Title: Development, validity, and reliability of the band and loop radiographic assessment scoring system (BRASS)

Article type: Original research

Running Title: Development of BRASS

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Abstract

Purpose: The purpose of this study was to develop a radiographic evaluation scale which, when combined with clinical criteria, could help reduce the failure rate of the conventional band and loop (CBL) space maintainer.

Materials and Methods: The Band and Loop Radiographic Assessment Scoring System (BRASS) was developed following best practices for scale development in healthcare. The process began with data collection through a literature review, followed by face and content validity assessment of the items generated using the sum-score decision rule and content validity ratio. Pre-testing of the scale was conducted through item-total correlation and factor analysis using the Tucker-Lewis Index, which facilitated item reduction. Pilot testing of the scale was subsequently carried out, and test-retest reliability, predictive validity, and two measures of construct validity were evaluated.

Results: The initial pool of 20 items was reduced to 10, distributed across three criteria based on the results of the goodness-of-fit test. The mean accuracy of the scale, based on predictive validity, was 89%. Test-retest reliability, measured by Cronbach's Alpha, was 0.87. Construct validity revealed a significant difference ($p < 0.05$) in evaluations conducted with and without the use of BRASS. Finally, multiple linear regression analysis indicated a strong model fit (R-squared = 0.991), further supporting the construct validity of the BRASS.

Conclusion: The development of BRASS, supported by strong validity and reliability metrics, presents it as a promising tool to enhance the clinical success of the conventional band and loop (CBL) space maintainer.

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Keywords: *pediatric dentistry, interceptive orthodontics, malocclusion, space maintenance, brass, preventive orthodontics, band and loop*

Introduction

The ability of pediatric dentists to intercept developing malocclusions through interceptive methods has been established with scientific rigor. The conventional band and loop (CBL) appliance is widely used to prevent unilateral space loss resulting from the premature loss of a primary tooth. Walter C. McBride was the first to publish a report on the construction of the CBL (1). The simplicity of its design was documented as early as 1939 (2), emphasizing its ease of use and successful clinical application, which facilitated a smooth transition from mixed to permanent dentition (3). Clinical trials involving the CBL have reported both its benefits and drawbacks. Kamki *et al.* (4), in their meta-analysis, identified cement loss, gingival slippage of the band, loop fracture, and band distortion as common issues associated with the CBL.

Calibrations, measurements, and evaluations hold a critical place in healthcare. Prognosis and treatment outcomes often hinge on valid and reliable criteria that translate quantifiable values into theoretical implications—particularly when such theoretical variables are not directly observable. This applies to the CBL as well. Andlaw *et al.* (5) have reported that clinical criteria can satisfactorily assess the appliance's stability, occlusal interference, absence of soft tissue blanching, and patient compliance. However, beyond clinical evaluation, addressing the shortcomings of the CBL also requires an understanding of its radiographic characteristics, which can be standardized through the development of an epistemological framework.

Radiographic evaluation of the CBL can reveal subtle factors contributing to the success of space maintainers, such as root resorption, alveolar bone levels, and subgingival adaptation. To address this research gap, there is a need for a standardized radiographic assessment scale that complements clinical findings and enhances treatment outcomes. Therefore, the objective of this article is to present the development, reliability, and validity of a comprehensive radiographic evaluation scale designed specifically for dental practitioners.

Materials and Methods

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Ethical approval

The Institutional Ethical Committee approved the protocol of this study (CDSRC/IEC/2024/06), which was also registered on Open Science Framework (10.17605/OSF.IO/Y8UXA).

Developing the scale

To develop our scale, a best practice guideline for scale development in healthcare as set by Boateng *et al.* (6) was followed. Furthermore, the reporting of this study is guided by the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist (Table 1).

Table 1. *STROBE checklist.*

`	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	6

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		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-7
		(*b*) Describe any methods used to examine subgroups and interactions	5-7
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5-7
		(*e*) Describe any sensitivity analyses	5-7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	NA

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		(c) Consider use of a flow diagram	NA
Descriptive	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	7-8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	7-8
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7-8
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-15
		(*b*) Report category boundaries when continuous variables were categorized	12-15
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12-15
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			

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Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

Item generation

This study was conducted at the Department of Pediatric and Preventive Dentistry, College of Dental Sciences and Research Centre (Ahmedabad, India) between February 2024 to May 2024. Item generation was initiated by a deductive approach through a thorough literature review that resulted in listing all the reasons for failure. A focus group of five clinicians (pediatric dentists) then anchored the reasons for failure with the associated component of the CBL. This initial list of items was then processed for validation.

Content validity and internal consistency

Content validation with the help of subject matter experts was further tested through a Delphi approach to ensure internal consistency. The generated items were examined in three rounds by a panel of six subject matter experts (four pediatric dentists, and two oral radiologists). The first round involved the inspection of each item for face validation by the sum score decision rule, whereas the following two rounds included quantitative analysis of each item by content validity ratio (CVR). To calculate the CVR, each expert scores an item on a 4-point scale (4 = Highly relevant, 3 = Quite relevant but needs rewording, 2= Somewhat relevant, 1= Not relevant). The CVR is calculated by the formula $(n_e\text{-}N/2)/N\div2$, where n_e is the number of raters who have scored an item 3 or 4, and N is the total number of raters. The value of CVR can range between -1 and +1. Based on the recommendations of Lawshe (1975), any item scored below 0.99 by a panel of six raters was discarded (6). The expert group also laid down the prerequisites for the intraoral periapical radiograph (IOPA) that would qualify for evaluation by our scale (Table 2). Since the eventual objective of the scale is to draw a quantitative inference, it is deemed fit to keep the response format of the scale close-ended and continuous. Each response score of an item was pictorial (visual analog), thereby reducing the subjectivity of the scale. Thus, each item had to be scored from a score of 1 to 5 depending on the pictorial depiction (Figure 1).

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Table 2. *Recommended radiographic prerequisites to qualify for evaluation by the scale.*

Radiographic prerequisites
Visible coronal and radicular areas of the banded tooth
Visible coronal and radicular areas of the tooth on which the loop rests
Visible coronal and radicular areas of the tooth distal to the banded tooth if available
Position of the erupting tooth in the missing space

Band and loop Radiographic Assessment Scoring System (BRASS)

ASPECT	Sr. No.	CRITERIA	1	2	3	4	5
BAND	1	Upper margin of the band	Below the contact point	Cusps not visible	Cusps partially visible	Proximal tilting of the band	2mm below the occlusal cusp
	2	Lower margin of the band	Uneven contour	Inverted arc	Dipping below the gingiva covering the entire pulp chamber	Straight contour	Follows the gingival contour
	3	Proximal contact	No contact or edentulous space	Overlapping	Cervical 1/3rd	Middle 1/3rd	Occlusal 3rd or established contact
	4	Proximal contour	Uneven contour	Open margin bilaterally	Open margin unilaterally	Follows the proximal contour of the tooth unilaterally	Follows the proximal contour of the tooth bilaterally
	5	Solder extent	A portion of wire loop is visible	Either the gingiva or the occlusal margin of wire is free of solder	Solder extended to occlusal and gingival third	Solder extends either to occlusal or gingival third	Encircles wire. Occlusal and gingival third free of solder
	6	Solder consistency	Uneven consistency with multiple voids	Uneven consistency with single void	Even consistency with multiple voids	Even consistency with single void	Uniform consistency
LOOP	7	Gingival contour	At the level or above the occlusal plane	Straight	Straight and surround	Curve	Curve and surround
	8	Contact	No contact	Only one arm in contact	At the contact point	Above the contact point	1mm Below the contact point
OTHERS	9	Adjacent tooth	Below the crest of alveolar bone	Occlusal table is at the level of lower border of the band	Occlusal table is at the level of middle of the band	Occlusal table is at the level of the lower border of the band	Completely erupted
	10	Root resorption of the tooth on which loop rests	Less than 1/3rd root present in single-rooted tooth	Less than 1/3rd root present in multi-rooted tooth	1/3rd – 2/3rd root present in single-rooted tooth	1/3rd – 2/3rd root present in multi-rooted tooth	2/3rd or more of the root intact

Calculations	*Total score* =_____ *Success determinant* = (____/ 10) * 100 = _____	**Inference**	>80% *(Adequate design with routine follow-up)* 50% - 80% *(Needs modification)* <50% *(Reconsider appliance design*

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Figure 1. *Band and loop Radiographic Assessment Scoring System.*

Our scale was pre-tested by observing if each of the nine post-graduate students could appreciate the scale items on nine different IOPA radiographs of band and loop taken through the bisecting angle technique. Based on their responses, item-total correlations were determined. If an item's adjusted item correlation total was below 0.3, it qualified for deletion from the scale.

It has been recommended that newly developed scales should be subjected to confirmatory factor analysis, especially when their foundations are based on a deductive approach (theoretical concepts). Thus, confirmatory factor analysis was done through the goodness of fit test by measuring the Tucker-Lewis Index (TLI) for each item. Items were removed from the scale if their TLI score was <0.9, indicating they were a poor fit for the scale.

After item redundancy, the scale's quantitative evaluation was put to the test. IOPA radiographs of nine completed cases wherein band and loop appliances were given, and whose follow-up records were maintained were provided to the nine post-graduate students. The students were blinded by the follow-up records and the eventual outcome of the cases. They were asked to predict the outcome of the case before getting trained on how to score using the newly developed scale. These initial observations were marked as O1.

After training the students in using the scoring system, they were again asked to evaluate the radiograph given to them and make their observations. This new set of observations was labeled as O2. After this baseline evaluation, each of the nine students was again given the same radiograph after two months to evaluate the radiographs using the scale. The observed data at the two-month time point was marked O3.

Predictive validity, test-retest reliability and construct validity.

The evaluation by the post-graduate students at two different time points (O2 vs O3) was used to check the scale's predictive validity and test-retest reliability. Construct validity using differentiation by known groups was evaluated by tests of significance (O1 vs O3). Since evaluation tools in healthcare require at least two tests for construct validity, a multiple regression equation based on the nine observations was carried out to determine if each criterion has a strong correlation with the eventual outcome of the scoring system (Table 3).

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Table 3. *Predictive validity, test-retest reliability and construct validity.*

	PILOT TESTING	PREDICTIVE VALIDITY	TEST-RETEST RELIABILITY	CONSTRUCT VALIDITY			
SR NO	**O1**	**O2**	**O3**	**MEAN ACCURACY**	**CRONBACH'S ALPHA**	**DIFFERENTIATION BY KNOWN GROUPS**	**MULTIPLE REGRESSION ANALYSIS**
1	*AD	**NM	NM	O2 vs O3 = 89%	O2 vs O3 = 0.87	O1 vs O3 = <0.05	X1 (β1 = 0.1976, p < 0.001) X2 (β2 = 0.2926, p < 0.001) X3 (β3 = 0.3123, p < 0.001) R-Squared = 0.991; Adjusted R-squared = 0.986 Intercept = -0.0957, p =0.020
2	AD	NM	NM				
3	RAD	RAD	†RAD				
4	AD	NM	AD				
5	AD	AD	AD				
6	AD	NM	NM				
7	AD	AD	AD				
8	AD	AD	AD				
9	AD	NM	NM				

*AD: Adequate Design; **NM: Needs Modification; †RAD: Reconsider Appliance Design

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA) and AMOS (Analysis of Moment Structures) for structural equation modeling. Descriptive statistics were used to summarize demographic data and baseline responses. Content validity was assessed using the Content Validity Ratio (CVR) based on Lawshe's method, with a threshold value of 0.99 applied for six expert raters. Items failing to

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meet the threshold were excluded. Internal consistency of the scale was determined using Cronbach's alpha coefficient, where a value of ≥0.7 was considered acceptable. Item-total correlations (ITC) were calculated to examine homogeneity among scale items. Items with ITC values below 0.3 were eliminated during pre-testing. To examine the factorial structure of the scale, Confirmatory Factor Analysis (CFA) was conducted using AMOS, and goodness-of-fit was evaluated through the Tucker-Lewis Index (TLI). Items with TLI scores below 0.90 were considered poor-fitting and subsequently removed. Construct validity was assessed using two approaches: Differentiation by known groups, using independent-samples t-tests to compare scores across baseline and post-training conditions (O1 vs. O3). Multiple Linear Regression Analysis to determine the extent to which individual scale components (X_1, X_2, X_3) predicted the overall design accuracy. The regression model's R-squared and adjusted R-squared values were used to assess model fit, and standardized β-coefficients and p-values were reported for each predictor variable. Predictive validity was evaluated by calculating the mean percentage agreement between assessments conducted at two time points (O2 vs. O3). Test-retest reliability was analyzed by comparing these same scores over a 2-month interval using Cronbach's alpha and measuring consistency over time. A reliability coefficient of 0.87 was established, indicating high reproducibility of the BRASS scale. All tests were two-tailed, and a p-value of <0.05 was considered statistically significant.

Results

The initial data gathering revealed 20 items that went through three rounds of Delphi consensus. Following an analysis of face validity through the sum-score decision rule, and content validity using the CVR formula, the Delphi consensus eliminated four items from the original item pool. Item-total correlations after pre-testing the scale revealed three items that were not homogenous. A confirmatory factor analysis using the Tucker-Lewis Index finalized 10 items that were statistically fit for inclusion in the final scale. A summary of item redundancy is given in Table 4.

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Table 4. *Item redundancy.*

ITEMS	DELPHI		PRE-TESTING	CONFIRMATORY FACTOR ANALYSIS USING GOODNESS OF FIT
	*SUMSCORE (R1)	**CVR (R2 and R3)	ITC	TUCKER-LEWIS INDEX
Upper margin of the band	24	1	0.8	0.92
Lower margin of the band	26	1	0.9	0.95
Band's lower border follows gingival contour	20	0.87		
Band position with respect to biological width	22	0.85		
Proximal contact of band	24	1	0.7	0.98
Proximal contour of band	26	1	0.68	0.98
Solder extent	22	1	0.7	0.97
Solder consistency	22	1	0.67	0.96
Marginal fit of band	20	0.8		
Excess cement above the band	17			
Excess cement below the band	16			
Loop following gingival contour	26	1	0.89	0.93
Loop contact point	26	1	0.88	0.94
Kinks on the loop	20	1	0.28	
Notch on the loop	20	1	0.25	
Thickness of the wire	20	1	0.2	
Status of the successor	22	1	0.5	0.86
Adjacent tooth condition	24	1	0.8	0.92
Alveolar crest position	19	1	0.33	0.8
Root resorption of tooth on which loop rests	24	1	0.87	0.94

*CVR: Content-Validity Ratio; **ITC: Item-Total Correlation

Mean accuracy of 89% across the two time points (O2 vs O3) demonstrated an acceptable predictive validity. Test-retest reliability using Cronbach's alpha was 0.87 which established a desired level of internal consistency.

Construct validity was performed by multiple linear regression analysis that determined that the R-squared value was 0.991 and the adjusted R-squared value was 0.986. The coefficients for each of the three design factors were statistically significant. This means that each time there is an increase in the value of X1, X2, and X3 by a score of 0.1976, 0.2926, and

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0.3123, respectively, there will be an increase in the eventual outcome as well. A summary of validity and reliability testing is given in Table 5.

Table 5. *Validity and reliability testing.*

	METHODOLOGY	OUTCOME
Face validity	Sum score decision rule	2 items removed from initial item pool of 20
Content Validity	Content Validity Ratio	3 items removed from the following item pool of 15
Item-Total Correlation	Done using statistical packages	3 items eliminated from an item pool of 15
Confirmatory Factor Analysis	Goodness of fit test using Tucker-Lewis Index	2 items eliminated from an item pool of 12
Predictive Validity	Accuracy across two time points	89% mean accuracy established for criterion validity
Test-retest reliability	Done using statistical packages	Cronbach's Alpha value = 0.87
Construct validity	Differentiation by known groups using t-test	Statistical significance shown between two groups ($p<0.05$)
	Multiple Linear Regression Equation	R-squared and Adjusted R-squared value calculated to be 0.991 and 0.986 confirming a strong relation between independent and dependent variables

In this study, we conducted a multiple linear regression analysis to examine the relationship between design factors (X1, X2, X3) and the outcome variable Y, which represents the design of Band and Loop. The model exhibited a strong fit (R-squared = 0.991, adjusted R-squared = 0.986), indicating that approximately 99.1% of the variance in Y can be explained by the variables included in the model. Coefficients for X1 ($\beta1 = 0.1976$, $p < 0.001$), X2 ($\beta2 = 0.2926$, $p < 0.001$), and X3 ($\beta3 = 0.3123$, $p < 0.001$) were all statistically significant, suggesting that each unit increase in X1, X2, and X3 is associated with respective increases of 0.1976, 0.2926, and 0.3123 units in Y. The intercept ($\beta0 = -0.0957$, $p = 0.020$) was also statistically significant. These findings underscore the importance of considering X1, X2, and X3 in

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designing Band and Loop configurations, contributing valuable insights for improving design practices.

Discussion

Early tooth loss may result from dental caries or trauma and can subsequently lead to malalignment or crowding of the successor teeth. Space maintenance in cases of unilateral loss of primary molars can be successful only if the appliance design is precise. Therefore, this study aimed to improve the design of the conventional band and loop (CBL) appliance by emphasizing radiographic evaluation.

There is a lack of literature regarding the availability of scales or evaluation tools that assess space maintainers both clinically and radiographically. Furthermore, the objectivity of quantitative criteria will always surpass the subjectivity of qualitative ones. The necessity for radiographic evaluation of the CBL stems from the fact that clinical criteria alone cannot ensure the long-term success of a space maintainer. A standardized evaluation scale can also assist in determining whether modifications are needed during follow-ups. Accordingly, the development of the Band and Loop Radiographic Assessment Scoring System (BRASS) marks the first attempt to provide a novel and structured perspective for evaluating the CBL.

Each item in BRASS has both clinical and radiographic relevance. Clinically, the upper margin of the band should rest apical to the proximal ridges (7). However, the exact positioning of this margin in relation to the contact point, particularly when it is below the contact point, as well as the subtle tilting of the band after placement, can only be evaluated radiographically. The radiographic assessment of the lower margin indicates whether the biological width (a non-clinically visible landmark) has been encroached upon, potentially triggering alveolar bone resorption. Features such as proximal contact assess the band's stability, while proximal contour—exclusively observable on radiographs—ensures the band is well adapted to the adjacent proximal surfaces.

Finite element analysis has shown that a band following the contour of the gingiva can better absorb occlusal stresses (8). This curvature in both arms of the loop is best visualized on radiographs. The position of the loop is also crucial, especially in how it contacts the tooth mesial to the edentulous space. Including this in the scoring system was essential, as

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radiographic confirmation ensures the appliance does not fail due to impingement at the contact point or soft tissue interference. Additionally, the position of the adjacent tooth must be monitored to ensure the band does not obstruct the eruption path of the successor tooth. Finally, root resorption of the abutment tooth on which the loop rests, is a critical factor in determining whether the tooth can resist the mesial drift forces of the adjacent tooth.

According to Boateng *et al.* (6), "A scale or construct defined by theoretical underpinnings is better placed to make specific pragmatic decisions about the domain, as the construct will be based on the accumulated knowledge of existing items." The same authors developed a definitive nine-step framework for scale development in healthcare. The development of BRASS adhered to each step in this framework, from item and domain generation to testing for dimensionality, validity, and reliability.

The original list of 20 items was reduced to 10 in the finalized version of the scale, representing a robust approach to content validation. Discriminant validity was further supported by the finding that 44% of raters altered their assessment of the appliance design when using the BRASS tool. Moreover, evaluations performed by raters at two different time points confirmed the inter-rater reliability and internal consistency of the scale. Boateng *et al.* (9) have also emphasized that any healthcare scale must be supported by at least two measures of construct validity. BRASS was therefore subjected to known-groups comparison and multiple linear regression analysis.

In addition to being easy to learn and teach due to its visual representations, the BRASS tool significantly narrows the margin of error when evaluating the CBL. Its use in pre-cementation evaluation allows for early detection of design flaws, enabling timely intervention and resulting in better clinical outcomes and patient compliance.

Clinical criteria for evaluating the CBL have typically been subjective. Baroni *et al.* (10) include occlusal interference, gingival blanching, loop decubitus, and soft tissue impingement among their evaluation parameters. During follow-up visits, Pinkham recommends checking the CBL clinically for appliance fit, cement washout, and the stability of the abutment tooth. To the best of our knowledge, there are currently no alternative radiographic tools available to assess the CBL. The BRASS tool enhances clinical success by accounting for subclinical features such as proximal contour, root resorption of the abutment tooth, and the position of adjacent teeth, factors that contribute to overall appliance stability.

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The scoring system can be utilized during the six-month follow-up interval, which is the standard recommended timeframe after space maintainer placement (11).

Despite its advantages, this scale has certain limitations. As a visual analog scale, every clinician must have access to a physical copy of the BRASS tool (Figure 1). Furthermore, although this scale was developed specifically to evaluate band and loop space maintainers, it applies only to the conventional variant and not to modified designs. Nonetheless, it is worth noting that the field of space maintenance has evolved, particularly for band and loop appliances, including the introduction of prefabricated designs. Given their widespread use and clinical reliability, the development of a radiographic assessment tool like BRASS is warranted to further enhance the effectiveness of the CBL. As a best practice, BRASS should be used in conjunction with clinical criteria.

This developmental study now paves the way for future enhancements to BRASS, including digitization and its application in longitudinal studies.

Conclusion

The development of Band and loop Radiographic Assessment Scoring System (BRASS), backed by its validity and reliability scores promises to be a viable tool to enhance the clinical success of the conventional band and loop space maintainer.

Türkçe öz: *Band ve loop radyografik değerlendirme ve puanlama sisteminin (BRASS) geliştirilmesi, geçerliliği ve güvenirliği. Giriş: Bu çalışmanın amacı, klinik kriterlerle birlikte kullanıldığında konvansiyonel band ve loop (CBL) yer tutucusunun başarısızlık oranını azaltmaya yardımcı olabilecek bir radyografik değerlendirme ölçeği geliştirmektir. Gereç ve Yöntem: Band ve Loop Radyografik Değerlendirme Puanlama Sistemi (BRASS), sağlık alanında ölçek geliştirmeye yönelik en iyi uygulamalar temel alınarak geliştirilmiştir. Süreç, literatür taraması yoluyla veri toplanmasıyla başlamış, ardından toplam puan karar kuralı ve içerik geçerliliği oranı kullanılarak oluşturulan maddelerin yüzey ve içerik geçerliliği değerlendirilmiştir. Ölçeğin ön testi, madde-toplam korelasyonu ve Tucker-Lewis İndeksi kullanılarak yapılan faktör analizi ile gerçekleştirilmiş ve madde sayısı azaltılmıştır. Ölçeğin pilot testi yapıldıktan sonra test-tekrar test güvenirliği, yordayıcı geçerliliği ve iki yapı geçerliliği ölçütü değerlendirilmiştir. Bulgular: Başlangıçta oluşturulan 20 maddelik havuz, uyum iyiliği testi sonuçlarına göre üç ölçüt altında gruplanan 10 maddeye indirgenmiştir. Ölçeğin yordayıcı geçerliliğe dayalı ortalama doğruluk oranı %89 olarak bulunmuştur ve test-tekrar test güvenirliği Cronbach's Alpha ile 0.87 olarak ölçülmüştür. Yapı geçerliliği, BRASS kullanılarak ve kullanılmadan yapılan değerlendirmeler arasında anlamlı fark olduğunu göstermiştir ($p<0.05$). Sonuç: Çoklu doğrusal regresyon analizi, maddelerin güçlü bir uyum sergilediğini ortaya koymuştur (R-kare: 0.991) ve bu da BRASS'ın yapı geçerliliğini*

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pekiştirmiştir. Geçerlilik ve güvenirlik puanlarıyla desteklenen BRASS'ın geliştirilmesi, CBL'nin klinik başarısını artırmaya yönelik uygulanabilir bir araç olduğunu göstermektedir.
Anahtar kelimeler: pedodonti, kesici ortodonti, maloklüzyon, yer tutucular, BRASS, koruyucu ortodonti, band ve loop.

Ethics Committee Approval: The Institutional Ethical Committee approved the protocol of this study (CDSRC/IEC/2024/06).

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DC, BS participated in writing the paper. DC, AP, BS has had access to all of the raw data of the study. DC, AP, BS has reviewed the pertinent raw data on which the results and conclusions of this study are based. DC, AP, BS have approved the final version of this paper. DC guarantees that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

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