.2319/101311-640.1>
- [25] Scott, P., Di Biase, A.T., Sherriff, M. and Cobourne, M.T. (2008) Alignment Efficiency of Damon3 Self-Ligating and Conventional Orthodontic Bracket Systems: A Randomized Clinical Trial. *American Journal of Orthodontics and Dentofacial Orthopedics*, **134**, 470.e1-8. <https://doi.org/10.1016/j.ajodo.2008.04.018>
- [26] Fleming, P.S., Lee, R.T., Marinho, V. and Johal, A. (2013) Comparison of Maxillary arch Dimensional Changes with Passive and Active Self-Ligation and Conventional Brackets in the Permanent Dentition: A Multicenter, Randomized Controlled Trial. *American Journal of Orthodontics and Dentofacial Orthopedics*, **144**, 185-193. <https://doi.org/10.1016/j.ajodo.2013.03.012>
- [27] Proffit, W.R., Fields, H., Larson, B. and Sarver, D.M. (2006) Contemporary Orthodontics. Mosby, St. Louis.
- [28] Janson, G., Maria, F.R.T. and Bombonatti, R. (2014) Frequency Evaluation of Different Extraction Protocols in Orthodontic Treatment during 35 Years. *Progress in Orthodontics*, **15**, Article No. 51. <https://doi.org/10.1186/s40510-014-0051-z>
- [29] Paquette, D.E., Beattie, J.R. and Johnston, L.E. (1992) A Long-Term Comparison of

- Nonextraction and Premolar Extraction Edgewise Therapy in “Borderline” Class II Patients. *American Journal of Orthodontics and Dentofacial Orthopedics*, **102**, 1-14. [https://doi.org/10.1016/0889-5406\(92\)70009-Y](https://doi.org/10.1016/0889-5406(92)70009-Y)
- [30] Brezulier, D., Fau, V. and Sorel, O. (2017) Influence of Orthodontic Premolar Extraction Therapy on the Eruption of the Third Molars: A Systematic Review of the Literature. *The Journal of the American Dental Association*, **148**, 903-912. <https://doi.org/10.1016/j.adaj.2017.07.023>
- [31] Sebbar, M. and Bourzgui, F. (2011) [Predictive Factors of Third Molar Eruption]. *Revue de Stomatologie et de Chirurgie Maxillo-faciale*, **112**, 263-268. <https://doi.org/10.1016/j.stomax.2011.05.003>