



The clinical effectiveness of unilateral conventional VS bonded space maintainers: A Systematic Review

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Abstract

Introduction: Space maintainer is an interceptive device, commonly used after premature loss of a deciduous tooth; its use allows the respect of eruption sequences and space management for a favorable permanent dentition development.

The aim of our work is to compare the clinical efficacy of conventional unilateral fixed, stainless steel space maintainers and composite bonded space maintainers in terms of space loss, presence of caries, gingival health, success and failure.

Methods: The data bases consulted were PUBMED, The Cochrane Library, SCIENCE DIRECT, and EBSCO HOST DATABASES. Our review was limited to articles in English and French, dated from 2010 onwards, and including all comparative studies, prospective and retrospective, randomized and non-randomized clinical trials. Opinion articles, single case reports, and systematic reviews were excluded.

Results: Among 249 articles, six met our inclusion criteria: four were randomized clinical trials and two were comparative studies

The included studies compared the outcome and clinical performances of the two types of space maintainers with an up to 12 months follow-up.

Conclusion: Bonded space maintainers are considered as an alternative treatment to conventional space maintainers.

Keywords: Band and loop, fiber reinforced composite, space maintainer

Introduction

The premature loss of primary teeth due to caries or trauma, causes an imbalance in inter and intra-arch relationships, resulting in a loss of space through mesial drift of the posterior teeth as well as a decrease in arch length. These modifications continue throughout the development of the permanent dentition, favoring the installation of malocclusions, crowding and dental inclusions, requiring subsequent orthodontic treatment.

Thus, in the context of interceptive orthodontic therapy, the concept of "space maintainer" was first introduced in the literature in 1907 with ANGLE. He was convinced that a high percentage of malocclusions were the result of premature loss of deciduous teeth. He proposed a device to maintain the space created by the loss of a temporary tooth while waiting for the eruption of the permanent tooth ^[1].

Different types of space maintainers exist (fixed, removable, unilateral and bilateral) and their indications depend on several parameters including occlusion, missing tooth or teeth, dental age, parental and child cooperation and other clinical factors ^[2, 3].

There is much controversy in the literature regarding the indication of a space maintainer after temporary tooth loss. [4, 5, 6]. The aim of our systematic review is to compare the clinical efficacy of two types of unilateral fixed space maintainers banded and bonded in terms of space loss, incidence of caries, gingival health, and longevity.

Materials and Methods

PICO question

In order to make better use of the different search engines, we formulated a search question according to the PICO [Patient/Problem, Intervention, Comparison and Outcome] method.

Table 1: PICO Question

Population	Young patients with temporary or mixed dentition who have lost a temporary molar and whose age ranges from 4 to 9 years
Intervention	Placement of a conventional and composite bonded space maintainer
Comparison	Before and after placement of the device
Outcome	Comparison between the two space maintainers in terms of space loss, incidence of caries, gingival health and longevity

Search Strategy

We performed an electronic search on the following databases: PUBMED, The Cochrane Library, SCIENCE DIRECT, and EBSCO HOST DATABASES, without any limitation of language, date, and type of articles.

Concerning the PUBMED database, we used keywords existing in the MESH language and gathered by the Boolean operator "AND", forming different search equations:

- "Space Maintenance" AND "Tooth loss" AND "Dental arch",
- "Space Maintenance" AND "Stainless Steel" AND "Tooth loss",
- "Space Maintenance" AND "Stainless Steel" AND "Efficacy treatment"
- "Space Maintenance" AND "Stainless Steel" AND "Composite resins",

- "Space Maintenance" AND "Glass" AND "Composite resins",
- "Space Maintenance" AND "Composite resins" AND "Efficacy treatment",

In contrast, our examination on the other databases were by formulating different search equations from a combination of keywords: "Space Maintainer", "Fixed Space Maintainer", "Conventional band and loop", "fiber reinforced composite resin", "Flow composite", "Efficacy" and "Space loss".

Inclusion and exclusion criteria

We present in the following table 2 the inclusion and exclusion criteria used to incorporate articles into the analysis.

Table 2: Inclusion and Exclusion Criteria

Inclusion criteria	<ul style="list-style-type: none"> ▪ Articles written in English or French. ▪ Full text available ▪ Date of publication from 2010 ▪ Studies comparing the clinical performance of bonded versus conventional space maintainers ▪ Retrospective studies, prospective studies, randomized and non-randomized clinical trials, meta-analyses and comparative studies
Exclusion Criteria	<ul style="list-style-type: none"> ▪ Articles investigating the efficacy of just one space maintainer with no comparison between the two devices ▪ Opinion or review articles ▪ Case reports. ▪ Case series ▪ Systematic review ▪ - Literature review

Results

Our methodology allowed us to identify a total of 249 articles. After eliminating duplicates and reading the title and abstract, we retained 189 articles.

After reviewing the full text of the selected articles, we

eliminated 48 articles that did not meet the inclusion criteria. Finally, six articles were retained in our systematic review: two were comparative studies [8, 12] and the other four were randomized clinical trials [7, 9, 10, 11].

We illustrate our selection process in the Flow chart (Fig.1).

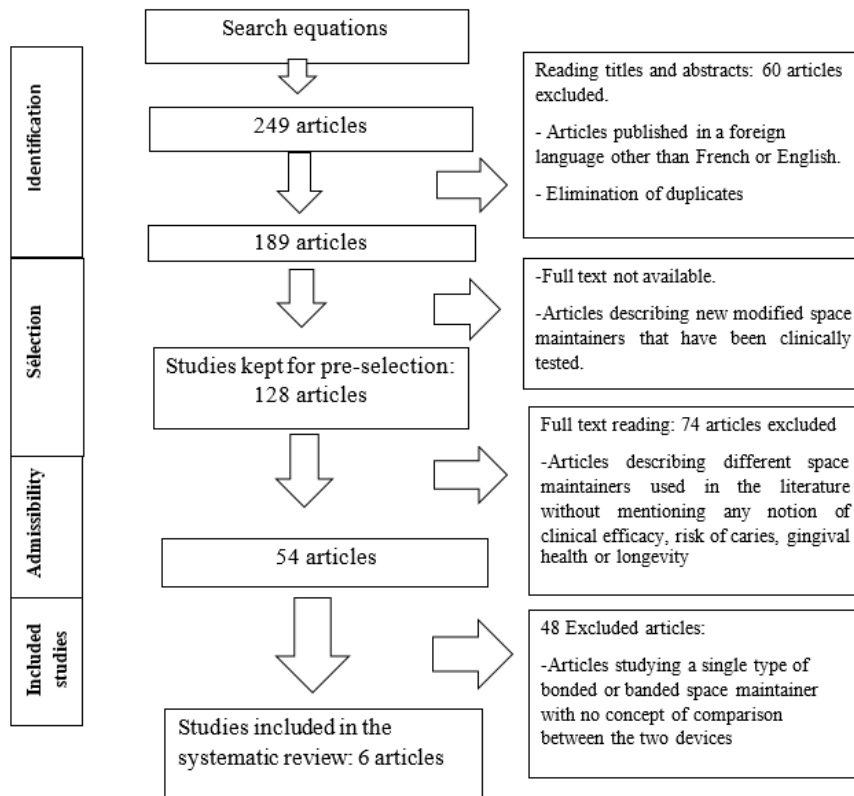


Fig 1: Flow Chart

Table 3: Included studies

Study	Type	Aim	Participants	Comparison	Results
Mittal S. <i>et al.</i> (2018) [7].	Randomized clinical trial Comparative study	A comparison of the performance and clinical effectiveness of two types of space maintainers: bonded and banded	45 children between 6 and 9 years of age with premature loss of a temporary molar were divided into three groups according to the type of space maintainer received: G1: Band and loop G2: FRCR (everStick) G3: GFRCR (glass fiber INTERLIG)	<ul style="list-style-type: none"> loss of space incidence of caries patients tolerability cost-effectiveness Failure and longevity. Follow-up after 3, 6 and 12 months was performed.	The loss of space is more pronounced with Band and Loop space maintainers, but the use of FRCR SM eliminates the problem of rotations or versions of adjacent teeth. FRCRs are more acceptable to patients and require less design time than conventional space maintainers.
GARG A. <i>et al.</i> (2014) [8].	Comparative study	A comparison of the clinical effectiveness of two types of space maintainers: Band and loop and FRCR.	30 children with premature loss of the first temporary molar in both quadrants were selected. a band and loop space maintainer was cemented in one quadrant, while in the other a FRCR was placed	<ul style="list-style-type: none"> Preparation time of the device Patient tolerability Clinical effectiveness in terms of success and failure rates 	This study showed a success rate for FRCR of 63.3% compared to 36.7% for BAND AND LOOP with limited preparation time and better aesthetics.
KATARIA S. <i>et al.</i> (2017) [9]	Randomized clinical trial Meta analyse	A clinical comparison of the performance of the conventional band and loop and GFRCR space maintainer	30 children between 4-8 years old with bilateral premature loss of the first deciduous molar are divided into two groups, the first with a conventional space maintainer and the second with a GFRCR bonded space maintainer.	<ul style="list-style-type: none"> Loss of space Gingival health Failure Clinical and radiological follow-up was initiated after 1, 3, 6 and 12 months	GFRC bonded space maintainers showed an overall success rate of 95.7% compared to conventional space maintainers with 69.2%, and this difference was statistically significant.
POTGIETER N. <i>et al.</i> (2018) [10]	Randomized clinical trial Meta-analyses In vivo study	Evaluation of clinical performance and reasons for failure of bonded and banded space maintainers	20 children between 4-9 years of age with premature loss of the temporary first molar are divided into two groups: 10 children received a conventional cemented space maintainer and the other 10 received the same design of the previous space maintainer but bonded in fiber reinforced composite	<ul style="list-style-type: none"> Failure rate Time of preparation Patient tolerability Follow-up up to 6 months after placement of the space maintainer was instituted	-No statistically significant difference was found between the failure rates of the BLSM and the loop design FRCSM when placed on temporary molars. -A 0.8 mm diameter stainless steel round wire for BLSM construction is not effective. -The effectiveness of the FRCSM loop design is limited by the composite bond strength
SETIA V. <i>et al.</i> (2014) [11]	Randomized clinical trial In vivo study	Evaluation of space maintainers in terms of incidence of caries, gingival health and survival rate	A sample of 60 premature extraction of temporary molars in children ranging in age from 4 to 9 years in age was selected. This sample was divided into four groups: <ul style="list-style-type: none"> Conventional band and loop Prefabricated FRCR Ribbond FRCR Super splint 	<ul style="list-style-type: none"> Survival rate Presence of caries Gingival health 3, 6 and 9 month follow-up was initiated	-Prefabricated space maintainer have a maximum success rate with 84.6%, while the FRCR Super splint was the least successful with 33.3%. -In terms of gingival health, prefabricated space maintainer reported a minimum of cases with poor gingival health, while the

					maximum of cases with poor gingival health (50%) were reported with the FRCR Super splint -None of the space maintainers developed caries at the end of 9 months.
RANI R. <i>et al.</i> , (2020) ^[12]	Comparative study	Comparison of the clinical efficacy of FRCR and conventional band and loop space maintainers	30 children aged 6-8 years old with at least one premature loss of temporary molars in two quadrants. The conventional space maintainer was placed in one quadrant while FRCR will be placed in the other.	Evaluation and comparison of clinical efficacy in terms of success and failure rates of the device after 1, 3, 6 and 9 months.	The retention of the FRCR space maintainer was found to be superior to the conventional band and loop space maintainer, and this difference was statistically significant. FRCR (Ribbond) space maintainers can be considered an alternative to conventional space maintainers

Discussion

"Space management" is the individualized consideration of any actual or potential loss of space. This concept allows for early action in developmental and eruption anomalies, but also for maximum exploitation of the space available in the dental arches.

Preserving or respecting the LEEWAY by using the space maintainer prevents parasitic movements related to the loss of space, such as the mesio-versions of the first permanent molars. This allows the maintenance of a few millimeters of arch length, which can eventually alleviate incisor crowding or potentially eliminate the need for extractions in subsequent orthodontic treatment ^[13, 14].

According to CHOONARA: "...Many orthodontic cases with crowding and loss of space in the permanent dentition could have their problems avoided or their severity reduced, if the practitioner's intervention leaned towards maintaining space in the mixed dentition..." ^[15].

Tooth drift depends on several elements, namely the dental age at the time of extraction, the pre-existing occlusion, the path and time of eruption of the successor tooth, and the intercuspitation. According to KATARIA *et al.*, in the face of premature loss of the temporary first molar, maxillary space loss is primarily related to mesial drift of the temporary second molar, whereas at the mandibular level, there is more distal drift movement of the temporary canine ^[9].

Conventional band and loop or crown and loop space maintainers are unilateral fixed devices designed with a stainless steel wire consisting of a ring or a crown on the abutment tooth and a wide loop through the edentulous space. This type of space maintainer is the most commonly used in pediatric dentistry, they adjust easily to changes in dentition and have a good clinical track record with a high success rate in the past ^[9, 11, 16].

Although the design of this type of space maintainer is relatively simple, however, it is considered to be time consuming requiring a laboratory phase with sometimes difficulty in obtaining a good fit of the ring or crown around the abutment tooth ^[17].

The introduction of prefabricated space maintainer in a variety of sizes in 1935, was intended to reduce chair time and the laboratory phase, when in reality the limitations were the same as those of conventional space maintainers. This led to the need to use a new adhesive material, namely composite resins ^[18, 19].

Resin-based dental composite is one of the materials that have undergone many changes and improvements over time. One of the most effective changes has been the incorporation of fibers with a filling composite resin. In general, the mechanical properties of fiber-reinforced composite (FRCR)

structures have been shown to be superior to those of unreinforced composites *in vitro* ^[20, 21].

The types of fibers commonly used in dentistry are glass (GFRCR) and polyethylene fibers. Glass fibers have high tensile strength combined with low extensibility. Their transparent appearance makes them well suited for dental applications with high aesthetic requirements ^[22].

A study by ALAVIS *et al.* in 2013 compared the mechanical properties of fiber reinforced composite resins (FRCR) and stainless steel (SS) by bending tests in different points (0.5, 1 and 1.5mm). This research concluded that FRC can be used in orthodontics for active or passive purposes as an aesthetic alternative for stainless steel ^[23].

Loss of space

The articles included in our systematic review that studied the loss of space after placement of a banded or bonded space maintainer are: two randomized clinical trials ^[7, 8] and one comparative study ^[9].

The study by MITTAL *et al.* in 2008 evaluated the clinical efficacy of three types of space maintainers: the conventional BAND AND LOOP, the FRCR and GFRCR with a follow-up of 3, 6 and 12 months. The space maintainer's ability to maintain the space was determined by the SWAINE AND WRIGHT method by evaluating the linear and spatial relationships between the two teeth bordering the space by measurements on the initial study models before placement of the space maintainer, and then after 3, 6, and 12-month intervals.

The study showed that the clinical performance of the three types of space maintainers is virtually the same. In addition, it noted the presence of a more pronounced loss of space in Group I, related to the lack of firm contact between the wire and the adjacent tooth, resulting in tooth versions and rotations. Therefore, the use of bonded space maintainers eliminates these problems by the presence of a contact surface linking the tooth to the space maintainer through the adhesive material. This observation is consistent with the work of GARG *et al.* in 2014, SIMSEK *et al.* in 2004 and YILMAZ *et al.* in 2006 ^[7, 8, 24, 25].

The study by GARG *et al.* showed that FRCR space maintainers are superior compared to conventional space maintainers in terms of clinical efficacy with a statically significant clinical success rate of 63.3% compared to 36.7% for conventional space maintainers ^[8].

In this same line of research, the study conducted by KATARIA *et al.* in 2017 seeking to compare the clinical efficacy of conventional and GFRCR space maintainers, showed an overall success rate of 95.7% for GFRCR comparing to conventional space maintainers with 69.2%,

and this difference was statistically significant ^[9].

In summary, the included articles concur that space loss is more pronounced with conventional than bonded space maintainers. However, for more concrete conclusions, a more thorough comparison should be made with the same method of space measurement to reduce any risk of bias.

Presence of caries

The study conducted by MITTAL *et al.* showed that throughout an estimated 12-month follow-up period, none of the patients receiving a bonded or banded maintainer developed caries. This is mainly due to the elimination of any food retention areas facilitating the maintenance of good oral hygiene. In addition, the BAND AND LOOP space maintainers were deposited every 6 months for fluoride treatment ^[7].

The results of the previous research agree with the work of SETIA *et al.* where none of the patients developed caries over a period of 9 months with fluoride application and instruction of good hygiene measures. An operator assessed the presence of caries clinically ^[11]. These results are in agreement with the study of SUBRAMANIAM *et al.* ^[16].

In contrast, a study by MIZHARI E. *et al.* observed the appearance of opaque enamel lesions after removal of conventional BAND AND LOOP space maintainers, mainly below the ring ^[26].

Gingival health

The study conducted by SETIA *et al.*, showed that the presence of dental plaque is greater in bonded space maintainers than conventional ones. This was explained by several reasons among which the good fit of the ring around the tooth reduces the retentive areas for dental plaque unlike bonded space maintainers ^[11].

These results contradict the work of KATARIA *et al.*, where the gingival health observed in a group of children with a GFRCR bonded space maintainer over a 12-month period was superior to those with a conventional space maintainer at a statically significant difference ($p=0.026$) ^[9].

The assessment of gingival inflammation was based in the two previous studies on the same SILLNESS and LOE index ^[9, 11].

Keeping up in the same line of research, AHMED AJ *et al.*, KARGUL B *et al.*, GRABER *et al.*, have shown that among the disadvantages of conventional stainless steel space maintainers are plaque accumulation, gingival inflammation, bacterial colonization and possible periodontal destruction ^[17, 27, 28].

The study conducted by RANI *et al.* in 2020, showed that 15% of the reasons for failure of conventional stainless steel space maintainers were mainly related to gingival inflammation due to the band or ring sliding gingivally ^[12].

Longevity and failure

The study by MITTAL *et al.*, showed that the main causes of failure of conventional space maintainers are related to the tendency of cement disintegration mainly explained by the isolation of the operative field, which is difficult to obtain in children but also to the failure of the soldering related to the low quality of manufacture ^[7].

On the other hand, the failure of bonded space maintainers was due to disbonding of the enamel-composite or fiber-composite interface, which can be explained by different reasons such as high chewing forces, non-use of the dam, low

adhesion strength of the composite to the aprismatic enamel of the temporary teeth compared to the permanent teeth. This study concluded that the success rate of both types of space maintainers were almost the same, with more affinity for bonded FRCR type space maintainers because they are esthetic, better tolerated by patients and more cost effective. The results of this study are in agreement with the work of POTGEITER *et al.* who add to the reasons for failure of conventional space maintainers the burying of the band or crown in the gingival direction ^[7,10].

According to GARG *et al.* the success rate of bonded FRCR space maintainers was higher than that of conventional space maintainers, with better patient acceptance, better clinical efficacy and less time to perform. This finding is consistent with studies by KATARIA *et al.* and RANI *et al.* ^[8, 9, 12].

However, the study by SETIA *et al.* showed that prefabricated bands with custom-made loops had the highest success rate (84.6%) at 9 months, followed by conventional BAND AND LOOP space maintainers and finally bonded space maintainers with a statically significant difference ($p<0.05$). The authors concluded that bonded space maintainers are more aesthetic and better tolerated by patients, but given their low success rates, they are recommended for a short period of time ^[11].

Conclusions

Premature loss of temporary teeth is a frequently encountered clinical situation that impacts the occlusion, TMJ, functions and aesthetics. Its manifestations can worsen when the patient is growing, favoring the installation of more severe malocclusion.

To fight against these complications, the space maintainer is an efficient way to preserve the length of the arch and the space after the loss of one or more teeth.

The conventional unilateral stainless steel fixed space maintainer (band and loop/crown and loop) is considered the "gold standard" in space management in pediatric dentistry, however it is a time consuming unsightly procedure with low patient tolerability.

Currently, with the development of composite resins, bonded space maintainers (FRCR-GFRCR) are increasingly used in children; they meet the aesthetic requirements and are better tolerated and accepted by young patients.

According to our systematic review, bonded space maintainers can be considered as an alternative treatment to conventional space maintainers with a high clinical efficacy and success rate, if the technique and the operative protocol are respected. Indeed, bonded space maintainers prevent any loss of space by rotation or tipping of the abutment tooth and protect the tooth against any silent carious lesion or periodontal damage.

Further research based on a larger sample size and a longer follow-up period would be needed before FRCR or GFRCR could be confidently recommended as a reliable alternative to band and loop or crown and loop space maintainer.

Competing Interests

The authors declare no competing interests with this case.

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