Brazilian Dental Science
Ciência Odontológica Brasileira
unesp
UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE

doi: 10.14295/bds.2015.v18i4.1167

Diagnostic reliability of a simplified epidemiologic tool to detect high-risk overjet for dental trauma

Confiabilidade diagnóstica de um instrumento simplificado para o exame epidemiológico de overjet de risco para traumatismo dentário

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ABSTRACT

Objective: To evaluate the diagnostic reliability of a simplified tool to detect high-risk overjet for dental trauma, using wooden tongue depressors and comparing it to the conventional method as recommended by the WHO (1997). **Material and Methods:** The study population was composed of 131 volunteers divided into two groups according to the overjet measurement in terms of risk for traumatic dental injury (G1: risk absent and G2: risk present). Overjet measurements were taken based on the upper and lower permanent incisors. The distance between the most prominent labial surface and its corresponding counterpart was measured using both the conventional and the simplified tool. The measurements were taken independently and on separate occasions by two previously calibrated dental surgeons (Kappa = 0.86). The gold standard method, as recommended by the WHO (1997), was performed by an external examiner using WHO probes. The simplified method, based on pencil-marked wooden tongue depressors was carried out in a blind manner by the other examiner. Sensitivity, specificity, positive and negative predictive values were calculated for the classification of risk for dental trauma in terms of overjet using the simplified method and compared to the conventional method for reliability, which proved reliable and reproducible. **Results:** the results revealed high values for sensitivity (S = 1), specificity (E = 0.93), positive (PPV = 0.95) and negative predictive value (NPV = 1). **Conclusion:** This study demonstrated that the examination using the simplified tool was reliable in identifying high-risk overjet, thus offering an alternative to the conventional examination in

RESUMO

Objetivo: Avaliar a confiabilidade diagnóstica de um instrumento simplificado para a identificação do *overjet* de risco para traumatismo dentário utilizando espátulas de madeira adaptadas, estabelecendo como comparação a metodologia convencional preconizada pela OMS (1997). **Material e Métodos:** A amostra foi composta por 131 voluntários divididos em dois grupos de acordo com a medida do *overjet* em relação ao risco de traumatismo (G1: ausência de risco e G2: presença de risco). Para a mensuração do *overjet* foram avaliados os incisivos permanentes superiores e inferiores. A distância entre a superfície vestibular mais proeminente e sua correspondente foi aferida de duas formas, pelo instrumento convencional, com o uso da sonda OMS e pela simplificada, com o uso da espátula de madeira adaptada, realizados independentemente e em momentos distintos por duas cirurgiãs-dentistas previamente calibradas (Kappa = 0,86). A metodologia preconizada pela OMS (1997), padrão-ouro, foi executada por examinadora alheia ao estudo. A metodologia simplificada, baseada no uso de espátulas de madeira marcadas à grafite, foi efetivada pela outra examinadora que, de forma cega, realizou os exames clínicos. Foram calculados os valores da sensibilidade, especificidade, valor preditivo positivo e valor preditivo negativo para a classificação do risco de traumatismo em função do *overjet* pelo método simplificado, tendo como comparação a metodologia convencional. **Resultados:** Os resultados revelaram altos valores para a sensibilidade (S = 1), a especificidade (E = 0,93) e para os valores preditivos, positivo (VPP = 0,95) e negativo (VPN = 1) e para a confiabilidade, mostrando-se confiável e reprodutível. **Conclusão:** O estudo comprovou que o exame com o instrumento simplificado apresentou confiabilidade diagnóstica para a identificação do *overjet*

situations where the method recommended by the World Health Organization is unavailable.

KEYWORDS

Diagnosis Oral; Epidemiology; Malocclusion; Oral Health; Tooth Injuries.

de risco, constituindo-se uma alternativa para o exame convencional em situações em que a metodologia preconizada pela Organização Mundial da Saúde não esteja disponível.

PALAVRAS-CHAVE

Diagnóstico Bucal; Epidemiologia; Má Oclusão; Saúde Bucal; Traumatismos Dentários.

INTRODUCTION

In recent years, a remarkable reduction in caries has been reported both in Brazil [1] and in the world [1-3], which has consequently drawn attention to other oral health issues, including dental trauma [2,4-7]. Dental trauma is a public health problem that is on the rise [8-11], being the second commonest reason for dental treatment among adolescents, losing only to tooth decay [5].

According to the literature, the prevalence of dental trauma in Brazil varies from 2.4 – 58.6%, mainly due to population selection criteria, place of data collection and the age groups studied [12,13]. The main causes of traumatic dental injuries are falls, sports, collisions, car accidents, violence, behavioral issues and lack of protective wear against accidents [4,5,14-16], as well as a predisposition relating to carious teeth and endodontically treated teeth [8,17]. Epidemiological information is however lost when trauma is associated to a carious lesion as the latter prevails [8,18].

Dental trauma was included for the first time as a specific nationwide measure in the last National Oral Health Survey in Brazil, which reported a prevalence of 20.5% in 12 year olds, where enamel fracture was the commonest lesion (16.5%), followed by enamel and dentin fracture (3.7%) [1].

Marked incisal overjet is one of the anatomical factors that increase susceptibility to dental injuries [2-4,19-22], and has been investigated by several authors who have reported a higher predisposition to trauma when the overjet was greater than 5 mm [2,19,21,23]. Traditionally, WHO probes have been used in studies evaluating overjet [2,9,10,35] as the gold standard established by that organization. Such tools had originally been designed for epidemiological studies of dental caries [18] but have also been used to measure overjet due to the markings on the instruments, which are uncomplicated to visualize and also permit scoring measurements from the tip of the instrument [8].

Epidemiological surveys on oral health that include the diagnosis of dental trauma are rare when compared to caries and periodontal disease [4]. Such studies significantly contribute to developing strategies that estimate the oral health condition of different population groups, which will in turn provide the grounds to propose adequate actions to tackle their needs and reduce their risk [24].

Issues relating to funding create difficulties for many Brazilian municipalities in obtaining both specific resources and qualified oral health professionals to perform epidemiological surveys. Therefore, the use of methods that reduce examination time, thus economizing highly desirable resources when the conventional method cannot be applied becomes appropriate [25,26].

Visual examination using a wooden tongue depressor has been increasingly used in epidemiological studies, particularly in dental caries surveys, due to reduced operational costs [27].

Reisen et al. [7] used wooden tongue depressors to identify the risk of dental trauma in terms of overjet size; however, no mention was made as to the reliability of the instrument.

The purpose of this study was to evaluate the diagnostic reliability of a simplified tool to identify high-risk overjet for dental trauma.

MATERIAL AND METHODS

Study design, sample population and inclusion/exclusion criteria

This survey was performed in Vitória, ES, Brazil, and included students aged between 15 and 50 years or older, enrolled in a technical and vocational education training (TVET) and those vocational education courses for adults and young adults (EJA - *Ensino Médio para Jovens e Adultos*) at the *Instituto Federal do Espírito Santo* (Federal Institute of Espírito Santo), Vitória Campus (N = 2623). The students were invited to participate in the study, with 283 volunteers accepting the invitation. This cross-sectional study had a preliminary stage at which the 283 subjects were examined in order to include subjects with varying degrees of overjet. The volunteers of the convenience sample were divided into two groups, as shown in Table 1.

The inclusion criteria stated that all volunteers must have a fully erupted permanent upper and lower incisor on the same side [4,12], with no extensive carious lesion that would hinder the measurements and that fell within the previously established groups. The exclusion criteria included: volunteers that had any lip lesion that would prevent the test from being performed; use of an orthodontic appliance [4]; incisor avulsion in the upper or lower arches; an anterior cross-bite or an edge to edge bite; and those who refused to take part in the study.

Table 1 - Levels of overjet for inclusion of the volunteers in the study

GROUP	RISK OF TRAUMA	n
1	Absent	77
2	Present	54

Inter- and intra-examiner calibration

Both examiners were calibrated in order to perform the epidemiological examinations [28]. Inter-examiner agreement was verified using Kappa [29], with a value of 0.86 considered adequate. Intra-examiner diagnostic agreement was analyzed using the kappa coefficient, with a value of 1.0 obtained for both the simplified tool and conventional examination.

Preparation of the wooden tongue depressors

A pencil mark was drawn on the wooden tongue depressors at 5 mm from one end with a 0.7 mm diameter lead, used due to its stability, thickness and image sharpness. The wooden tongue depressors were obtained from the same manufacturer to standardize their regularity and symmetry. In order to compensate for the presence of the 0.5 mm round end on the WHO probe, the simplified method included the width of the pencil mark. The same examiner evaluated each wooden tongue depressor using a millimeter ruler, to guarantee a standardized examination tool.

Preliminary examination

Examination to determine sample groups was performed by a dental surgeon not directly involved in the study, denominated “Examiner A”. Examinations were performed in a dental surgery under artificial light [30], with the dental chair as close to the ground as possible, the back support at a right-angle, the head of the patient supported by the chair and the examiner positioned to the side of the patient. The teeth were examined without being dried [31].

Both permanent upper and lower incisors were fully erupted for assessment of overjet. Both methods accepted anterior overjet as the distance in millimeters between the labial

surface of the most prominent upper incisor and the corresponding lower incisor [31].

Examiner A used the WHO kit, containing a specific probe known as the WHO probe, and a dental mirror with a handle [8]. The groups were defined as follows: (G1) overjet measured before the upper limit of the black stripe and (G2) overjet measured at the upper limit of the stripe or beyond.

As per the aforementioned recommendations, the position of the most prominent labial surface of the upper incisor and its lower counterpart were identified in relation to the markings on the WHO probe with the patient in centric relation [4,31] and the end of the probe in contact with the labial aspect of the lingual-most incisor. The probe was positioned parallel to the incisal edge at a right angle to the normal dental arch.

Simplified examination

Examiner B performed the simplified method in a blind fashion, using the previously prepared wooden tongue depressors. Examinations were performed at the aforementioned school, within normal school hours, under natural light. The examiner and volunteer sat facing each other, with the latter leaning their head against a wall. No dental equipment was required. The teeth were examined without being dried [31]. Overjet was measured based on the upper and lower incisors, as per the conventional method, and the subjects were assigned to their respective groups: G1 - overjet up to the pencil-marked stripe on the wooden tongue depressor and G2 - overjet on the stripe or beyond.

The volunteers were positioned in centric relation and the end of the wooden tongue depressor placed in contact with the buccal surface of the lingual-most incisor. The wooden tongue depressor was positioned parallel to the incisal edge at a right angle to the normal dental arch. The measurement obtained was placed in the corresponding overjet group. All health and safety norms, established by the Ministry of Health, were strictly adhered to for both the conventional and simplified methods [8].

Sample size and power

Two hundred and eighty three volunteers were evaluated and 131 (53.5%) fulfilled the inclusion criteria. A sample size study was performed to minimize random error in the Kappa calculation. From the population sample obtained, both Kappa and confidence intervals were calculated. Sampling error was calculated based on the amplitude of the confidence interval and the sample size required to reach a sampling error of 5% was estimated. Kappa and the lower limit of the confidence interval were compared to the Landis and Koch classification [32].

An agreement of 96.9% was observed, with Kappa 0.9341 (95%CI: 0.8689-0.9994), which showed that the lower limit of the Kappa test obtained in the present study (0.8689) was classified as an almost perfect agreement [32], thus needing no increase in sample size.

Reproducibility

The diagnostic reproducibility was tested for both examiners by re-examining 10% of the sample [4], where 100% agreement was observed between examiners A and B.

Analysis of results

Regarding the simplified method, which used the customized tool for the diagnosis of high-risk overjet for dental trauma, sensitivity, specificity, positive and negative predictive values with their respective 95% confidence intervals were calculated, thus establishing a means of comparison against the conventional method recommended by the WHO (1997) [18]. All calculations were performed on SAS (SAS Institute Inc., Cary, NC, USA, Release 9.2, 2008).

Ethical considerations

This study complied with the norms determined by Resolution 196 of 10/10/1996 by

the *Conselho Nacional de Saúde do Ministério da Saúde* (National Health Council of the Ministry of Health). The Research Ethics Committee of São Leopoldo Mandic Dental Institute and Research Center approved this study (number 198.880). All volunteers and/or responsible guardians gave their informed consent before their participation.

RESULTS

The comparisons of the results for the diagnosis of high-risk overjet for dental trauma using the simplified tool and the conventional method [18] are shown in Table 2. High values for sensitivity, specificity, and positive and negative predictive values were observed, with a satisfactory performance by the simplified method in comparison to the conventional method (Table 3).

Table 2 - Absolute and relative frequencies N (%) for the diagnosis of high-risk overjet for dental trauma using the probe and wooden tongue depressor

Wooden tongue depressor	WHO probe	
	Risk absent	Risk present
Risk absent	77 (58.8%)	4 (3.1%)
Risk present	0 (0.0%)	50 (38.2%)

Table 3 - Performance by the simplified method in comparison to the conventional method

	Values
Sensitivity (*95% CI)	1.00 (1.00-1.00)
Specificity (*95% CI)	0.93 (0.86-1.00)
Positive Predictive Value (*95% CI)	0.95 (0.90-1.00)
Negative Predictive Value (*95% CI)	1.00 (1.00-1.00)

DISCUSSION

The attempt to compare the two methods aimed at verifying reliability as well as to validate the simplified tool. Santos Silva et al. [33] on the use of alternative approaches to the gold standard when cost effectiveness and accessibility, as well as the reliability of the simplified method could be demonstrated.

No studies were found in the literature on the validation of an alternative and/or simplified method to measure high-risk overjet for dental trauma. This may have occurred because most studies have either used the conventional method recommended by the WHO or have adopted alternative methods previously reported by other authors [4,34], despite no validation.

Soriano et al. [2] and Traebert et al. [9,19,35] used the conventional method recommended by the WHO [18] to measure overjet size in order to substantiate their analyses. Conversely, Reisen et al. [7] used pencil-marked wooden tongue depressor to measure overjet size without validation of the method. Nevertheless, they did highlight important aspects to this approach, such as simplicity, ease and agility to apply it, as well as its good acceptance levels. The present study demonstrated the validity of the simplified tool to diagnose a high-risk condition for dental trauma, namely marked overjet.

Diagnostic tests with high sensitivity and specificity yield low rates of false positive results, ascertaining that when the result is negative the individual does not have the particular disease [36]. This was demonstrated in the present study, where false-positives were not reported, thus showing this methods high sensitivity. The rate of false-negative results was 3.1%. A likely explanation for this could be the presence of dental crowding, since the thickness of the wooden tool prevented it from reaching the most retruded tooth, leading to the occurrence of a false-negative high-risk overjet. Regarding the diagnostic reliability of the alternative method, this study demonstrated the simplified method to be reliable and highly reproducible, according to the inter and intra-rater variation obtained using the weighted kappa test (0.86) and kappa coefficient (1.0) [29], respectively.

Alternatives to the conventional method are described in the literature. Some authors [37,38] hav measured overjet size based on the use of study models, which permitted direct

measurement of the overjet. This method was no doubt useful to obtain measures for overjet, however, alternatives to the conventional method should ideally be easy to perform by most individuals and have a feasible operational cost that allows its use in routine practice.

Some diagnostic methods present limited clinical application due to access to resources, time and clinical validation. This is also true for the diagnosis of high-risk overjet for trauma. Furthermore, the diagnosis of high-risk overjet using study models would require skillful human resources for the clinical procedures as well as consumables, which are not generally practical within the scope of public health surveys.

Sgan-Cohen et al. [39] measured incisal overjet using of a dental mirror, a torch and a millimeter ruler. It was a slow method that demonstrated reliability similar to that of the wooden tongue depressors. Issues such as the time needed to ascertain the millimeter measurements were unfavorable when compared to the possibility of a simple response ('yes' or 'no') of tools that have a fixed measure for marked overjet, not to mention the cost involved in acquiring torches and millimeter rulers of an adequate size, which could render these examinations financially unfeasible.

The low-cost, simplicity and ease of use inherent to wooden tongue depressors have been reported elsewhere in the literature [4,7,34]. Robson [34] used 'popsicle sticks' to measure overjet size by making a pencil mark on the stick where the incisor reached its maximum distance and then measuring it using a ruler. Paiva [4] used square-ended tongue depressors to estimate overjet, also making a pencil mark between the labial aspects of the most prominent upper and lower incisors. In the laboratory, the marking was complemented in width using a pencil and ruler and grooves were made using a Stanley knife so that a digital gauge could be attached to it.

The reduced cost when using 'popsicle sticks' or tongue depressors was obvious in the methodology used by the authors [4,34], however, the number of stages required to obtain the final overjet measurement contradicted the purpose of this study, since such an approach would increase operating time, and the need for further stages, including laboratorial steps, which would push the accessibility of the alternative method further away.

Some limitations of the simplified tool/ alternative method include the need for double-checking the markings on all spatulas, which may have a knock-on effect on standardization. This highlight weak points that may need adjustments prior to future surveys.

This study demonstrated that the diagnostic tool assessed was sensitive and specific, showing high positive and negative predictive values, thus proving its usefulness at correctly identifying high-risk overjet when truly present, in addition to detecting its absence when it really was not present, as confirmed by the gold standard WHO probe.

CONCLUSION

This study has demonstrated the diagnostic reliability of a simplified tool to detect high-risk overjet as an alternative to the conventional WHO probe method. Taking into account the results obtained, the simplified tool may be useful whenever the WHO method is not available.

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Date submitted: 2015 Aug 25

Accept submission: 2015 Dec 04