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Dental trauma splint color preference of adults

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SUMMARY

The prevalence of dental trauma among children and adults is high. Most luxated teeth need splinting. The titanium trauma splint (TTS) is a widely used appliance with good performance properties. Esthetics is increasingly important for most patients. Splints placed on the front teeth have a clearly visible impact on patients' appearance and, thus, on their quality of life during splint therapy. Therefore, the aim of the present study was to evaluate the esthetic preferences of adult patients with regard to different splint color and surface finish characteristics. TTS appliances were fabricated in four different colors (silver, gold, green and violet) and two different surface finishes (matt or polished) to yield a total of eight variants. The finished splints were applied to the

teeth of a human model, photographed by a professional photographer, and printed as posters. Adults aged between 18 and 79 years were asked to complete a written survey containing items regarding their TTS color and surface preferences based on the posters with photographs as well as questions about previous tooth bleaching treatments, the importance of having esthetic teeth in general, and the prioritization of esthetic versus function-driven dentistry. Over 80% of participants preferred the silver matt splint over the other variants. Neither gender nor age nor other parameters had a significant influence on the choice of splint color or surface. Women placed greater importance on esthetic rather than function-driven treatment.

Introduction

The prevalence of dental trauma is high (ANDREASEN & ANDREASEN 1990; ANDERSSON 2013). Every effort should be made to save and maintain injured permanent teeth (KASTE ET AL. 1996; HAMILTON ET AL. 1997; FLORES ET AL. 2001; KAHLER ET AL. 2016). Traumatically luxated or avulsed permanent teeth need to be repositioned or replanted and stabilized with a splint (BARRET & KENNY 1997; FLORES ET AL. 2001; POHL ET AL. 2005; ANDERSSON ET AL. 2016; DIANGELIS ET AL. 2017). Various trauma splints and splinting techniques are available that achieve more or less good clinical results (OIKARINEN ET AL. 1992; KAHLER ET AL. 2016; BEN HASSAN ET AL. 2016). The aim of successful splinting is to support the healing process of the periodontal ligament (PDL) (VON ARX ET AL. 2000, 2001A, 2001B; FILIPPI ET AL. 2002; BEN HASSAN ET AL. 2016). To support healing, a splint should have passive and flexible mechanical characteristics that allow physiologic tooth mobility (KRISTERSON & ANDREASEN 1983; OIKARINEN 1990; MAZZOLENI ET AL. 2010; BEN HASSAN ET AL. 2016). One of the existing splints with good mechanical properties is the titanium trauma splint (TTS) by Medartis® (Basel, Switzerland). As a “low rigidity flexible splint”, the TTS causes very little restriction of mobility and thus enhances the process of periodontal healing (KRISTERSON & ANDREASEN 1983; BERUDE ET AL. 1988; MANDEL 1989; BEN HASSAN ET AL. 2016). The TTS was first introduced 20 years ago; it originally came in a golden matt version; it is easy to apply and requires little chairside time (BEN HASSAN ET AL. 2016).

Esthetic demands have increased during the last years (LARSSON 2010; JOINER & LUO 2017), and a dental accident needing splinting of teeth has a considerable esthetic impact on the patient. Previous studies have shown that there are other splints with better esthetics than the TTS, e.g., nylon fishing lines (BEN HASSAN ET AL. 2016). The TTS achieves good clinical results, but has esthetic disadvantages, which impact the patient’s quality of life during splint therapy (VON ARX ET AL. 2001A; FILIPPI ET AL. 2002; BEN HASSAN ET AL. 2016). The reported esthetic impact of the TTS is most probably related to its conspicuous color (JOINER & LUO 2017). A characteristic of modern society is the importance placed on a pleasant physical appearance. During interaction between people, two of the first things observed are the eyes and the mouth; therefore, it is logical that the mouth and front teeth are important aspects (SAMORODNITZKY-NAVEH ET AL. 2007; DUDEA ET AL. 2012; NAYAK ET AL. 2019). Splinted teeth often impair a patient’s oral health-related quality of life and personal esthetics during daily life and business (VON ARX ET AL. 2001A; BEN HASSAN ET AL. 2016). Important parameters for successful treatment are not only clinical parameters but also patient-related satisfaction (HEYDECKE 2002; SPANEMBERG ET AL. 2019). If the treated teeth are not perceived as sufficiently pleasing to the patient’s eye, there can be negative effects such as the patient feeling embarrassed, being unhappy, avoiding smiling and suffering (HEYDECKE 2002; ALKHATIB ET AL. 2004; LARSSON 2010; DUDEA ET AL. 2012; SPANEMBERG ET AL. 2019). To avoid treatment outcomes that cause feelings like this and impair the patient’s quality of life, it is important to have an esthetically well-accepted treatment option after a dental accident. To improve patient satisfaction during splint therapy in adults, we tested eight different TTS variants in four different colors (gold, silver, violet and green) with two different surface finishes each (matt and polished).

The aim of this study was to evaluate patients’ splint color and surface finish preferences and to identify the most preferred TTS variant with the highest optical acceptance rate in order to improve the patients’ quality of life during splint therapy.

Materials and Methods

Eight different TTS variants were fabricated (Medartis® Basel, Switzerland) in order to determine which achieved the highest optical acceptance rate in adults. The splint variants differed in color (gold, silver, violet and green) and surface finish (matt or polished) (Fig. 1), and were not commercially available at the time of the survey besides the gold polished version. This study was in accordance with the principles of the Declaration of Helsinki and the informed consent was obtained.

Splint preparation and application

Each splint variant was adjusted and preformed on a plaster cast of a single human female’s teeth with composite resin (Tetric Evo Flow A1, Ivoclar Vivadent®, Schaan, Liechtenstein), light-cured with a polymerization lamp (three-point fixation) (Blue-phase, Ivoclar Vivadent®, Schaan, Liechtenstein) for 30 seconds, removed from the cast, and placed on the model’s teeth without using new composite or damaging the teeth in any way. Placed like this, each splint was photographed in a standardized manner on the same model (Fig. 2). The model was not

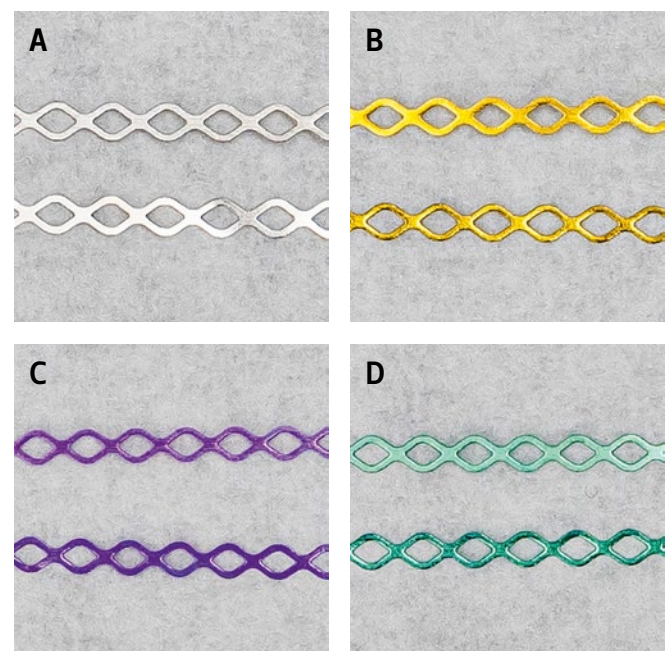


Fig. 1 Titanium trauma splint variants in four different colors (silver [A], gold [B], violet [C] and green [D]) and two different surface finishes: matt (upper variant) and polished (lower variant)



Fig. 2 Silver matt titanium trauma splint

Tab. I Questionnaire items

Age	
Gender	Female/Male
Color blindness	Yes/No
Preferred color	(1) Gold, (2) Silver, (3) Violet, (4) Green
Preferred surface finish	Matt/Polished
Previous bleaching	Yes/No
Treatment priority	Function/Esthetics
Importance of having esthetic teeth	Scale of 1 to 6 (1, lowest, to 6, highest)

an actual patient but based on an individual who had suffered a dental accident in the past.

The pictures were taken by a professional photographer with a Nikon D700 full-frame body and a 24–70 mm f/2.8 lens. The following settings were used for all photographs: focal length 70 mm, aperture f9, shutter speed 1/160. The photos were processed with PowerPoint (Microsoft®, Redmond, USA) and printed as 59.4 × 84.1 cm posters (DIN A1) showing all eight different splint color (gold, silver, violet and green) and surface finish (matt vs. polished) combinations.

Splint preference questionnaire

Each participant completed a written questionnaire surveying their trauma splint color and surface finish preferences as well as their age, sex, eyesight (color blindness) and opinions regarding the importance of dental esthetics, including questions on previous bleaching treatments, the prioritization of esthetic versus function-driven dental treatment, and the importance of having esthetic teeth in general. Questionnaire items are summarized in Table I.

The survey was conducted in a single private dental office and completed by 397 people aged between 18 and 79 years. Twenty-five were excluded due to color-blindness or illegible hand-

writing. The remaining 372 participants consisted of 222 females and 150 males, who were divided into five different age groups for the statistical analysis: 18–30 years, 31–40 years, 41–50 years, 51–60 years and older than 60 years.

Descriptive statistics comprised the mean and standard deviation (SD) of continuous variables as well as the median and interquartile range (IQR) of categorical variables. The following significance tests were also performed as indicated: Student's t-test, F-test, Fisher's exact test, chi-square test, Wilcoxon rank-sum test and/or Kruskal-Wallis test.

Adjustment for age and gender was accomplished using additional regression models. Variable linear regression models were used in the case of Gaussian distribution of outcomes, and logistic regression models were performed in the case of binary outcome variables. In the case of Poisson-distributed variables, a general linear model was run to allow for over-dispersion of the Poisson distribution. The difference between mean values or odds ratios (OR) was estimated with the corresponding 95% confidence interval (CI) and p-value according to the regression model. A p-value <0.05 was considered significant. No adjustment for multiple comparisons was done due to the descriptive nature of the study. All analyses were performed using the statistical program R (version 3.5.3).

Results

More women (n = 222, 59.7%) participated in the survey than men (n = 150, 40.3%). The 31 to 40-year-olds formed the largest group (n = 119, 32.0%). Of the 372 participants, 335 (90.1%) preferred the silver splint, and most of them preferred the silver splint with a matt surface. No examined factor (age, previous bleaching treatments, prioritization of function versus esthetic-driven dental treatment, and the importance of having esthetic teeth in general) had a significant influence on color or surface preference. The silver matt splint was the most popular variant (n = 306, 82.3%) across all age groups (Tab. II). Participants who preferred the matt surface were on average five years younger than the mean study population (p = 0.026). Furthermore, this surface was preferred 2.7 times more by women than men (OR = 2.7, p = 0.004). In contrast to women, men generally had lower regard for esthetic compared to function-driven treatment (p = 0.049) (Tab. III). Regarding the importance of having esthetic teeth in general, men found it less important than women (p < 0.001).

Tab. II Color and surface finish choices by age group

Age	Total	gold matt	gold polished	silver matt	silver polished	violet matt	violet polished	green matt	green polished
18–30	70	3 (4.3%)	0 (0.0%)	60 (85.7%)	3 (4.3%)	2 (2.9%)	0 (0.0%)	1 (1.4%)	1 (1.4%)
31–40	119	3 (2.5%)	1 (0.8%)	102 (85.7%)	8 (6.7%)	1 (0.8%)	0 (0.0%)	2 (1.7%)	2 (1.7%)
41–50	86	0 (0.0%)	2 (2.3%)	70 (81.4%)	9 (10.5%)	1 (1.2%)	1 (1.2%)	3 (3.5%)	0 (0.0%)
51–60	53	3 (5.7%)	1 (1.9%)	41 (77.4%)	3 (5.7%)	2 (3.8%)	0 (0.0%)	2 (3.8%)	1 (1.9%)
>60	44	1 (2.3%)	2 (4.5%)	33 (75.0%)	6 (13.6%)	0 (0.0%)	1 (2.3%)	0 (0.0%)	1 (2.3%)
Total	372	10 (2.7%)	6 (1.6%)	306 (82.3%)	29 (7.8%)	6 (1.6%)	2 (0.5%)	8 (2.2%)	5 (1.3%)

Tab. III Prioritization of functional versus esthetic-driven treatment

Treatment priority	Women	Men	Total
Functionality	135 (60.8%)	110 (73.3%)	245 (65.9%)
Esthetics	63 (28.4%)	31 (20.7%)	94 (25.3%)
Both	24 (10.8%)	9 (6.0%)	33 (8.9%)

Discussion

Among researchers and the general population, awareness of the impacts of oral health and anterior esthetics is increasing, and these factors can affect a person's quality of life in a negative way (HAWLEY ET AL. 1996; ALKHATIB ET AL. 2004; LARSSON 2010; DUDEA ET AL. 2012; SPANENBERG ET AL. 2019). This study was performed to help to avoid a further decrease of patients' quality of life due to splinting therapy. The results of our survey showed that silver matt was the most popular TTS variant, and it was the splint with the highest optical acceptance rate. No factor studied had an influence on splint color or surface choice. Our findings also show that women have higher esteem for esthetics than men.

Various splints are available in different materials and have been tested in previous studies (BEN HASSAN ET AL. 2016). They include the wire-composite splint, the twist-flex wire, the button-bracket splint, the resin splint, the titanium trauma splint, the single and double fiberglass splint, the nylon (fishing) line, the power chain and other splints (VON ARX ET AL. 2001A; FILIPPI ET AL. 2002; BEN HASSAN ET AL. 2016). Some of them – like the double fiberglass splint – are too stiff to achieve good periodontal healing, and others – like the twist-flex wire – are not easy to apply. The nylon line achieved good results and stiffness characteristics and was found to be the most esthetically pleasing, but was difficult to apply due to its small diameter. Another disadvantage was that it broke easily away from the bonding material, resulting in tooth movement and the need for resplinting (BEN HASSAN ET AL. 2016). Besides esthetics and durability, the need to not have to repeat treatment over and over again is also important for a good quality of life during splint therapy (SPANENBERG ET AL. 2019). The TTS was shown to achieve good clinical results: due to its low stiffness, it causes relatively little restriction of mobility; moreover, it is easy to apply, has good stability and does not detach over the splinting period. Because of its preshaped holes, the bonding material does not leak all over the tooth surface and the splint remains mechanically well secured on the tooth (ME-SHARI ET AL. 2016). However, it causes minor esthetic impairment and has the highest material costs (VON ARX ET AL. 2001A).

It might be considered a limitation that this study only compared different variants of the TTS. A lot of other splints like the nylon fishing line have shown good esthetic results as well. Due to the study design, we cannot know if the participants would have chosen the silver matt TTS over the nylon fishing line. From the conducted survey we can only say that the silver TTS causes less esthetic impairment than the golden TTS and that more patients prefer the matt surface over the polished one.

In the present study, patients that were well and did not suffer a dental trauma were questioned. Therefore, they were not exposed to such a stressful situation. It remains open, whether

trauma patients also see aesthetics as a priority. Furthermore, children and adolescents were deliberately excluded from the study even though they belong to the majority of patients experiencing dental accidents. The authors assumed that aesthetic aspects are more important to adults. That is why the survey focused on them. How the results would differ for children and adolescents would need to be assessed in a further study.

The use of a TTS is of short duration. This raises the question, whether there even is a need for different colored splints, or if a golden one suffices. With the results of the present survey the authors attempted to alleviate the burden of difficult dental situations, such as a trauma, by reducing the aesthetic impact to a minimum. Previous studies demonstrated that the TTS achieves good clinical results. However, from an aesthetic perspective, they are perceived as bothersome (VON ARX ET AL. 2001A, 2001B; FILIPPI ET AL. 2002; BEN HASSAN ET AL. 2016). Therefore, it is the authors' belief that dental trauma patients are receptive towards an aesthetic treatment.

The present study investigated eight TTS variants in four different colors with two different surface finishes each. The main objective was to identify any possible preferences regarding optical acceptance of the different splints. The colors were easy to distinguish, but it was difficult to differentiate between the matt and polished surfaces. Nevertheless, the results were statistically significant.

The fact that the difference between the surface finishes was quite small leads to the question of whether the participants should have had the option to check "I don't see any difference". This option was not included on the questionnaire in order to get a clear "EITHER/OR" decision. In these cases, the participants were encouraged to have a closer look at the splints and then decide which one they liked best, and not to merely take a quick look and answer "I don't see any difference". For a better visual presentation, it might have been helpful to provide a video of the model wearing the different TTS variants. However, it would not have been possible to produce identical videos showing the different splints without computer-animated procedures.

Our study findings suggest that silver matt is by far the most preferred TTS color and surface finish combination. Therefore, it is highly recommended to use silver matt trauma splints, as they can satisfy the needs of almost all patients.

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Ethical Approval

This study was approved through the Ethics Committee Northwest and Central Switzerland EKNZ, in 2016.

Zusammenfassung

Einleitung

Die Wahrscheinlichkeit, einmal im Leben einen Zahnunfall zu haben, ist hoch. Unfallbedingt dislozierte oder avulierte Zähne können repositioniert bzw. replantiert und mithilfe von Zahntraumaschiene stabilisiert werden. Um eine parodontale Heilung zu erzielen, muss die Schiene passiv aufliegen und eine gewisse Zahneigenbeweglichkeit ermöglichen. Die Titantraumaschiene (TTS) von Medartis® (Basel, Schweiz) entspricht den

geforderten Eigenschaften. Das Original gibt es seit über 20 Jahren mit einer gold-matten Oberfläche.

Mittels TTS stabilisierte Unfallzähne zeigen gute Behandlungsergebnisse. Leider ist die Schiene deutlich sichtbar, was Patienten teilweise als ästhetisch kompromittierend beurteilen. Ästhetische Ansprüche haben in den letzten Jahren zugenommen. Zusätzlich zum Wunsch nach der medizinisch optimalen Behandlung werden minimalste ästhetische Einbussen während der Behandlungsdauer gefordert. Vorgängige Studien haben gezeigt, dass andere Schienen bessere ästhetische Resultate erzielen als die TTS. Die Autoren vermuten, dass dies auf die goldene Farbe der TTS zurückzuführen ist. Um Gefühle wie Scham oder die Vermeidung von Lachen bzw. Sprechen zu verhindern, ist es wichtig, gute ästhetische Ergebnisse bereits während der Traumabehandlung anzustreben. Ziel der vorliegenden Untersuchung war es, zu evaluieren, ob Patienten ästhetische Präferenzen für TTS in anderen Ausführungen zeigen. Es wurden acht verschiedene TTS-Varianten hergestellt. Die Patienten sollten auswählen, welche Variante sie im Falle einer unfallbedingten Zahnschienung wählen würden.

Material und Methoden

Die TTS wurden in Gold, Silber, Grün und Violett hergestellt, je in einer matten und in einer glänzenden Ausführung. Sie wurden auf Gipsmodellen adaptiert und nach Aushärtung der Klebestellen auf ein weibliches Gebiss appliziert. Die Schienen wurden professionell fotografiert, identisch dargestellt und auf Poster von 59,4 × 84,1 cm gedruckt. Jeder Studienteilnehmer wurde aufgefordert, sich für eine Farbe und anschliessend für eine Oberfläche zu entscheiden. Weiter wurde nach dem Alter, nach dem Geschlecht, nach einer etwaigen Farbenblindheit, nach der Einschätzung der Wichtigkeit von schönen Zähnen, nach früheren Bleachings sowie nach der Priorität einer ästhetischen gegenüber einer funktionellen Therapie gefragt. Insgesamt wurden 397 Patienten zwischen 18 und 79 Jahren interviewt. Nach Ausschluss von farbenblinden Patienten und unvollständig ausgefüllten Fragebogen wurden die Daten statistisch ausgewertet.

Resultate

Insgesamt wurden 372 Personen in die Studie eingeschlossen, wobei mehr Frauen (n = 222, 59,7%) als Männer (n = 150, 40,3%) teilnahmen. 335 (90,1%) von 372 Teilnehmern präferierten die silberne Schiene. Die matte Variante der silbernen Schiene wurde von insgesamt 306 (82,3%) der Befragten gewählt. Keiner der eruierten Faktoren (Alter, früheres Bleaching, Priorität von Ästhetik oder Funktion sowie Wichtigkeit schöner Zähne) hatte einen statistisch signifikanten Einfluss auf das Resultat. Über alle Varianten hinweg wählten Frauen 2,7-mal häufiger eine matte Schiene als Männer. Die Studienteilnehmer, die eine matte Variante als Präferenz angaben, waren im Durchschnitt fünf Jahre jünger als diejenigen, die eine glänzende Variante bevorzugten. Männliche Studienteilnehmer bewerteten schöne Zähne im Allgemeinen als weniger wichtig im Vergleich zur weiblichen Studienpopulation.

Diskussion

Die ästhetischen Ansprüche sind auch bei zahnmedizinisch unabdingbaren Behandlungen wie Schienung nach Zahntrauma gestiegen. Dem soll durch eine möglichst wenig die Ästhetik kompromittierende Schienung Rechnung getragen werden.

TTS mit einer silbrig-matten Oberfläche erfüllen diesen Anspruch gemäss der vorliegenden Untersuchung am besten.

Résumé

Introduction

La probabilité d'avoir un accident dentaire une fois dans sa vie est élevée. Les dents disloquées ou avulsées à la suite d'un accident peuvent être repositionnées ou réimplantées et stabilisées à l'aide d'attelles de traumatologie dentaire. Afin d'obtenir une guérison parodontale, l'attelle doit être posée de manière passive et permettre une certaine mobilité dentaire. L'attelle de traumatologie en titane (TTS) de Medartis® (Bâle, Suisse) correspond aux caractéristiques requises. Le modèle original est disponible depuis plus de 20 ans avec une finition dorée mate.

Les dents accidentées stabilisées avec la TTS présentent de bons résultats de traitement. Malheureusement, l'attelle est clairement visible et jugée comme gênante sur le plan esthétique par certains patients. Les exigences esthétiques ont augmenté au cours des dernières années. Outre le désir d'un traitement médical optimal, des atteintes minimales à l'esthétique sont souhaitées pendant la durée du traitement. Des études antérieures ont montré que d'autres attelles offraient de meilleurs résultats esthétiques que la TTS. Les auteurs présumant que cela est dû à la couleur dorée de la TTS. Afin d'éviter que les patients souffrent de sentiments tels que la honte ou s'abstiennent de sourire ou de parler, il est important de chercher à obtenir de bons résultats esthétiques dès le traitement du traumatisme. L'objectif de la présente étude était d'évaluer si les patients montrent des préférences esthétiques pour les attelles TTS dans d'autres modèles. Huit variantes différentes de TTS ont été fabriquées. Les patients ont été invités à choisir la variante qu'ils choisiraient s'ils devaient porter une attelle dentaire à la suite d'un accident.

Matériel et méthodes

Les attelles TTS ont été réalisées dans une variante dorée, argentée, verte et violette, chacune avec une finition mate et une finition brillante. Elles ont été adaptées sur des modèles en plâtre et appliquées sur une dentition féminine après le durcissement des surfaces adhésives. Les attelles ont été photographiées professionnellement, représentées à l'identique et imprimées sur des affiches de 59,4 cm × 84,1 cm. Chacun des participants de l'étude a été invité à choisir une couleur préférée, puis une finition préférée. Il a également été demandé aux participants d'indiquer leur âge, leur sexe, leur éventuel daltonisme, l'importance qu'ils accordent aux belles dents, s'ils ont effectué un blanchiment dentaire et s'il privilégie la thérapie esthétique ou la thérapie fonctionnelle. Au total, 397 patients âgés de 18 à 79 ans ont été interrogés. Après exclusion des patients daltoniens et des questionnaires remplis de manière incomplète, les données ont fait l'objet d'une évaluation statistique.

Résultats

Au total, 372 personnes ont été prises en compte dans l'étude, avec un nombre plus élevé de femmes (n = 222, 59,7%) que d'hommes (n = 150, 40,3%). 335 (90,1%) des 372 participants ont choisi l'attelle argentée comme préférence. La variante mate de l'attelle argentée a été choisie par 306 (82,3%) des participants au total. Aucun des facteurs définis (âge, blanchiment dentaire effectué, priorité de l'esthétique ou de la fonction et importance des belles dents) n'a eu d'influence statistique.

quement significative sur le résultat. Pour toutes les variantes, les femmes ont choisi une attelle mate 2,7 fois plus souvent que les hommes. Les participants de l'étude qui ont préféré une variante mate avaient en moyenne 5 ans de moins que ceux qui préféraient une variante brillante. Les participants masculins de l'étude ont accordé d'une manière générale une moins grande importance aux belles dents que les participantes féminines.

Discussion

Les exigences esthétiques ont augmenté également pour les soins dentaires indispensables, tels que la pose d'attelles à la suite d'un traumatisme dentaire. Il convient de tenir compte de cette tendance en réalisant des attelles qui portent le moins d'atteintes possible à l'esthétique. Selon la présente étude, les attelles TTS avec une finition argentée mate répondent le mieux à cette exigence.

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