Research Article

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Development of the implant surgical technique and assessment rating system

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Purpose: There has been no attempt to establish an objective implant surgical evaluation protocol to assess residents' surgical competence and improve their surgical outcomes. The present study presents a newly developed assessment and rating system and simulation model that can assist the teaching staffs to evaluate the surgical events and surgical skills of residents objectively.

Methods: Articles published in peer-reviewed English journals were selected using several scientific databases and subsequently reviewed regarding surgical competence and assessment tools. Particularly, medical journals reporting rating and evaluation protocols for various types of medical surgeries were thoroughly analyzed. Based on these studies, an implant surgical technique assessment and rating system (iSTAR) has been developed. Also, a specialized dental typodont was developed for the valid and reliable assessment of surgery.

Results: The iSTAR consists of two parts including surgical information and task-specific checklists. Specialized simulation model was subsequently produced and can be used in combination with iSTAR.

Conclusions: The assessment and rating system provided may serve as a reference guide for teaching staffs to evaluate the residents' implant surgical techniques.

Keywords: Dental implantation, Educational assessment, Oral surgical procedures.

INTRODUCTION

Current surgical training in dentistry is based on the Halstedian apprenticeship model that was introduced over 100 years ago [1]. In this model, the assessment of technical proficiency is solely the responsibility of the surgical preceptor. However, this type of assessment can be largely subjective [2], and unreliable as the assessment is global, and not based on specific criteria. Also, it would possess poor test-retest reliability and could be affected by poor inter-observer reliability since even experienced senior surgeons have a high degree of disagreement while rating the skills of a trainee [3]. More importantly, objective assessment of surgical competence is crucial because deficiencies in training and performance are difficult to correct without factual data [2,4,5], and surgeons should be technically competent before entering operating room. Currently, training and certifying bodies are under pressure to develop new ways to assess and rate the implant surgical competence of residents.

Current methods of assessment in surgical field include written examinations, operative log books, time taken for a procedure, direct observation and assessment by trainers [2]. Recently, various types of assessment tools were developed and introduced by many researchers in medical fields. Although these newly developed methods still rely on the judgments of examiners, the inclusion of set criteria for assessing

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skill can remove much of the subjectivity from the evaluation process. For instance, global rating scales are utilized in the Objective Structured Assessment of Technical Skills, which is consisted of six stations where residents and trainees perform procedures on live animal or bench models in fixed time periods [6]. Hereafter, various modifications and improvements were presented in the medical fields. The McGill Inanimate System for Training and Evaluation of Laparoscopic Skills was developed to assess laparoscopic skills and to score them objectively [7], while the Objective Assessmenet of Skills in Intraocular Surgery was established to assess the ophthalmic surgery [8]. Contrarily, dexterity analysis systems such as the Advanced Dundee Endoscopic Psychomotor Trainer were developed, which was originally designed as a tool for the selection of trainees for endoscopic surgery, based on the ability of psychomotor tests to predict innate ability to perform relevant task [9]. Virtual reality simulator has also been introduced to evaluate the laparoscopic trainees, and the Minimally Invasive Surgical Trainer-Virtual Reality is one of the first virtual reality laparoscopic simulators [10].

While there are competitive attempts to develop the assessment tool in medical fields, there is no or little attempt to establish an objective assessment tool for dental implant surgery. Furthermore, pressures both from inside and outside the profession have recently resulted in the need for dental surgeons to show that they can operate well. The assessment of implant surgical technique has been a neglected field until recently, and very few training programs have objective evaluation methods of surgical skills for implants as part of their training program for residents. Therefore, the aim of this study is to develop and establish an objective assessment tool for teaching and evaluating the surgical competence for dental implant placement by residents.

MATERIALS AND METHODS

Development of implant surgical technique assessment and rating system (iSTAR)

The MEDLINE, and PubMed databases were searched to identify existing methods for evaluating implant surgery. Particularly, medical journals reporting rating and assessment tools for various types of surgeries were thoroughly analyzed. Terms such as *implant surgical skills evaluation, implant surgery assessment,* or *implant surgery education* were used, and the results showed that no articles discussing the evaluation of residents' surgical competence for implant placement have been published. Given the lack of guidance on evaluating surgical competence in the field of dental implant, we developed a new evaluation tool to measure, objectively, residents' surgical performance in implant surgery, which is entitled the iSTAR.

The assessment tool for dental implant surgery was developed including surgical information and task-specific checklists. According to the previous studies, global rating scales are known to have superior ability to discriminate among resident levels when compared to checklists [6,11]. However, checklists are valuable to include because they can provide the residents with a list of specific items upon which to improve and, therefore, the task-specific checklist was utilized in the iSTAR.

The development of specialized simulation typodont

As part of this study, the specialized dental typodont was developed since real-life operative situations cannot be standardized, given the variability and unpredictability of live surgery. Bench model simulations have been demonstrated to be reliable as using live anesthetized animals in other medical fields [12]. The use of prosthetic models reduces the number of animals used in training and is less likely to pose any biological hazard. Furthermore, it requires less maintenance over long shelf life. Therefore, the authors have developed a two layered silicone-covered resin dental models (JCP-All in, M. Tech Korea, Guri, Korea; International and domestic patent pending) (Fig. 1).

The newly developed typodont presents several missing

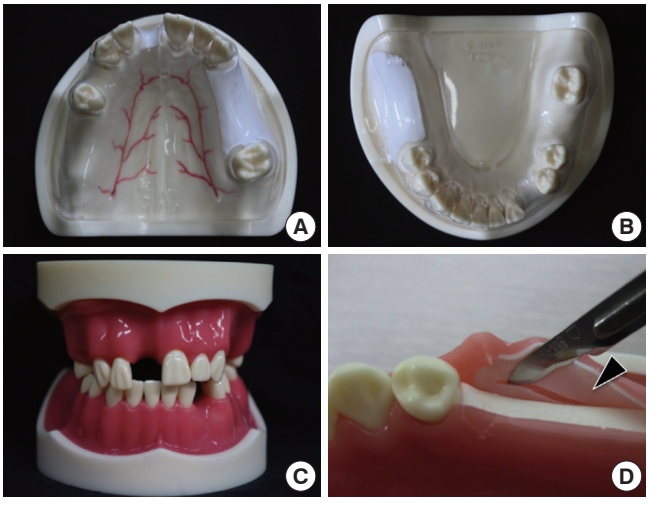

Figure 1. Newly developed specialized simulation typodont for the evaluation of implant surgical performance (JCP All-in, M. Tech Korea, Guri, Korea; International and domestic patents pending). (A, B) Missing teeth, greater palatine arteries and underlying periosteum are shown in the maxilla and mandible models through transparent gingiva for the demonstration. (C) Frontal view with the definitive human-like gingiva is covered. (D) Periosteum-like silicon is additionally applied under the gingiva to evaluate the periosteal releasing incision and guided bone regeneration performance. Arrowhead shows the periosteal releasing incision made on the specialized periosteum under the gingiva.

teeth areas with reduced alveolar bone volume, which ultimately requires guided bone regeneration during the implant placement. The soft tissue is represented by silicone, and a few areas are covered with two-layered silicone to present the gingiva and underlying periosteum. Since these soft tissues have different properties of extendibility, the trainees can practice placing periodontal releasing incision on the periosteum and achieve tension free primary closure. Also, the typodont has different alveolar bone density from D1 to D4 [13] to mimic the actual human alveolar bone. The palatal gingiva has the human-like thickness, and the running of the greater palatine artery is presented on the palatal bone for the practice of soft tissue graft.

The assessment protocol

The implant placement procedure is performed on the model above mentioned. The resident is given instructions detailing what they are being asked to do. All necessary instruments will be laid out at the station for the resident. The resident is videotaped and the recordings are later watched by expert surgeons who complete the iSTAR. Each checklist identifies the step necessary to complete the task properly using a 5-point Likert scale.

RESULTS

In the present study, the composite iSTAR evaluation form was developed consisting of 2 parts: surgical information and task-specific checklists (Table 1, Fig. 2). The task-specific checklist assesses operative skills providing a 'structured gestalt' of implant surgical performance.

In the late 1960s, Brånemark et al. [14] introduced the concept of osseointegration whereby predictable long-term implant function could be achieved following a strict and simple protocol. This documented the installation of titanium implants involving a submerged healing phase of between 3 to 6 months depending on bone quality, followed by a delayed phase of prosthetic loading on cross-arch fixed prostheses in the edentulous jaws. However, various types of dental implants have been introduced and numerous techniques for bone augmentation and soft tissue management have been documented over the 50 years.

Task specific check list was prepared based on the standard protocol of the Brånemark Implant System [15,16], and modified principles regarding the treatment of partially edentulous jaws were included [17]. First, flap design of crestal incision is evaluated, and the decision about the inclusion of crevicular area of neighboring teeth should be made based on the space available for the implants. However, considering the fact the residents are novice in the surgical procedures, it seems necessary to properly elevate the flap so that enough view of the surgical field is acquired to avoid missing the anatomical deformities and facilitate the irrigation of the bone during drilling.

Second, bone drilling should be graded keeping in mind that excessive heating must be avoided at all times and accidental trauma from drilling must be prevented. Also, drilling must be performed with the highest precision in order to avoid unstable implant placement or over-tensioned fixation [18].

Third, implant positioning should be decided under anatomic and clinical situation, and the implant should be preferably placed in the natural tooth position both in a mesiodistal and in a buccolingual dimension. The distance between two implants should not be less than about 7 mm, measured from center to center, and the drilling point should be 3.5 to 4 mm away from the prominence of the neighboring tooth, and the following implant positions are then marked in a distal direction until reaching the area of minimum bone volume for implants [19]. Implant direction is to place the implants within the natural tooth position with normal axis be directed through the crown or the occlusal surface of the bridge to be. Regarding the buccolingual dimension, the long axis of mandibular implants will mainly be directed towards the limbus part of the incisors or the palatal cusps of the teeth in the maxilla. For implants placed in the maxilla, the corresponding inclination should be towards the incisive edges of the frontal teeth or the buccal cusps of the premo-

Table 1. Part I of implant surgical technique assessment and rating system; surgical information.

Resident's name	
Operation date	
Tooth number	
Implant corporation/system	
Date after extraction	_____year ____month
Reason for extraction	Due to periodontal reason
	Due to endodontic reason
	Due to fracture
	Other:
Seibert classfication	I
	II
	III
Keratinized gingiva	>4 mm
	2-4 mm
	<2 mm
Duration for treatment	_____hour ____minute
Patient's response	Comfortable and no pain
	Uncomfortable
	Painful

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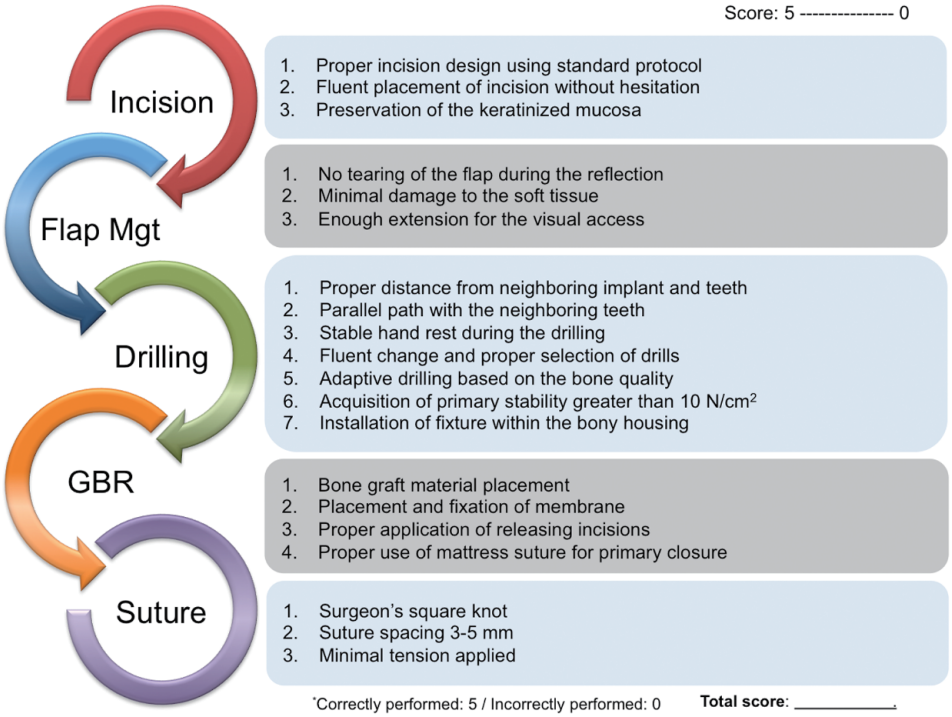

Figure 2. Part II of implant surgical technique assessment and rating system; task-specific checklist. Mgt: management, GBR: guided bone regeneration.

lars or molars of the mandible.

Fourth, the implant fixture should be long and wide enough as possible without damaging neighboring teeth or anatomically important structures. Primary stability should be obtained and the rotation of the fixture should not be present. Hereafter, healing abutment or cover screw should be chosen based on the surgical procedures.

DISCUSSION

The main purpose of this study is to introduce to the field of dental education a method of assessment and rating for the dental implant surgery that has been proven in other medical fields to be reliable and valid. Such a standardized assessment tool is needed to ensure residents' basic competency before entering the operating room. Despite the obvious importance of ensuring the surgical competence of residents, the traditional method for assessment was inadequate and largely subjective, and the absence of objective and straightforward assessment system in dental education has inspired the development of iSTAR proposed in the present study. The goal of this article was to address the necessity of the objective assessment tool for the implant surgical skills of the residents, and to discuss the important factors that should be included in the assessment tool, not to deliver the fully validated format. Therefore, the iSTAR proposed in this preliminary study should be refined by educators in the current surgical field.

First, we understand that no guideline designed to aid can be perfect. It is the responsibility of the teaching staffs' role to implement and upgrade this assessment tool. Our hope is that the concept will be embraced as valid and ultimately adopted by residency programs as a useful measure of the surgical skills of periodontal residents. This tool will be useful not only for ensuring the basic surgical competence of residents as they progress through their training, but also for evaluating the effectiveness of teaching methods, which will ultimately enhance the quality of the treatment provided to the general patients.

Good assessment should be reliable, valid, educational, acceptable and feasible in terms of cost effectiveness and delivery [20]. The iSTAR consists of two pages of checklist and it takes minimal time to input the data. Also, it is simple to gather the meaningful information from the evaluation sheet. Therefore, it seems that iSTAR is feasible and easy to use in the operating room or during watching videotaped operation. However, this assessment tool needs to be assessed for the face and content validity, inter-rater reliability, and eventually, predictive validity. By these efforts, the specific assessment form will be further refined, and will be applied in a variety of ways in the training of residents.

In summary, our goal was to develop an objective and standardized assessment tool of implant surgical skills for the

residents. Future studies will assess the face validity and content validity of this test as well as the inter-rater reliability of this format and improve the simulation typodont. Through these studies, the specific validity of the iSTAR will be further refined and ultimately benefit the residents' education. We hope the development of this objective surgical evaluation tool will lead to a nationally standardized assessment tool to facilitate future prospective multicenter studies on resident education.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported. The international and domestic patents for the dental typodonts are currently applied for.

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