

The use of functional appliances for class II malocclusions: a nation-wide cross-sectional survey of orthodontists in Australia

Thomas Hastie, Mithran Goonewardene, Richard Lee, Steven Naoum and Mike Razza

Department of Orthodontics, School of Dentistry, Faculty of Health and Medical Sciences, The University of Western Australia, Australia

Background: If detected at the appropriate age, a Class II malocclusion can be improved or camouflaged by utilising functional appliances to manipulate a child's skeletal growth spurt to advantage.

Aim: The aim of this study was to evaluate the use of functional appliances by orthodontists currently practising in Australia.

Methods: This was a cross-sectional study design that utilised a nation-wide online survey consisting of 22 questions related to: clinic/clinician demographics, appliance preference and treatment timing, the provision of first phase functional appliance treatment and treatment protocols for removable functional appliance therapy. The survey was distributed via the Australian Society of Orthodontists to its 428 members. Statistical analysis was conducted through Qualtrics XM® data analysis software, version 04/30/2023 (Qualtrics XM®, Provo, UT, USA. <https://www.qualtrics.com>) with a significance level set at $P < 0.05$.

Results: A total of 166 responses were received representing a response rate of 38.8%. Ninety-nine per cent of survey respondents ($n = 139$) reported prescribing functional appliances to correct a Class II malocclusion with the Twin Block appliance as the most-commonly prescribed. It was found that a two phase, removable functional appliance followed by fixed appliances was the preferred choice for Class II treatment when utilising a functional appliance. The most common age to commence functional appliance therapy was between 10 and 12 years, incorporating 9 to 12 months of full-time wear, followed by a 4- to 6-month retention period. There appears to be a clear relationship between an orthodontist's preferred choice of Class II treatment when employing functional appliances and their orthodontic training institution.

Conclusion: It is common practice for orthodontists in Australia, to utilise functional appliances in the management of a Class II malocclusion. However, the prescribing patterns for functional appliance therapy are not uniform. Variations appear evidenced-based depending on the practice location and the institution from which the orthodontist graduated.

(Aust Orthod J 2024; 40: 96 - 110. DOI: 10.2478/aoj-2024-0025)

Received for publication: May, 2024

accepted: September, 2024.

Thomas Hastie: tom.hastie@uwa.edu.au; Mithran Goonewardene: mithran.goonewardene@uwa.edu.au; Richard Lee: richard.lee@uwa.edu.au; Steven Naoum: steven.naoum@uwa.edu.au; Mike Razza: mike.razza@uwa.edu.au

Introduction

A Class II skeletal malocclusion is the most frequent skeletal problem faced in orthodontics and has a reported global prevalence of 19.6%.¹⁻³ Often resulting in a convex facial profile, a Class II skeletal malocclusion is characterised by an anteroposterior discrepancy between the upper and lower jaws due

to a retrognathic mandible, a prognathic maxilla or a combination of the two.⁴ If detected and treated in childhood, it is possible to improve a Class II malocclusion by taking advantage of a child's growth spurt by growth modification or camouflage.^{4,5}

A functional appliance is an orthodontic appliance, either fixed or removable, that is used for growth

modification in late pre-adolescent and adolescent patients. Fabricated from a construction bite, a functional appliance impacts the timing and direction of skeletal growth by posturing the mandible forward to elicit forces on the surrounding muscles, their fascia and the periodontium.⁶ Whilst some evidence suggests that functional appliances can increase overall skeletal growth,⁷⁻⁹ these effects have been shown to be minimal and likely of negligible clinical importance when natural growth is considered.¹⁰⁻¹⁴ Ultimately, functional appliances treat Class II malocclusions by dento-alveolar and soft tissues changes that, in effect, camouflage the skeletal discrepancy.¹⁵

Functional appliances have known characteristics. Fixed functional appliances allow for significant bite advancement with limited vertical bite opening.¹⁶ However, they place a higher premium on oral hygiene and are subject to a high rate of catastrophic breakage and subsequent emergency appointments.^{17,18} Removable functional appliances may affect vertical bite opening and also interfere with mandibular movement which may preclude full-time use and adequate compliance.¹⁷⁻²² By eliminating the issue of compliance, the treatment duration of fixed appliances is often shorter.^{23,24} Whilst many argue that being removable is a disadvantage of a functional appliance, advocates contend that this is their greatest strength, by highlighting that they may be removed for socially sensitive occasions.²⁵ With their relative low cost and simplicity in fabrication and repair (in most cases), removable functional appliances continue to be a popular alternative to their fixed, compliance-free alternatives.¹⁸

Perhaps the greatest controversy surrounding pre-adolescent functional appliance therapy, is whether it produces any significant benefit compared to the alternative, one-phase comprehensive treatment during adolescence. Multiple investigations have addressed this topic and concluded that early treatment of a Class II skeletal malocclusion during pre-adolescence is no more effective than later comprehensive orthodontic treatment during adolescence.^{22,24,26-33} This is explained by skeletal changes that are attained during pre-adolescent treatment tend to be, at a minimum, partially reversed by later compensatory growth.^{24,27} Of importance is the impact that pre-adolescent treatment has on a patient's oral health-related quality of life. It has

been shown that 16.1% of children between the ages of 10 and 14 years possessing a skeletal Class II malocclusion, experience bullying.³⁴ It is not surprising that patients who receive pre-adolescent treatment report improved self-concepts relating to physical appearance, confidence, popularity, happiness and satisfaction.^{31,32,34,35} It has also been shown that resolving protrusive maxillary incisors reduces the risk of dental trauma and functional appliance therapy is a treatment option directed at this issue.^{32,36} Therefore, the primary indication for pre-adolescent functional appliance therapy is for psychosocial problems related to dental and facial appearance or elevated risks of incisal trauma.

As of May 2024, there were 632 registered and reported practising orthodontists in Australia, all with variability in academic training, treatment philosophy, skill, experience and laboratory resources.³⁷ With a great variety of functional appliances available to treat a Class II skeletal malocclusion, the aim of the present study was to evaluate appliance use by orthodontists currently practising in Australia and to uncover and explain any trends seen in their prescription through the use of a nation-wide survey, thereby providing a valuable reference for intra-disciplinary quality control.

Methods and materials

Ethical approval: The present study was a cross-sectional in design that utilised a nation-wide online survey to evaluate the use of functional appliances by orthodontists in Australia. Ethics approval was granted in accordance with the requirements of the National Statement on Ethical Conduct in Human Research (National Statement) and the policies and procedures of The University of Western Australia (2022/ET000560).

Survey development: The survey design and questionnaire were based on similar studies carried out in the United Kingdom and in Malaysia.^{38,39} Prior to distribution, the survey underwent in-house testing and review by five orthodontists within the University of Western Australia Department of Orthodontics, following which, minor amendments were made to ensure applicability to the Australian orthodontic community. The final survey was administered in English via Qualtrics XM®, version 04/30/2023 (Qualtrics XM®, Provo, UT, USA).

<https://www.qualtrics.com>). The survey consisted of 22 multiple-choice and 'rank order' questions and was divided into four sections: demographics, appliance preference and treatment timing, provision of first phase functional appliance treatment and treatment protocols for removable functional appliance therapy (Table I). The survey was so designed that should a question be answered in a way that would make the remaining questions redundant, the survey would terminate and the participant would not need to continue. This was achieved by utilising the Qualtrics XM® 'question behaviour' feature. The estimated time to complete the survey was 3 minutes.

Survey population and distribution: Convenience sampling was limited to orthodontists practising in Australia and registered by the Dental Board of Australia and the Australian Health Practitioner Regulation Agency. All were members of the specialist body for orthodontists in Australia, the Australian Society of Orthodontists (ASO) ($n = 428$ as of December 2023).⁴⁰ Non-practising members, students and international ASO members were excluded from the study as they did not meet this eligibility criteria.

Permission to conduct and circulate the survey was obtained and circulated by the ASO. The survey was distributed electronically by an email link or accessed via a QR code on the ASO website and at an ASO Foundation for Research and Education conference. Prior to commencing the survey, each participant was required to electronically consent to participate. Data collection was carried out between May and November 2023. Participation was voluntary, anonymous and no incentive was provided to participate.

Statistics analysis

Data collected from completed surveys were analysed and interpreted using the Qualtrics XM® data analysis platform to create descriptive and inferential statistics. Chi square testing was conducted to identify and relate association between data sets, from which frequency tables were generated. Significance was set at $P < 0.05$.

Results

A total of 166 participants consented to participate in the survey which represented a response rate of

38.8%. Of the consenting participants, 76.5% ($n = 127$) completed all applicable survey questions with 56% ($n = 93$) completing the survey in its longest version. Thirty-four participants ended their survey participation prematurely which generated a dropout rate of 20.5%. However, their responses to the answered questions were included in the study.

Demographics

Most orthodontists who participated were aged between 30 and 39 years old ($n = 45$; 30.4%) and had been practising as specialists for zero to 9 years ($n = 53$; 35.8%). Seventy-eight per cent of the respondents ($n = 115$) obtained their orthodontic speciality qualification within Australia, with the majority graduating from the University of Melbourne ($n = 32$; 21.6%). The private sector was the primary place of practice ($n = 132$; 89.2%) and the state of Victoria ($n = 42$; 28.4%) recorded the highest number of practising orthodontists (Table II).

Appliance preference and treatment timing: Ninety-nine per cent of the respondents ($n = 139$) reported prescribing functional appliances to correct a Class II malocclusion, and the Twin Block ($n = 92$; 32.2%) noted as the most commonly-prescribed appliance (Table III). Patient compliance and efficiency/treatment length were rated equally as the most important factors in appliance selection, and the cost of fabrication as the least important factor. Two phase, removable functional appliances followed by fixed appliance therapy ($n = 66$; 47.5%) was the preferred choice of Class II treatment when employing functional appliances (Table IV).

Of the 2.1% ($n = 3$) of orthodontists who reported that they did not prescribe a functional appliance to correct a Class II malocclusion, efficiency/treatment time was indicated as the greatest factor governing their choice.

There was no statistically significant correlation found between the number of years an orthodontist had been practising as a specialist, or their principal place of practice (private clinic, government clinic or tertiary/university dental facility) and their preferred choice of Class II treatment. However, there was a strong, statistically significant relationship between the institution from which an orthodontist obtained their speciality qualification and their preferred choice of Class II treatment (Figure 1). Of the Australian trained orthodontists, graduates from the

Table I. Survey questionnaire

Question Set	
Demographics	1. What is your age? a. 20-29 years old b. 30-39 years old c. 40-49 years old d. 50-59 years old e. 60 years and older 2. In which country did you obtain your orthodontic speciality qualification ? a. Australia b. Other: (please specify _____) 3. From which institution did you obtain your orthodontic speciality qualification? a. University of Adelaide b. University of Melbourne c. University of Queensland d. University of Sydney e. University of Western Australia f. Other: (please specify _____) 4. How many years have you practiced as a specialist orthodontist? a. 0-9 years b. 10-19 years c. 20-29 yearsd. 30-39 yearse. More than 40 years 5. In which state or territory do you primarily practice? a. Australian Capital Territory b. New South Wales c. Northern Territory d. Queensland e. South Australia f. Tasmaniah. Victoriiah. Western Australia 6. At which orthodontic service do you spend most of your clinical time? a. Private clinic b. Government clinic c. Tertiary/university dental facility

Table I. Survey questionnaire

Appliance Preference and Treatment Timing	1. In your clinical practice, which functional appliances do you commonly prescribe for correction of a Class II malocclusion ? (If applicable, select multiple answers) a. Twin Block b. Bionator c. Activator d. Headgear alone e. Headgear with a concurrent functional appliance f. Clear aligners with mandibular advancement features g. Herbst h. Forsus i. Mara j. Twin Force k. Other: (Please specify _____) l. I do not use functional appliances If <i>I do not use functional appliances</i> WAS selected, please complete the question 2 ONLY of this question set then END the survey. 2. Click and drag to rank the importance of the following factors in your choice to NOT prescribe functional appliance therapy to treat a Class II malocclusion. (Top response (1)– most important; bottom response (5) – least important) a. Cost of fabrication/purchase b. Patient compliance c. Breakages and laboratory support d. Effectiveness e. Efficiency/treatment time If <i>I do not use functional appliances</i> was NOT selected, please completed questions 3-5 of this question set. 3. Click and drag to rank the importance of the following factors in your choice of functional appliance (top response (1) – most important; last response (6) – least important) a. Cost of fabrication/purchase b. Patient compliance c. Breakages and laboratory support d. Efficiency/treatment length e. Patient comfort f. Clinical time required for instalment, adjustment and removal. 4. What is your PREFERRED choice of Class II treatment when employing functional appliances ? a. Two phase: Removable functional appliance followed by fixed appliance therapy b. Two phase: Fixed functional appliance followed by fixed appliance therapy c. One phase: Fixed appliance with a Class II corrector 5. Are Class II cases referred to you at the appropriate age for functional appliance treatment? a. Often b. SometimesSeldom
---	---

Table I. Survey questionnaire

Provision of First Phase Functional Appliance Treatment	1. Do you offer First Phase treatment (early functional appliance treatment) in the mixed dentition for treatment of a Class II malocclusion? a. Yes b. No <i>If yes, please answer Q2 and Q3 ONLY of this question set</i> 2. Estimate how many First Phase functional appliances you have prescribed in the last 12 months to treat Class II malocclusions in the mixed dentition? a. 0 – 6 b. 6 – 12 c. 12 – 24 d. More than 24 3. How do you complete your First Phase functional appliance treatment in the mixed dentition when treating a Class II malocclusion? a. ONLY with fixed functional appliance therapy b. ONLY with removable functional appliance therapy c. MAJORITY with fixed functional appliance therapy d. MAJORITY with removable functional appliance therapy <i>If only with fixed functional appliance therapy, please end the survey</i> <i>If no, please answer Q4 ONLY of this question set</i> 4. Click and drag to rank the importance of the following factors in your choice to NOT prescribe First Phase functional appliance therapy in the mixed dentition for treatment of a Class II malocclusion. (Top response (1)– most important; bottom response (5) – least important) a. Cost of fabrication/purchase b. Patient compliance c. Breakages and laboratory support d. Effectiveness e. Efficiency/treatment time
Treatment Protocols for Removable Functional Appliance Therapy	1. What age range do you typically begin removable functional appliance treatment ? a. 5 years and younger (primary dentition) b. 6-9 years old (early mixed dentition) c. 10-12 years old (late mixed dentition) d. 13 years and older (permanent dentition) 2. What is your typical removable functional appliance wear regime? a. Full time including mealtimes b. Full time NOT including mealtimes c. Part time 3. How long is your active removable functional appliance phase? a. 0-3 months b. 4-6 months c. 6-9 months d. 9-12 months e. Greater than 12 months 4. Do you encourage use of a chart or diary to measure patient compliance with removable functional appliance therapy? a. Yes, routinely b. Yes, occasionally c. No 5. Following removable functional appliance therapy, do you have a period of retention when the appliance is worn less often? a. Yes b. No <i>If no, please end the survey</i> 6. What is your routine length of post functional appliance retention? a. 0-3 months b. 4-6 months c. 7-9 months d. 10-12 months e. Greater than 12 months 7. Do you carry out any adjustment to the removable functional appliances during the retention period? a. Yes b. No

Table II. Demographics of the survey respondents

	Percentage (%)	Count (n)
What is your age?		
20-29 years old	1.4%	2
30-39 years old	30.4%	45
40-49 years old	23.7%	35
50-59 years old	21.6%	32
60 years and older	23.0%	34
In which country did you obtain your orthodontic speciality qualification?		
Australia	77.7%	115
Other	23.3%	33
From which institution did you obtain your orthodontic speciality qualification?		
University of Adelaide	15.5%	23
University of Melbourne	21.6%	32
University of Queensland	18.2%	27
University of Sydney	9.5%	14
University of Western Australia	12.8%	19
Other	22.3%	33
How many years have you practiced as a specialist orthodontist?		
0-9 years	35.8%	53
10-19 years	21.6%	32
20-29 years	22.3%	33
30-39 years	14.2%	21
More than 40 years	6.1%	9
In which state or territory do you primarily practice?		
Australian Capital Territory	2.0%	3
New South Wales	14.2%	21
Northern Territory	0.0%	0
Queensland	27.0%	40
South Australia	12.8%	19
Tasmania	2.0%	3
Victoria	28.4%	42
Western Australia	13.5%	20
At which orthodontic service do you spend most of your clinical time?		
Private clinic	89.2%	132
Government clinic	3.4%	5
Tertiary/university dental facility	7.4%	11

Table III. Commonly prescribed functional appliances for correction of a Class II malocclusion

	Percentage	Count (n)
Twin Block	32.2%	92
Bionator	2.8%	8
Activator	0.7%	2
Headgear alone	4.2%	12
Headgear with a concurrent functional appliance	3.15%	9
Clear aligners with mandibular advancement features	5.9%	17
Herbst	18.9%	54
Forsus	26.2%	75
Mara	0.7%	2
Twin Force	0.4%	1
Other	3.9%	11
I do not use functional appliances	1.1%	3

Table IV. Preferred choice of Class II treatment when employing functional appliances

	Percentage	Count (n)
Two phase: Removable functional appliance followed by fixed appliance therapy	47.5%	66
Two phase: Fixed functional appliance followed by fixed appliance therapy	17.3%	24
One phase: Fixed appliance with a Class II corrector	35.6%	49

University of Melbourne and from the University of Western Australia represented those whose greatest use was the Herbst appliance ($n = 18$; 33.3% and $n = 8$; 14.8%, respectively) and the Forsus appliance ($n = 20$; 26.7% and $n = 16$; 21.3%, respectively). Whilst graduates from the University of Queensland ($n = 22$; 23.9%) and from the University of Adelaide ($n = 19$; 20.7%) represented the greatest number of Twin Block appliance prescribers (Table V).

Of the Australian states and territories, orthodontists in Queensland represented the greatest number of Twin Block appliance prescribers ($n = 28$; 30.4%) followed by New South Wales ($n = 18$; 19.6%) and South Australia ($n = 17$; 18.5%). Orthodontists in Victoria prescribed the greatest number of Herbst ($n = 24$; 44.4%) and Forsus appliances ($n = 26$; 34.7%), while orthodontists in Western Australia prescribed the second greatest number of Forsus appliances ($n = 18$; 24%) (Table VI).

Provision of first phase functional appliance therapy: Seventy-three per cent of orthodontists ($n = 101$) offered first phase treatment (early functional appliance treatment) during the mixed dentition for the management of a Class II malocclusion. Over the 12-month period preceding the release of this survey, 43.3% ($n = 42$) of orthodontists prescribed zero to 6 functional appliances. It was most common, when treating a Class II malocclusion in the mixed dentition, to complete first phase functional appliance treatment 'only with' or 'majority with' removable functional appliance therapy, 45.4% ($n = 44$) and 37.1% ($n = 36$), respectively. Less common choices included treatment 'majority with' or 'only with' fixed functional appliance therapy, 11.3% ($n = 11$) and 6.2% ($n = 6$), respectively.

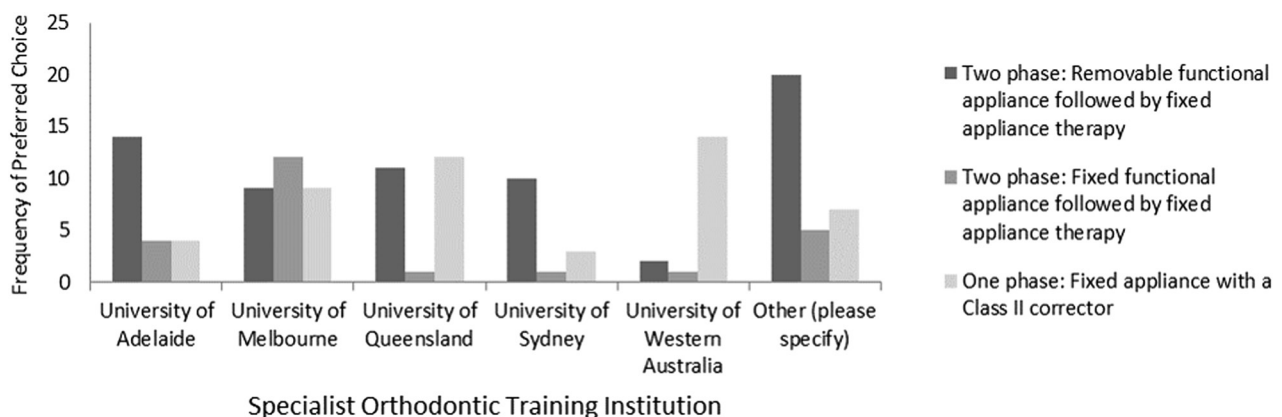
**Figure 1.** Impact orthodontic training institute has on preferred choice of Class II treatment when employing functional appliances.

Table V. Impact of specialist training institution on prescribed functional appliances

Q: In your clinical practice, which functional appliances do you commonly prescribe for correction of a Class II malocclusion ? (if applicable, select multiple answers)														
	Total	Twin Block	Bionator	Activator	Headgear alone	Headgear with a concurrent functional appliance	Clear aligners with mandibular advancement features	Herbst	Forsus	Mara	Twin Force	Other (please specify)	I do not use functional appliances	
Q: From which institution did you obtain your orthodontic speciality qualification?	Total Count (All)	286.0	92.0	8.0	2.0	12.0	9.0	17.0	54.0	75.0	2.0	1.0	11.0	3.0
University of Adelaide	37.0	19.0	0.0	0.0	0.0	1.0	0.0	2.0	8.0	5.0	0.0	1.0	1.0	0.0
	12.9%	20.7%	0.0%	0.0%	0.0%	8.3%	0.0%	11.8%	14.8%	6.7%	0.0%	100.0%	9.1%	0.0%
	69.0	8.0	2.0	0.0	0.0	9.0	4.0	5.0	18.0	20.0	0.0	0.0	3.0	0.0
University of Melbourne	24.1%	8.7%	25.0%	0.0%	0.0%	75.0%	44.4%	29.4%	33.3%	26.7%	0.0%	0.0%	27.3%	0.0%
	51.0	22.0	1.0	0.0	0.0	0.0	1.0	1.0	6.0	14.0	1.0	0.0	3.0	2.0
University of Queensland	17.8%	23.9%	12.5%	0.0%	0.0%	0.0%	11.1%	5.9%	11.1%	18.7%	50.0%	0.0%	27.3%	66.7%
	24.0	13.0	0.0	0.0	0.0	0.0	0.0	2.0	4.0	4.0	1.0	0.0	0.0	0.0
University of Sydney	8.4%	14.1%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%	7.4%	5.3%	50.0%	0.0%	0.0%	0.0%
	44.0	8.0	3.0	1.0	2.0	2.0	1.0	2.0	8.0	16.0	0.0	0.0	2.0	1.0
University of Western Australia	15.4%	8.7%	37.5%	50.0%	16.7%	11.1%	11.1%	11.8%	14.8%	21.3%	0.0%	0.0%	18.2%	33.3%
	61.0	22.0	2.0	1.0	0.0	0.0	3.0	5.0	10.0	16.0	0.0	0.0	2.0	0.0
Other	21.3%	23.9%	25.0%	50.0%	0.0%	0.0%	33.3%	29.4%	18.5%	21.3%	0.0%	0.0%	18.2%	0.0%

Table VI Impact of primary practice location on prescribed functional appliances

Q: In your clinical practice, which functional appliances do you commonly prescribe for correction of a Class II malocclusion ? (if applicable, select multiple answers)															
Q: In which state or territory do you primarily practice?	Total Count (All)	Total	Twin Block	Bionator	Activator	Headgear alone	Headgear		Clear aligners with mandibular advancement features	Herbst	Forsus	Mara	Twin Force	Other (please specify)	I do not use functional appliances
							with a concurrent functional appliance								
		286.0	92.0	8.0	2.0	12.0	9.0	17.0	54.0	75.0	2.0	1.0	1.0	11.0	3.0
Australian Capital Territory	5.0	3.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
	1.7%	3.3%	0.0%	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%
New South Wales	41.0	18.0	1.0	0.0	0.0	1.0	1.0	2.0	6.0	9.0	1.0	1.0	1.0	1.0	0.0
	14.3%	19.6%	12.5%	0.0%	0.0%	8.3%	11.1%	11.8%	11.1%	12.0%	50.0%	100.0%	9.1%	0.0%	0.0%
Northern Territory	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Queensland	69.0	28.0	1.0	0.0	0.0	0.0	1.0	3.0	11.0	17.0	1.0	0.0	0.0	5.0	2.0
	24.1%	30.4%	12.5%	0.0%	0.0%	0.0%	11.1%	17.6%	20.4%	22.7%	50.0%	0.0%	0.0%	45.5%	66.7%
South Australia	27.0	17.0	0.0	0.0	0.0	0.0	0.0	2.0	5.0	2.0	0.0	0.0	0.0	1.0	0.0
	9.4%	18.5%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%	9.3%	2.7%	0.0%	0.0%	0.0%	9.1%	0.0%
Tasmania	8.0	2.0	0.0	0.0	0.0	0.0	0.0	2.0	1.0	2.0	0.0	0.0	0.0	1.0	0.0
	2.8%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%	1.9%	2.7%	0.0%	0.0%	0.0%	9.1%	0.0%
Victoria	90.0	15.0	2.0	1.0	1.0	8.0	6.0	6.0	24.0	26.0	0.0	0.0	0.0	2.0	0.0
	31.5%	16.3%	25.0%	50.0%	50.0%	66.7%	66.7%	35.3%	44.4%	34.7%	0.0%	0.0%	0.0%	18.2%	0.0%
Western Australia	46.0	9.0	4.0	1.0	1.0	2.0	1.0	2.0	7.0	18.0	0.0	0.0	0.0	1.0	1.0
	16.1%	9.8%	50.0%	50.0%	50.0%	16.7%	11.1%	11.8%	13.0%	24.0%	0.0%	0.0%	0.0%	9.1%	33.3%

Table VII. Treatment protocols for removable functional appliance therapy

	Percentage	Count (n)
What age range do you typically begin removable functional appliance therapy?		
5 years and younger (primary dentition)	0.0%	0
6-9 years old (early mixed dentition)	11.4%	14
10-12 years old (late mixed dentition)	81.3%	100
13 years and older (permanent dentition)	7.3%	9
What is your typical removable functional appliance wear regime?		
Full time including mealtimes	24.4%	30
Full time not including mealtimes	64.2%	79
Part time	11.4%	14
How long is your active removable functional appliance phase?		
0-3 months	0.0%	0
4-6 months	6.5%	8
6-9 months	25.2%	31
9-12 months	63.4%	78
Greater than 12 months	4.9%	6
Do you encourage use of a chart or diary to measure patient compliance with removable functional appliance therapy?		
Yes, routinely	13.8%	17
Yes, occasionally	13.8%	17
No	72.4%	89
Following removable functional appliance therapy, do you have a period of retention when the appliance is worn less?		
Yes	75.6%	93
No	24.4%	30
What is your routine length of post functional appliance retention?		
0-3 months	23.4%	22
4-6 months	34.4%	32
7-9 months	11.8%	11
10-12 months	16.1%	15
Greater than 12 months	14.0%	13
Do you carry out any adjustment to the removable functional appliances during the retention period?		
Yes	63.4%	59
No	36.56%	93

Of the 26.8% ($n = 37$) of orthodontists who did not offer first phase treatment (early functional appliance treatment) during the mixed dentition for the treatment of a Class II malocclusion, effectiveness was identified as the primary deciding factor, followed by efficiency/treatment time, patient compliance and the cost of fabrication/purchase. Breakage and laboratory

support was reported as the least important factor to not prescribe.

There was no statistically significant relation found between the institution from which an orthodontist obtained their speciality qualification, how many years they had been practising as a specialist, and their principal place of practice (private clinic,

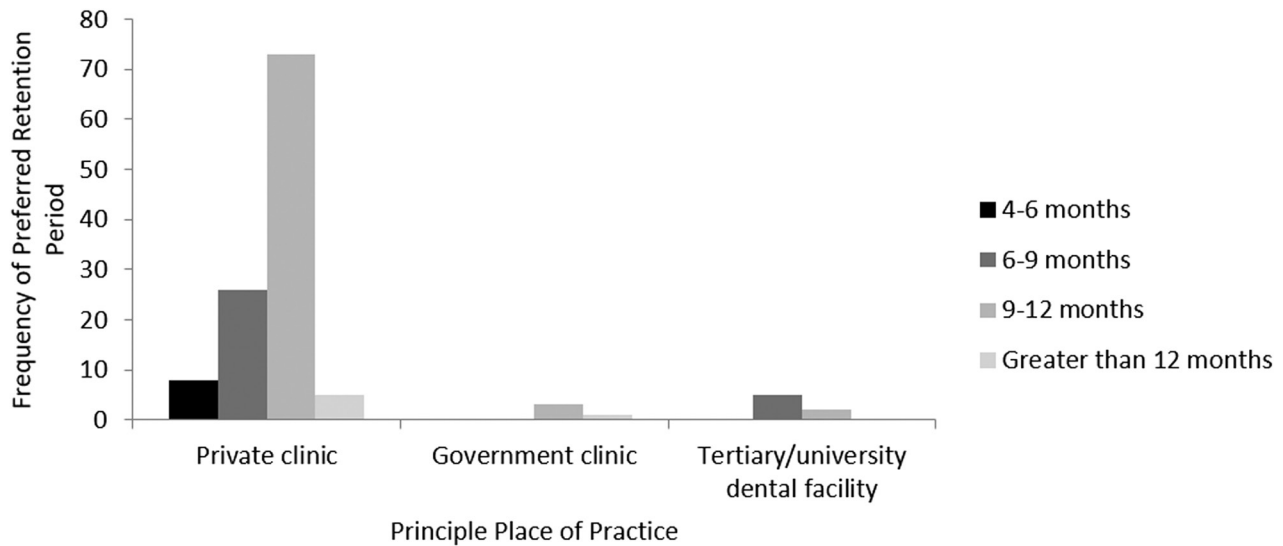


Figure 2. Orthodontic retention period length based on primary place of practice.

government clinic or tertiary/university dental facility). In addition, there was no statistically significant relationship between whether they offered first phase treatment (early functional appliance treatment) during the mixed dentition for the treatment of a Class II malocclusion or the number of first phase functional appliances that were prescribed during the 12 months prior to the survey.

Treatment protocols for removable functional appliance therapy: Eighty-one per cent of orthodontists ($n = 100$) typically began removable functional appliance treatment when a patient was between the ages of 10 and 12 years (late mixed dentition). The most typical removable functional appliance wear regime was full time, not including mealtimes ($n = 79$; 64.2%) with 9 to 12 months as the most common active functional appliance phase ($n = 78$; 63.4%) (Table VII). There was found to be a statistically significant relationship ($P < 0.05$) between an orthodontist's preferred active removable functional appliance phase length and their principal place of practice (Figure 2).

Twenty-eight per cent ($n = 34$) of orthodontists (13.8% ($n = 17$) routinely) encouraged the use of a chart or diary to record patient compliance. Seventy-six per cent ($n = 93$) of orthodontists had a period of retention following removable functional appliance therapy when the appliance was worn less. Most often, the retention period was 4 to 6 months ($n = 32$; 34.4%). Sixty-three per cent of orthodontists ($n = 59$)

carried out adjustments to the removable functional appliance during this retention period (Table VII).

Discussion

A Class II skeletal malocclusion is the most frequent skeletal problem in orthodontics globally. If detected at an appropriate age, this skeletal defect can be improved or camouflaged by utilising functional appliances to manipulate a child's skeletal growth spurt.¹⁻⁵

The use of functional appliances is commonplace in orthodontic practice, not only in Australia but around the world. Ninety-nine per cent of the respondents of the present survey reported prescribing a functional appliance to correct a Class II malocclusion. This is comparable to other global national figures, although geographical trends are noted. For example, 90% of Malaysian orthodontists and 75% of UK orthodontists reported the Twin Block appliance as their most popular/preferred appliance.^{38,39} Whereas in European, American and Scandinavian studies, the Bionator and Activator appliances were more prevalent.^{15,17,24,38,39} The results of the present survey indicate that orthodontists in Australia, like their UK and Malaysian colleagues, most frequently prescribe the Twin Block functional appliance. However, compared to the 75% and 90% popularity/preferred rates seen in the UK and Malaysia respectively,^{38,39}

the prescription rate for the Twin Block appliance by orthodontists in Australia is much lower at 32.2% ($n = 92$). The discrepancy in these research findings is likely due to differences in questionnaire formatting. The present study allowed for the selection of multiple appliances that the respondent may regularly prescribe rather than selecting or listing only their most commonly or preferred prescribed appliance as reported in other studies.

Whilst Australian and Malaysian orthodontists listed clinical effectiveness and efficiency as the most important advantage and deciding factor for which functional appliance were prescribed, the impact and perception of cost was markedly different.³⁸ Orthodontists in Australia cited the fabrication cost as the least important factor in their choice of functional appliance. Whereas cost-effectiveness was the second most important factor for orthodontists in Malaysia and more than half (55.6%) claimed that the fabrication cost of an appliance played a role in appliance preference.³⁸

Along with the variation seen internationally, interstate variation is noted in Australia. The interstate variations could be explained by the teaching philosophy of each respective orthodontic training program and the likelihood of graduates from these training programs remaining in the same state to practice. For example, graduates from the University of Western Australia, orthodontists in Western Australia, graduates from the University of Melbourne and orthodontists in Victoria reported the Forsus appliance as their most commonly-prescribed functional appliance. Whereas graduates from the University of Adelaide, orthodontists in South Australia, graduates from the University of Queensland, orthodontists in Queensland, graduates from the University of Sydney and orthodontists in New South Wales all recorded the Twin Block appliance as their most commonly-prescribed functional appliance.

The ideal timing to commence functional appliance therapy is a widely debated topic within orthodontic and academic circles. Multiple studies have shown that due to factors such as compensatory growth, any skeletal improvement obtained during early treatment for a Class II skeletal malocclusion during pre-adolescence was no more effective than comprehensive orthodontic treatment conducted during later adolescence years.^{24,26–33,35,38} Yet, only

26.8% ($n = 37$) of orthodontists in Australia who responded to this survey, cited effectiveness as their primary reason and did not offer first phase treatment (early functional appliance therapy) for the management of a Class II malocclusion. Of the 73.2% ($n = 101$) of orthodontists in Australia who offered first phase treatment (early functional appliance treatment), 93.8% ($n = 91$) utilised removable functional appliances and 11.4% ($n = 14$) commenced therapy on patients between the ages of 6 and 9 years and 81.3% ($n = 100$) commenced therapy between the ages of 10 and 12 years. These prescribing patterns are in accordance with other countries such as Malaysia where 11.1% of orthodontists commence first phase treatment on patients between the ages of 6 and 9 years and 94.4% between the ages of 10 and 14 years.³⁸ The advantages of first phase treatment is that it allows for the patient's oral health-related quality of life along with their increased risk of incisal trauma, to be addressed. The importance of contributing to the improvement of a patient's self-concept relating to physical appearance confidence, popularity, happiness, and satisfaction cannot be underestimated.^{31,32,34,35}

Almost one half of orthodontists in Australia ($n = 72$; 43.9%) reported that Class II patients are not referred at an appropriate age for functional appliance therapy. However as oral health-related quality of life and the risk of incisal trauma is a driving force to commence first phase treatment, greater awareness and/or education of general dental practitioners in Australia regarding the preferred referral age, is needed.

A limitation of the present study includes the sample population and the subsequent risk of selection bias. The survey was distributed through the ASO and therefore, was made available exclusively to its members. Therefore, the results of the survey may not reflect the opinions and practices of all orthodontists in Australia as not all are members of the ASO. Secondary to this and for practical reasons, it was not feasible to include all conceivable market-available functional appliances (for relevant questions) in the survey, nor all available Class II malocclusion treatment options. For example, as a result of survey participant feedback, the researchers were made aware that for some orthodontists in Australia, their preferred Class II malocclusion treatment option was to manage with two phase, removable appliance therapy involving clear aligners. Subsequently, there

will be an over-representation within the data of treatment choices or functional appliances available for selection, that may not truly reflect a survey participant's clinical practice. Finally, whilst the present study adds to current knowledge regarding the use of functional appliances, the findings may not be extrapolated to represent other countries nor global healthcare systems. Therefore, further research is required with the potential for other researchers to repeat or mirror the present study's methodology.

Conclusion

The current analysis of the data suggests the following concluding points regarding the use of functional appliances in Australia:

- (1) It is common practice for orthodontists in Australia to utilise functional appliances in the management of a Class II malocclusion.
- (2) The Twin Block appliance is the most prescribed functional appliance in Australia.
- (3) There appears to be a statistically significant relationship between the institution from which an orthodontist obtained their speciality qualification and their preferred choice of Class II treatment when employing functional appliances.
- (4) When utilising functional appliances, a two phase, removable functional appliance followed by fixed appliances is the preferred choice of Class II malocclusion treatment.
- (5) The typical age to commence removable appliance therapy is between 10 and 12 years of age incorporating 9 to 12 months of full-time wear followed by a 4 to 6 months retention period.

Conflict of interest

The authors declare that there is no conflict of interest.

Corresponding author

Dr Mithran Goonewardene: Department of Orthodontics, School of Dentistry, Faculty of Health and Medical Sciences, The University of Western Australia, 17 Monash Avenue Nedlands, Western Australia 6009, Australia E). Email: mithran.goonewardene@uwa.edu.au

Acknowledgments

The authors acknowledge and appreciate the support received by the Australian Society of Orthodontists and the Australian Society of Orthodontists Foundation for Research and Education.

References

1. Alhammadi MS, Halboub E, Fayed MS, Labib A, El-Saaidi C. Global distribution of malocclusion traits: a systematic review. *Dental Press J Orthod.* 2018;23:40. e1–e10.
2. Tulloch JFC, Medland W, Tuncay OC. Methods used to evaluate growth modification in Class II malocclusion. *Am J Orthod Dentofac Orthop.* 1990;98:340–7.
3. Cozza P, Baccetti T, Franchi L, De Toffol L, McNamara Jr JA. Mandibular changes produced by functional appliances in Class II malocclusion: a systematic review. *Am J Orthod Dentofac Orthop.* 2006;129:599. e1–e12.
4. Makhbul MZM, Hassan WNW. A clinical audit of the success rate of removable functional appliances treatment. *Malaysian Dental J.* 2019;61–73.
5. Baccetti T, Franchi L, McNamara Jr JA. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. *Semin Orthod.* 2005;11:119–29.
6. Mills J. The effect of functional appliances on the skeletal pattern. *Br J Orthod.* 1991;18:267–75.
7. Franchi L, Pavoni C, Faltin Jr K, McNamara Jr JA, Cozza P. Long-term skeletal and dental effects and treatment timing for functional appliances in Class II malocclusion. *Angle Orthod.* 2013;83:334–40.
8. Freeman DC, McNamara Jr JA, Baccetti T, Franchi L, Fränkel C. Long-term treatment effects of the FR-2 appliance of Fränkel. *Am J Orthod Dentofac Orthop.* 2009;135:570. e1–e6.
9. Malta LA, Baccetti T, Franchi L., Faltin Jr K, McNamara Jr JA. Long-term dentoskeletal effects and facial profile changes induced by bionator therapy. *Angle Orthod.* 2010;80:10–7.
10. DeVincenzo JP. Changes in mandibular length before, during, and after successful orthopedic correction of Class II malocclusions, using a functional appliance. *Am J Orthod Dentofac Orthop.* 1991;99:241–57.
11. Hansen K, Pancherz H. Long-term effects of Herbst treatment in relation to normal growth development: a cephalometric study. *Eur J Orthod.* 1992;14:285–95.
12. Koretsi V, Zymperdikas VF, Papageorgiou SN, Papadopoulos MA. Treatment effects of removable functional appliances in patients with Class II malocclusion: a systematic review and meta-analysis. *Eur J Orthod.* 2015;37:418–34.
13. Cacciatore G, Ugolini A, Sforza C, Gbinigie O, Plüddemann A. Long-term effects of functional appliances in treated versus untreated patients with Class II malocclusion: a systematic review and meta-analysis. *PLoS One.* 2019;14:e0221624.
14. Moro A, Mattos CF, Borges SW, Flores-Mir C, Topolski F. Stability of Class II corrections with removable and fixed functional appliances: a literature review. *J World Federation Orthod.* 2020;9:56–67.
15. Flores-Mir C, Major PW. A systematic review of cephalometric facial soft tissue changes with the Activator and Bionator appliances in Class II division 1 subjects. *Eur J Orthod.* 2006;28:586–93.
16. Shen G, Hägg U, Darendeliler M. Skeletal effects of bite jumping therapy on the mandible—removable vs. fixed functional appliances. *Orthod Craniofac Res.* 2005;8:2–10.

17. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, Chadwick S, et al. Effectiveness of treatment for Class II malocclusion with the Herbst or twin-block appliances: a randomized, controlled trial. *Am J Orthod Dentofac Orthop*. 2003;124:128–37.
18. Al-Moghrabi D, Salazar FC, Pandis N, Fleming PS. Compliance with removable orthodontic appliances and adjuncts: a systematic review and meta-analysis. *Am J Orthod Dentofac Orthop*. 2017;152:17–32.
19. Pacha MM, Fleming PS, Johal A. A comparison of the efficacy of fixed versus removable functional appliances in children with Class II malocclusion: a systematic review. *Eur J Orthod*. 2016;38:621–30.
20. Ghafaria J, Shoferb F, Jacobsson-Hunta U, Markowitz D, Lasterb L. Headgear versus function regulator in the early treatment of Class II, division 1 malocclusion: a randomized clinical trial. *Am J Orthod Dentofac Orthop*. 1998;113:51–61.
21. El-Huni A, Salazar FBC, Sharma PK, Fleming PS. Understanding factors influencing compliance with removable functional appliances: a qualitative study. *Am J Orthod Dentofac Orthop*. 2019;155:173–81.
22. O'Brien K, Wright J, Conboy F, Sanjie Y, Mandall N, Chadwick S, et al. Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomized, controlled trial. Part 1: dental and skeletal effects. *Am J Orthod Dentofac Orthop*. 2003;124:234–43.
23. Pancherz H. The effects, limitations, and long-term dentofacial adaptations to treatment with the herbst appliance. *Semin Orthod*. 1997;3:232–43.
24. Tulloch JC, Phillips C, Proffit WR. Benefit of early Class II treatment: progress report of a two-phase randomized clinical trial. *Am J Orthod Dentofac Orthop*. 1998;113:62–74.
25. Proffit WR, Fields HW, Larson BE, Sarver DM. Contemporary orthodontics. Sixth edition, ed. Philadelphia, PA: Elsevier; 2019:357–94.
26. Livieratos FA, Johnston Jr LE. A comparison of one-stage and two-stage nonextraction alternatives in matched Class II samples. *Am J Orthod Dentofac Orthop*. 1995;108:118–31.
27. Dolce C, McGorray SP, Brazeau L, King GJ, Wheeler TT. Timing of Class II treatment: skeletal changes comparing 1-phase and 2-phase treatment. *Am J Orthod Dentofac Orthop*. 2007;132:481–9.
28. Tulloch JC, Phillips C, Koch G, Proffit WR. The effect of early intervention on skeletal pattern in Class II malocclusion: a randomized clinical trial. *Am J Orthod Dentofac Orthop*. 1997;111:391–400.
29. Tulloch JC, Proffit WR, Phillips C. Influences on the outcome of early treatment for Class II malocclusion. *Am J Orthod Dentofac Orthop*. 1997;111:533–42.
30. Keeling SD, Wheeler TT, King GJ, Garvan CW, Cohen DA, Cabassa S, et al. Anteroposterior skeletal and dental changes after early Class II treatment with bionators and headgear. *Am J Orthod Dentofac Orthop*. 1998;113:40–50.
31. O'Brien K, Wright J, Conboy F, Appelbe P, Davies L, Connolly I, et al. Early treatment for Class II Division 1 malocclusion with the Twin-block appliance: a multi-center, randomized, controlled trial. *Am J Orthod Dentofac Orthop*. 2009;135:573–9.
32. Thiruvengkatachari B, Harrison JE, Worthington HV, D O'Brien KD. Orthodontic treatment for prominent upper front teeth (Class II malocclusion) in children. *Cochrane Database Syst Rev*. 2013;CD003452. doi: 10.1002/14651858.CD003452.pub3.
33. Tulloch JC, Proffit WR, Phillips C. Outcomes in a 2-phase randomized clinical trial of early Class II treatment. *Am J Orthod Dentofac Orthop*. 2004;125:657–67.
34. Seehra J, Fleming PS, Newton T, DiBiase AT. Bullying in orthodontic patients and its relationship to malocclusion, self-esteem and oral health-related quality of life. *J Orthod*. 2011;38:247–56.
35. O'Brien K, Wright J, Conboy F, Chadwick S, Connolly I, Cook P, et al. Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomized, controlled trial. Part 2: Psychosocial effects. *Am J Orthod Dentofac Orthop*. 2003;124:488–94.
36. Thiruvengkatachari B, Harrison J, Worthington H, O'Brien K. Early orthodontic treatment for Class II malocclusion reduces the chance of incisal trauma: Results of a Cochrane systematic review. *American Am J Orthod Dentofac Orthop*. 2015;148:47–59.
37. Registrant Data - Dental Board of Australia: Dental Board AHPPRA; 2024. Available from: <https://www.dentalboard.gov.au/About-the-Board/Statistics.aspx>
38. Bahar AD, Kamarudin Y, Chadwick S. A national survey of orthodontists in Malaysia and their use of functional appliances for Class II malocclusions. *Aust Orthod J*. 2021;37:217–26.
39. Chadwick S, Banks P, Wright J. The use of myofunctional appliances in the UK: a survey of British orthodontists. *Dental Update*. 1998;25:302–8.
40. Annual Report. Australian Society of Orthodontists; 2023. Available from: <https://www.aso.org.au>