**SAC Assessment Tool in Implant Dentistry: Evaluation of the Agreement Level Between Users**

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**Purpose:** The SAC Assessment Tool is a clinical decision support system based on the foundations of the SAC Classification System in Implant Dentistry developed by the International Team for Implantology in 2009. It objectively classifies a patient’s rehabilitation with dental implants as straightforward, advanced, or complex, from both a surgical and restorative perspective. The aim of this research was to test the agreement between observers with different qualification levels and clinical experience when using this clinical decision support system as a method that mitigates risk. **Materials and Methods:** A total of 30 patients were randomly selected from clinical records, and diagnostic casts, intraoral and extraoral images, and panoramic radiographs were obtained. All data were analyzed with and without the SAC Assessment Tool by a dentist with advanced training and clinical experience in implant dentistry (control dentist) and compared with three colleagues (dentists 1, 2, and 3) with fewer qualifications and less clinical experience. All data were analyzed using statistical agreement tests (Fless kappa), interclass correlation, and agreement rate. The level of significance (α) was set at .05. **Results:** All patients included in this research presented 104 edentulous areas, which were subjected to surgical evaluation for possible placement of dental implants. Concerning the degree of risk evaluation for dental implant treatment, the results of this study found that the agreement rate of the control dentist without SAC and control dentist with SAC was excellent (81.7%); the agreement rate of the control dentist and dentists 1, 2, and 3 with the use of SAC was satisfactory (67.3% to 76.0%); the variable that presented a lower agreement rate (34.6%) was the comparison between dentists 1, 2, and 3 without use of the SAC Assessment Tool. **Conclusion:** The SAC classification seems to be a useful tool to assist dentists with less experience in implant dentistry with defining the complexity of the treatment and hence with patient selection. It helps in the collection and homogenization of important clinical data to assess the risk of implant-based rehabilitations, thus contributing to an increase in the agreement rate. Int J Oral Maxillofac Implants 2020;35:990–994. doi: 10.11607/jomi.8023

**Keywords:** clinical decision support system, dental education, dental graduate, dental implants, educational

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In 2007, a consensus of experts identified by the International Team for Implantology (ITI) developed a patient classification system named in 2009 as the "SAC Classification in Implant Dentistry." The intent of this system is to objectively classify the patient's treatment as straightforward, advanced, or complex, from both a surgical and restorative perspective, based on individual conditions, and to use this to identify the risk to the outcome.

As with all the classification instruments, this tool aimed to standardize the diagnosis of different clinical situations. However, it should be noted that the clinical knowledge and experience of the dentist may always induce some subjectivity to the diagnosis and treatment planning, particularly when evaluating a clinical parameter, where, for example, an experienced clinician may consider it a complex situation while a novice clinician may consider it straightforward due to their lack of experience in that specific situation.

The SAC Classification System is constituted by several factors inserted into two groups: generic determinants and modifying factors. Generic determinants (esthetic zone vs nonesthetic zone, treatment complexity, and complication risks) direct to the final classification type functioning as a standard value for each case, whereas the modifying factors (genericities, esthetics, surgical, and restorative) have the characteristic of being able to change the final classification, scoring the difficulty of the treatment.

Following this system, the SAC Assessment Tool emerged as a clinical decision support system (CDSS), with an inference engine based on guidelines defined by the SAC Classification, that produces a report of the patient's features and establishes the degree of complexity of the treatment regarding a possible surgical and/or restorative intervention considering dental implants.

This final report of the case clearly identifies each clinical factor/parameter that was evaluated, with its specific degree of risk (S, A, or C), and the global classification of the case (S, A, or C). For visualization purposes, a straightforward result is usually colored in green, advanced in yellow, and complex in red, just like a traffic light. The format of this report allows it to be included in a patient's e-health record and facilitate communication/discussion of the case report with peers, if needed.

However, it should be noted that the SAC Assessment Tool, although it is a tool based on guidelines created by an expert's opinions and consensus, also has an associated error rate, if the assumptions that the authors describe are not fulfilled or correctly identified. It should work as a complement to a rigorous and detailed diagnosis and treatment plan.

The aim of this research was to test the agreement between observers when using the clinical decision support system SAC Assessment Tool as a method to mitigate risk.

**MATERIALS AND METHODS**

This research was performed within a convenience sample of patients of a University Dental Clinic. The inclusion criteria of the sample were as follows: (1) adult patients (age > 18 years), (2) patients with a first appointment in the prosthodontics clinic without any oral rehabilitation, and (3) partially edentulous patients with at least one edentulous area for evaluation. All the patients who were totally edentulous or did not correspond to the assumptions (patients-specific) described for the use of the SAC Classification System were excluded. To achieve the aim of this research, the minimum sample size was defined with n = 30.

For each patient, the following data were collected: anamnesis/clinical history, diagnostic casts, intraoral images, and panoramic radiography.

Data were collected under the supervision of a prosthodontics clinical professor to confirm the integrity. All the respondents agreed and authorized this study and signed an informed consent form. This protocol was approved by the Institutional Review Board and followed the Declaration of Helsinki. All the edentulous areas with a clinical indication to be rehabilitated with an implant-supported dental prosthesis were analyzed, without and with the SAC Assessment Tool/Assessment of Surgical Cases. In several cases, the same patient could have more than one edentulous area, and in these situations, each area was considered as an independent case. Even though the medical history of the patient is equal, there are several generic determinants and modifying factors that are unique in each edentulous space and may lead to a different degree of surgical risk according to the SAC Classification System of straightforward (S), advanced (A), or complex (C).

Thus, these edentulous areas were first analyzed by a dentist with recognized clinical experience in oral rehabilitation with dental implants by their national and international peers (eg, advanced training in oral surgery, more than 30 years of experience in implant dentistry, national and international speaker, invited professor in national and foreign universities, and with publications related to implant dentistry), whose data were considered as the control (control dentist) for comparative analysis purposes. Then, the same data were analyzed by a group of three dentists (dentists 1, 2, and 3), all with a similar qualification level and years of experience in implant dentistry (short-term postgraduate education in implant dentistry [less than 12 months, part-time] and 5 years of clinical experience in implant dentistry). In this way, this study was trying to manage...
a group of dentists with approximately the same experience and clinical skills concerning the knowledge and practice of implant dentistry. The definition of this protocol was based on the fact that only dentists with some education in implant dentistry may be able to understand the clinical factors/determinants and the associated risk factors, in contrast with a dentist who recently graduated.

The time period established, between both examinations (with/without the use of the CDSS), was 4 weeks, to allow a more independent observation of the cases. This analysis was performed in two steps. First, the edentulous areas were analyzed without the use of the SAC Assessment Tool (–SAC), and the degree of risk for a hypothetic surgical intervention was directly classified as straightforward, advanced, or complex (first set of variables), based on the knowledge of the evaluator. Second, the models were analyzed with the support of the SAC Assessment Tool (+SAC), and the risk degree identified by the CDSS was also registered as straightforward, advanced, or complex (second set of variables).

This particular order of analysis (–SAC, followed by +SAC) was established in order not to influence the observers with the parameters/criteria used in the SAC assessment tool.

Data were analyzed using the computer software R Project (R Project for Statistical Computing). The results of this study were also analyzed using descriptive statistics. To determine interobserver and intraobserver agreement, this study used the concordance ratio (agreement), interclass correlation (ICC: the closer this ratio is to 1.0, the higher the reliability), and Fleiss kappa (the closer it is to 1.0, the higher the agreement). The level of significance (α) was set at .05.

The agreement was measured by (1) comparing the results of the control dentist with and without SAC; (2) dentist 1 vs dentist 2 vs dentist 3 with and without SAC; (3) dentists 1, 2, and 3 with and without SAC, respectively; (4) control dentist without SAC vs dentists 1, 2, and 3 with and without SAC, respectively; and (5) control dentist with SAC vs dentists 1, 2, and 3 with SAC, respectively.

### RESULTS

The 30 patients who were included in this research presented 104 edentulous areas, which were subjected to surgical evaluation for possible placement of dental implants, without and with the use of the SAC Assessment Tool. The statistical analysis of the agreement between different evaluators is described in detail in Table 1. The following results should be highlighted, according to the statistical analysis performed: Agreement results varied from 81.7% (control dentist, with SAC vs without SAC), to 67.3% (control dentist vs dentist 1, 2, and 3 with and without SAC, respectively; (4) control dentist without SAC vs dentists 1, 2, and 3 with and without SAC, respectively; and (5) control dentist with SAC vs dentists 1, 2, and 3 with SAC, respectively.

<table>
<thead>
<tr>
<th>Agreement</th>
<th>ICC</th>
<th>Value K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CD(–SAC) vs CD(+SAC)</td>
<td>81.7%</td>
<td>0.841 [0.774; 0.89]</td>
</tr>
<tr>
<td>2. D1(–SAC) vs D2(–SAC) vs D3(–SAC)</td>
<td>34.6%</td>
<td>0.558 [0.44; 0.62]</td>
</tr>
<tr>
<td>3. D1(–SAC) vs D1(+SAC)</td>
<td>71.2%</td>
<td>0.737 [0.635; 0.814]</td>
</tr>
<tr>
<td>4. D2(–SAC) vs D2(+SAC)</td>
<td>58.7%</td>
<td>0.599 [0.46; 0.709]</td>
</tr>
<tr>
<td>5. D3(–SAC) vs D3(+SAC)</td>
<td>70.2%</td>
<td>0.723 [0.616; 0.803]</td>
</tr>
<tr>
<td>6. D1(+SAC) vs D2(+SAC) vs D3(+SAC)</td>
<td>57.7%</td>
<td>0.646 [0.546; 0.733]</td>
</tr>
<tr>
<td>7. CD(–SAC) vs D1(–SAC)</td>
<td>60.6%</td>
<td>0.625 [0.464; 0.741]</td>
</tr>
<tr>
<td>8. CD(–SAC) vs D2(–SAC)</td>
<td>51.9%</td>
<td>0.538 [0.387; 0.661]</td>
</tr>
<tr>
<td>9. CD(–SAC) vs D3(–SAC)</td>
<td>54.8%</td>
<td>0.599 [0.46; 0.709]</td>
</tr>
<tr>
<td>10. CD(–SAC) vs D1(+SAC)</td>
<td>54.8%</td>
<td>0.56 [0.41; 0.679]</td>
</tr>
<tr>
<td>11. CD(–SAC) vs D2(+SAC)</td>
<td>59.6%</td>
<td>0.65 [0.524; 0.749]</td>
</tr>
<tr>
<td>12. CD(–SAC) vs D3(+SAC)</td>
<td>58.7%</td>
<td>0.59 [0.449; 0.703]</td>
</tr>
<tr>
<td>13. CD(+SAC) vs D1(+SAC)</td>
<td>67.3%</td>
<td>0.708 [0.545; 0.81]</td>
</tr>
<tr>
<td>14. CD(+SAC) vs D2(+SAC)</td>
<td>76.0%</td>
<td>0.785 [0.669; 0.849]</td>
</tr>
<tr>
<td>15. CD(+SAC) vs D3(+SAC)</td>
<td>69.2%</td>
<td>0.669 [0.547; 0.763]</td>
</tr>
</tbody>
</table>

CD = control dentist; D1 = dentist 1; D2 = dentist 2; D3 = dentist 3; +SAC = using SAC Assessment Tool; –SAC = without using SAC Assessment Tool.
The success rate and clinical survival of prosthetic reha-
bulisations with dental implants for fully or partially edentulous areas are high.7–10 However, it is necessary to be aware of the risks and complications inherent in this type of treatment in order to avoid failures associated with diagnostic errors and to design the best treatment plan for the patient.3,10

The SAC Classification System acts as a tool to support the clinical decision by systematizing the risk factors of a rehabilitation with dental implants.3 These are the fundamentals of any CDSS, as can be found in the literature.11–14 To the authors’ knowledge, there are no publications in the literature regarding the agreement between observers when using the SAC Assessment Tool, particularly the Assessment of Surgical Cases. Due to methodologic purposes and time/availability constraints, it was not possible to do a clinical in loco assessment by each of the evaluators, which may be considered to be a limitation of this research. However, trying to obviate this issue, the protocol was defined as described in the Materials and Methods section. The most relevant patient data were collected in the form of anamnesis, diagnostic casts, clinical photography, and panoramic radiographs. In this way, it was easier for each of the evaluators to do the purposed assessment. It has to be pointed out that the SAC system utilized in this research was developed in 2007/2008, and published in 2009, so many of the most modern techniques available today, such as CBCT, different implant designs, and digital planning/guided surgery were not part of the tool. These modern options should be incorporated in an SAC tool update to be published by the ITI.

The design of this study did not include a calibration session. Given the reduced number of patients and experts, a calibration session was logistically impractical. It is also important to highlight that the focus of this research was to test the competence of the observers to analyze clinical cases and to compare it with the use of a CDSS. As stated in the introduction section, this type of clinical diagnosis includes several parameters/variables, and it is not expected to achieve the exact same diagnosis (eg, as in tooth decay), but rather a similar result, particularly when using a CDSS. Also, the same patient could have more than one edentulous area, and the general and some local conditions could be related. This could be understood as a possible bias due to a possible dependency between evaluations in the same patient. All of these issues will be considered in a prospective validation of the tool with a larger sample of patients.

Also, it would be relevant to have the CBCT scans of all the patients. However, these were patients who went to the University Clinic for a first appointment, and due to ethical reasons, a CBCT scan could not be required only for this research purpose. An alternative would be to perform this analysis with the SAC Assessment Tool only in patients who had already accepted a treatment plan with dental implants. However, this would substantially reduce the sample size.

With this methodology, it was possible to obtain results that were later processed through statistical concordance tests.

It is also necessary to consider that for a diagnosis (straightforward, advanced, or complex), the clinical experience of the evaluators is of great importance. If there is a risk associated with the patient, or a risk associated with clinician experience/skills, it must be considered. As Maruthappu et al15 states, in a systematic review from 2015, there is an association between an improved performance and an increased surgical treatment volume and years of practice. This is a preponderant factor in the evaluation.

When comparing the results of the control dentist without the SAC Assessment Tool vs the control dentist with the SAC Assessment Tool, to verify if there was divergence among evaluations of the authors’ reference, the agreement rate was very high (81.70%), which indicates that the computer tool did not significantly change the answers of an expert. Due to the recognized expertise of this clinician, these results seem to be fully understandable, since this clinician undoubtedly has more knowledge to diagnose this type of clinical situation.

On the other hand, when the results of the other three dentists without use of the SAC Assessment Tool were compared, the agreement rate was poor (34.60%), which means that there was not a considerable agreement between different dentists. Although the present

### DISCUSSION

**Table 2 Summary of Results of Agreement Tests Between Control Dentist and Dentists 1, 2, and 3**

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Without SAC</th>
<th>CD without SAC</th>
<th>CD with SAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD vs D1</td>
<td>60.6%</td>
<td>54.8%</td>
<td>67.3%</td>
</tr>
<tr>
<td>CD vs D2</td>
<td>51.9%</td>
<td>59.6%</td>
<td>76.0%</td>
</tr>
<tr>
<td>CD vs D3</td>
<td>54.8%</td>
<td>58.7%</td>
<td>69.2%</td>
</tr>
</tbody>
</table>

CD = control dentist; D1 = dentist 1; D2 = dentist 2; D3 = dentist 3.
study tried to manage a group of dentists with approximately the same experience, this poor agreement rate between them may be justified by variable clinical knowledge, together with the number and complexity of all the variables presented in these treatments, which may affect this clinical decision-making process.

According to several authors, it is important to implement advanced training in implant dentistry in predoctoral students. Currently, oral rehabilitation using implants is an irreversible reality, functioning as one of the most durable treatments. However, for good clinical practice to complement the success rate, it is necessary to invest in the training of future clinicians, including dental or postdoctoral students.

Mattheos et al reported that it is necessary to make a movement to introduce some uniformity among oral implantology programs. As an example, the EAO Certification/Diploma in Implant Dentistry and the ITI Curriculum are educational programs that may lead to a more standardized education in implant dentistry, with better quality, which is very important for increasing the clinical success rates, and significantly promote the scientific domain of implant dentistry.

When the same evaluators were compared, but using the SAC Assessment Tool, there was an increase in the agreement data (57.70%), which highlights the importance of this computer tool in the homogenization of results, due to the perfectly identified generic determinants and modifying factors.

The results of this study indicate that there was an increase in the agreement rate when the evaluators used the SAC compared with the expert using the SAC.

The integration of the SAC Assessment Tool into an advanced training course in oral rehabilitation would be an asset, allowing students to progress clinically and scientifically.

CONCLUSIONS

The SAC Classification System increased the agreement rate between evaluators with fewer qualifications and less clinical experience in implant dentistry. This tool seems to be a valid and efficient way to educate dentists with less experience in implant dentistry and ultimately improve patient care.

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