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A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues – the Implant Crown Aesthetic Index

A pilot study on validation of a new index

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Abstract

Objectives: The important item of aesthetics is rarely included in evaluation studies. The aim of this study was to develop and validate an index for rating aesthetics of implant-supported single crowns and adjacent soft tissues.

Material and methods: Nine items were selected, which have an influence on the aesthetic result. The items are based on the anatomic form, colour and surface characteristics of the crown and on the anatomic form, colour and surface characteristics of the peri-implant soft tissues. Two oral-maxillofacial surgeons and two prosthodontists rated 24 implant-supported single-tooth restorations and adjacent soft tissues on a form with the nine items of the rating index. The rating was carried out twice by each of the examiners. Weighted Cohen's κ was calculated to express the intra- and interobserver agreement.

Results: Intraobserver results indicated that the agreement between the first and second rating of both the prosthodontists was good (both 0.7) and that the agreement of the oral-maxillofacial surgeons was moderate (0.49 and 0.56). The best interobserver agreement was found between the two prosthodontists (0.61, good agreement).

Conclusions: The Implant Crown Aesthetic Index is an objective tool in rating aesthetics of implant-supported single crowns and adjacent soft tissues. The rating is best be carried out by one prosthodontist to have the highest reliability.

Dental implants are generally placed in human beings to support single crowns, fixed partial bridges, fixed full bridges or removable overdentures (Esposito et al. 1998). Reasons for use of these dental implants in prosthetic treatment is an improvement in function and aesthetics of the prosthetic restoration (Belser et al. 1998). Literature studies show excellent survival rates of single-tooth restorations on dental implants, varying from 96.1% to 98.9% after 7.5 years in function (Creugers et al. 2000). Other criteria of function, which are often evaluated, are radiographic bone loss, sulcus probing depth, peri-implant hygiene and prosthetic complications (Henry et al.

1996; Malevez et al. 1996; Scheller et al. 1998; Wannfors & Smedberg 1999; Johnson & Persson 2000). However, the important item of aesthetics is rarely included in evaluation studies. Aesthetics can be rated in a subjective and an objective manner. A subjective method is the use of questionnaires, which must be completed by the patient (Moberg et al. 1999). An objective method with a rating score, which has to be carried out by a professional observer has never been described in the field of dental implants. There is an index for conventional crowns (California Dental Association 1977), but this index is not applicable to implant-supported

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crowns. The index of the California Dental Association includes for example secondary caries. Also the Ryge criteria (Ryge 1980) are used many times in evaluation studies, but mainly in rating aesthetics and marginal integrity of composite restorations. Both indices ignore the adjacent mucosa, which can influence the aesthetic result to a high degree and is often compromised in implant treatment (Chang et al. 1999). Jemt (1999) introduced an index to assess the height of interproximal mucosa adjacent to single-implant restorations, but did not take the entire peri-implant contour and surface structure into account. An objective rating score, with a division in different items, not only gives insight in the aesthetic result of a specific treatment, but also facilitates analysis in order to improve surgical and/or prosthetic treatment. It is also possible to compare the aesthetic result as a function of time in order to analyse the stability of a treatment procedure.

The aim of this study was to develop and validate an index for rating aesthetics of implant-supported single crowns and adjacent soft tissues. The hypothesis is that there is a satisfactory validation of the index.

Material and methods

Out of the literature nine items were selected, which have an influence on the aesthetic result (California Dental Association 1977; Chang et al. 1999; Moberg et al. 1999; Touati et al. 1999). The items are based on the anatomic form, colour and surface characteristics of the crown and on the anatomic form, colour and surface characteristics of the peri-implant soft tissues. The nine selected items were:

- *mesiodistal dimension of the crown*: the mesiodistal dimension must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a five-point rating scale (grossly undercontoured, slightly undercontoured, no deviation, slightly overcontoured, grossly overcontoured);
- *position of the incisal edge of the crown*: the position must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a five-point rating scale (grossly undercontoured, slightly undercontoured, no

deviation, slightly overcontoured, grossly overcontoured);

- *labial convexity of the crown*: convexity of the labial surface of the crown must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a five-point rating scale (grossly undercontoured, slightly undercontoured, no deviation, slightly overcontoured, grossly overcontoured);
- *colour and translucency of the crown*: colour and translucency of the crown must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a three-point rating scale (gross mismatch, slight mismatch, no mismatch);
- *surface of the crown*: labial surface characteristics of the crown such as roughness and ridges must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a three-point rating scale (gross mismatch, slight mismatch, no mismatch);
- *position of the labial margin of the peri-implant mucosa*: the labial margin of the peri-implant mucosa must be at the same level as the contralateral tooth and in harmony with the adjacent teeth, a judgement can be given on a three-point rating scale (deviation of 1.5 mm or more, deviation less than 1.5 mm, no deviation);
- *position of mucosa in the approximal embrasures*: the interdental papillae must be in their natural position, a judgement can be given on a three-point rating scale (deviation of 1.5 mm or more, deviation less than 1.5 mm, no deviation);
- *contour of the labial surface of the mucosa*: the contour of the mucosa at the alveolar bone must be in harmony with the adjacent and contralateral tooth, a judgement can be given on a five-point rating scale (grossly undercontoured, slightly undercontoured, no deviation, slightly overcontoured, grossly overcontoured);
- *colour and surface of the labial mucosa*: colour (redness) and surface characteristics (presence of attached mucosa) must be in harmony with the adjacent and contralateral tooth and must have a natural appearance, a judgement can be given on a three-point

rating scale (gross mismatch, slight mismatch, no mismatch).

It has been decided to use the adjacent and contralateral tooth as a reference and not the generally accepted rules for shape and position of teeth. These rules are derived from young female patients and cannot be applied to all patients, since the proportions between the general shape of the face, size, sex and other teeth have to be maintained (Touati et al. 1999).

Penalty points were given to each of these items if not matching to the desired situation: one penalty point for minor (slight) deviations and five penalty points for major (gross) deviations. The total score leads to a judgement about aesthetics:

- 0 penalty points = excellent;
- 1 or 2 points = satisfactory;
- 3 or 4 points = moderate;
- 5 or more points = poor aesthetics.

It can be noticed that one major deviation automatically leads to a poor aesthetic result and can never be accepted as moderate or satisfactory.

In Fig. 1a–c examples are given of the index for rating aesthetics.

To test the reliability of the newly developed index intra- and interobserver agreement must be calculated (Landis & Koch 1977). Four examiners (two oral-maxillofacial surgeons and two prosthodontists) underwent familiarisation with the index, followed by calibration. After this 24 slides of implant-supported single-tooth restorations in the aesthetic region of the maxilla were selected to participate in the study. Each of the 24 implant-supported single-tooth restorations and the adjacent soft tissues were rated on a form with the nine items of the rating index. The rating was carried out twice by each of the examiners. There was a 2-week time interval period between the ratings to prevent recollection of the first rating. Weighted Cohen's κ has been calculated to express the intra- and interobserver agreement. κ represents the observed proportion of nonchance agreement.

Results

The intraobserver agreement and weighted Cohen's κ are listed in Table 1. It can be noticed that there was a good agreement between the first and second ratings of the

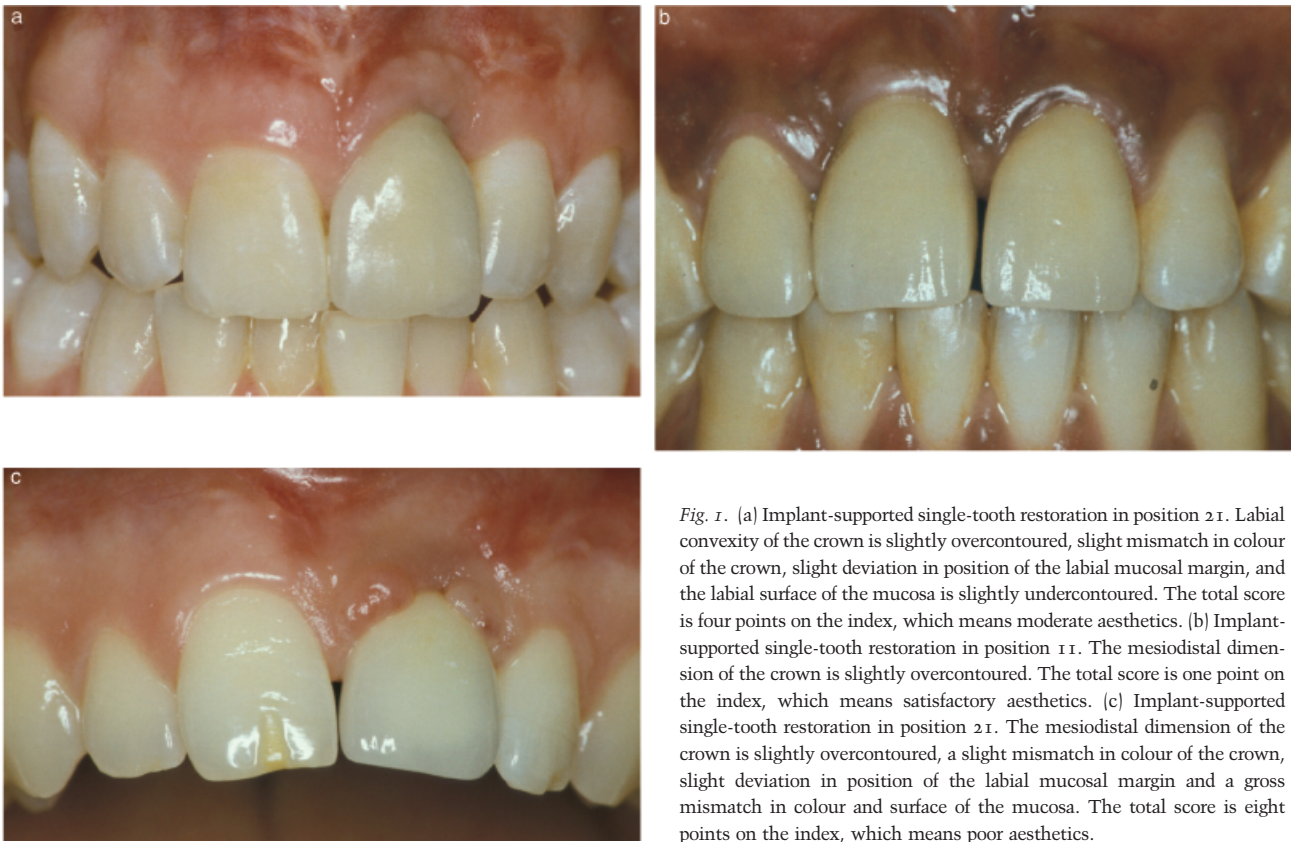


Fig. 1. (a) Implant-supported single-tooth restoration in position 2 I. Labial convexity of the crown is slightly overcontoured, slight mismatch in colour of the crown, slight deviation in position of the labial mucosal margin, and the labial surface of the mucosa is slightly undercontoured. The total score is four points on the index, which means moderate aesthetics. (b) Implant-supported single-tooth restoration in position 1 I. The mesiodistal dimension of the crown is slightly overcontoured. The total score is one point on the index, which means satisfactory aesthetics. (c) Implant-supported single-tooth restoration in position 2 I. The mesiodistal dimension of the crown is slightly overcontoured, a slight mismatch in colour of the crown, slight deviation in position of the labial mucosal margin and a gross mismatch in colour and surface of the mucosa. The total score is eight points on the index, which means poor aesthetics.

Table 1. Intraobserver agreement and weighted Cohen's κ (general over all items)

	Observed agreement (%)	Cohen's κ
Surgeon 1	84.7	0.49
Surgeon 2	67.1	0.56
Prosthodontist 1	86.1	0.7
Prosthodontist 2	86.6	0.7

Strength of agreement: <0.2 = poor, 0.21–0.4 = fair, 0.41–0.6 = moderate, 0.61–0.8 = good, 0.81–1 = very good.

prosthodontists and that the prostodontists were more consistent in their scores. The interobserver agreement and weighted Cohen's κ are listed in Table 2. The best agreement was noticed between the two prosthodontists.

Discussion

The intraobserver results (Table 1) indicate that the agreement between the first and second ratings of both the prosthodontists is good (both 0.7) and that the agreement of the oral-maxillofacial surgeons is moderate (0.49 and 0.56) according to the procedure of Landis & Koch (1977). The intraobserver agreement of the prosthodontists is better

Table 2. Interobserver agreement and weighted Cohen's κ (general over all items)

	Observed agreement (%)	Cohen's κ
Surgeon 1 vs. surgeon 2	74.1	0.41
Surgeon 1 vs. prosthodontist 1	75.9	0.43
Surgeon 1 vs. prosthodontist 2	82.4	0.54
Surgeon 2 vs. prosthodontist 1	70.4	0.48
Surgeon 2 vs. prosthodontist 2	72.7	0.46
Prosthodontist 1 vs. prosthodontist 2	81.5	0.61

Strength of agreement: <0.2 = poor, 0.21–0.4 = fair, 0.41–0.6 = moderate, 0.61–0.8 = good, 0.81–1 = very good.

than the agreement of the oral-maxillofacial surgeons. The making of the implant crown is the last part of the total implant treatment. Prosthodontists are daily involved with prosthetic restorations and evaluation of the total treatment. This experience could be a reason why prosthodontists are more consistent in their scores than oral-maxillofacial surgeons. The best interobserver agreement (Table 2) was found between the two prosthodontists (good agreement). All the other calculated weighted Cohen's κ show a moderate agreement. Again, the experience of the prosthodontists could be an important factor.

The rating has been carried out on slides projected on a screen. In this way the

observation settings are standardised, without interference of the possible opinion of the patient. On the other hand, real colour and surface characteristics are more difficult to examine on slides. Also, a good comparison with the contralateral tooth is not always possible on slides if this tooth is not in the direct vicinity, e.g. with the rating of bicuspid. In this case, the adjacent teeth alone were used for comparison.

It has been chosen to use the adjacent and contralateral tooth as a reference and not the generally accepted rules for shape and position of teeth. One should always take into account the harmony with other teeth, even if gross deviations exist with aesthetic principles.

These initial results with the aesthetic index are very promising, but its practical use as a standard procedure has to be confirmed in a large-scale clinical study. The index could be a very useful tool in scientific research. It makes comparison between various surgical and prosthetic procedures possible. The index could also give a better, objective, insight in one's own aesthetic results in daily practice.

From this study it can be concluded that the Implant Crown Aesthetic Index is an objective tool in rating aesthetics of implant-supported single crowns and adjacent soft tissues. The rating is best carried out by one prosthodontist to have the highest reliability.

Résumé

L'aspect important qu'est l'esthétique est rarement inclus dans les études d'évaluation. Le but de cette étude était de développer et de valider un index pour évaluer l'esthétique d'implants avec une couronne unique et les tissus mous adjacents. Neuf points ayant une influence sur le résultat esthétique ont été sélectionnés. Ces points sont basés sur une forme anatomique, des caractéristiques de surface et de couleur de la couronne et de la forme anatomique, la couleur et les caractéristiques de surface des tissus mous paroiimplantaires. Deux chirurgiens maxillo-faciaux et deux spécialistes en prothèse ont évalué 24 restaurations de dents uniques sur implants et leurs tissus mous adjacents dans un formulaire avec les neuf points de l'indice d'évaluation. L'évaluation a été effectuée deux fois par chacun des examinateurs. Le kappa de Cohen a été calculé pour exprimer l'accord intra- et inter-observateurs. Les résultats intra-observateurs ont indiqué que l'accord entre la première et la deuxième évaluation étaient bonnes pour les spécialistes en prothèse (les deux 0,70) et l'accord pour les chirurgiens était moyen (0,49 et 0,56). Le meilleur accord inter-observateurs était trouvé entre les deux spécialistes de prothèse (0,61, bon accord). L'indice d'esthétique de la couronne sur implant est un outil objectif dans l'évaluation de l'esthétique des couronnes uniques sur implant et les tissus mous adjacents. L'évaluation est mieux effectuée par un spécialiste en prothèse pour obtenir la plus haute précision.

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Zusammenfassung

Ein neuer Index zur Wertung der Aesthetik von implantatgetragenen Einzelkronen und der angrenzenden Weichgewebe – der Implantat Kronen Aesthetik Index

Ziele: Der wichtige Faktor Aesthetik wird kaum in Untersuchungen miteinbezogen. Das Ziel dieser Studie war, einen Index zur Wertung der Aesthetik von implantatgetragenen Einzelkronen und der angrenzenden Weichgewebe zu entwickeln und zu werten.

Material und Methoden: Neun Punkte wurden ausgewählt, welche einen Einfluss auf das Ästhetische Resultat haben. Die Punkte basierten auf der anatomischen Form, Farb- und Oberflächencharakteristiken der Krone und auf der anatomischen Form, Farb- und Formcharakteristiken der peri-implantären Weichgewebe. Zwei Kieferchirurgen und zwei Prothetikspezialisten bewerteten 24 implantatgetragene Einzelkronen und die angrenzenden Weichgewebe auf einem Formular mit 9 Punkten des Wertungsindex. Die Bewertung wurde von jedem Untersucher zweimal durchgeführt. Es wurden gewichtete Cohen's Kappa berechnet, um die Übereinstimmung innerhalb der Untersucher und zwischen den verschiedenen Untersuchern auszu-drücken.

Resultate: Die Resultate innerhalb der Untersucher zeigten, dass die Übereinstimmung zwischen der ersten und der zweiten Bewertung bei beiden Prothetikern gut war (beide 0,7) und dass die Übereinstimmung bei den Kieferchirurgen mässig ausfiel (0,49 und 0,56). Die beste Übereinstimmung wurde zwischen zwei verschiedenen Untersuchern wurde zwischen den beiden Prothetikern gefunden (0,61, gut Übereinstimmung).

Schlussfolgerungen: Der Implantat Kronen Aesthetik Index stellt ein objektives Werkzeug zur Bewertung der Aesthetik von implantatgetragenen Einzelkronen und der angrenzenden Weichgewebe dar. Die Bewertung wird am besten durch einen Prothetikspezialisten durchgeführt, um die höchste Zuverlässigkeit zu erhalten.

Resumen

Objetivos: El punto importante de la estética raramente se incluye en estudios de evaluación. La intención del presente estudio fue desarrollar y validar un índice para valorar la estética de las coronas unitarias implantosoportadas y los tejidos blandos adyacentes.

Material y métodos: Se seleccionaron nueve puntos, que tienen influencia en el resultado estético. Los puntos se basan en la forma anatómica, color y características de la superficie de la corona y en la forma anatómica, color y características de la superficie de los tejidos blandos periimplantarios. Dos cirujanos maxilofaciales y dos prostodoncistas valoraron 24 restauraciones unitarias implantosoportadas y los tejidos blandos adyacentes en un formulario con nueve puntos del índice de valoración. La valoración se llevó a cabo dos veces por cada examinador. Se calculó el weighted kappa de Cohen para expresar la concordancia intra- e interobservador.

Resultados: Los resultados intraobservador indicaron que el acuerdo entre la primera y la segunda valoración de ambos prostodoncistas fue buena (ambos 0,70) y que el acuerdo de los cirujanos maxilofaciales fue moderada (0,49 y 0,56). El mejor acuerdo interobservador se encontró entre los dos prostodoncistas (0,61, buen acuerdo).

Conclusiones: El Índice de Estética de Coronas de Implantes es una herramienta objetiva en la valoración de la estética de las coronas unitarias implantosoportadas y los tejidos blandos adyacentes. La valoración se llevó mejor a cabo por un prostodoncista que tuvo la mayor fiabilidad.

要旨

目的: 審美性の重要な項目が評価研究に含まれることはまれである。本研究の目的は、インプラント支持の単独クラウン及び隣接する軟組織の審美性を評価するためのインデックスを開発し検証することであった。

材料と方法: 審美的な結果に影響をもたらす9項目を選択した。これらの項目は、クラウンとインプラント周囲軟組織の解剖学的形態、色、表面特性に基づいていた。口腔顎顔面外科医2名と補綴歯科専門医2名が24本のインプラント支持単独クラウンと隣接する軟組織について、9項目の評価インデックスによって採点した。各審査者が2回採点を行った。審査者個人内と個人間の一致度を示すためにWeighted Cohen's kappaを計算した。

結果: 審査者内の結果では、2人の補綴歯科専門医の1回目と2回目の採点の一致度は良く(両方とも0.70)、口腔顎顔面外科医の一致度は中程度(0.49と0.56)であった。審査者間の一致度については、2人の補綴歯科専門医の間が最良であった(0.61、良い一致度)。

結論: インプラント・クラウンの審美性インデックス(Implant Crown Aesthetic Index)は、インプラント支持の単独クラウン及び隣接する軟組織の審美性を評価するための客観的な手段である。最高の信頼性を得るには1人の補綴専門医が採点を行うのが最良である。

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