

A radiographic study on the prevalence of knife-edge residual alveolar ridge at proposed dental implant sites

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كثيرا ما تستخدم الغرسات السنية لتعويض الاسنان المفقودة كلياً او جزئياً عند كثير من المرضى. قبل البدء في وضع الغرسات السنية يجب دراسة كمية و نوعية العظم المتبقى بواسطة الاشعة. بعد قلع الاسنان امتصاص قمة العظم السنخي مما يؤدي الى تقليل طول العظم المتبقى. اذا كان تاكل العظم من الجهة الامامية و الخلفيه اكثر من قمة العظم يتكون عظم سنخي على شكل حافة السكين. يهدف هذا البحث الى دراسة العظم السنخي المتبقى قبل استخدام الغرسات السنية. تم فحص ٢٤٨ صورة شعاعيه مقطعيه لثلاثون مريضاً و مريضه. ولقد وجد ان ١٢٠ موضع كان على شكل حافة السكين معظمها في عظام فك المرضى الذين فقدوا اسنانهم كلياً منذ فترة تزيد عن عشرة سنوات. لذا ينصح باستخدام الغرسات السنية مباشرة او بعد فترة زمنية قصيرة بعد خلع الاسنان للمحافظة على شكل و حجم العظم السنخي المتبقى.

Dental implants are widely used in restoration of completely or partially edentulous dental arches. Before placement of endosseous implants in the jaws, both the quantity and quality of the residual ridge must be assessed radiographically. Remodeling activity after tooth extraction is localized primarily at the crestal area of the residual ridges, resulting in reduction of the height of bone and creation of various three-dimensional shapes of the residual ridges. When bone resorption at the lingual and buccal aspects is greater than that at the crestal area, a knife-edge type of residual ridge develops.

OBJECTIVE: The aim of this study was to evaluate the prevalence of the knife-edge morphology of the residual alveolar bone at proposed implant sites in partially or completely edentulous patients. **MATERIAL AND METHODS:** Computed tomography (CT) cross-sectional images of the upper and lower jaws were assessed at the proposed sites before implant placement. Images of 258 proposed implant sites belonging to 30 patients were assessed radiographically. **RESULTS:** In 120 proposed implant sites out of 258 (46.5%), the residual alveolar ridge had a knife-edge configuration, the majority belonging to completely edentulous patients who lost their teeth more than ten years previously. **CONCLUSION:** High prevalence of knife-edge ridge was found, therefore, replacement of missing teeth by immediate implant is recommended to prevent atrophy or knife-edge morphology of the residual ridge.

INTRODUCTION

Dental implants are widely used in restoration of completely or partially edentulous dental arches.¹⁻³ Before considering placement of an endosseous implant in the jaw, both the quantity and quality of the bone must be assessed radiographically.⁴ A variety of imaging techniques are currently available for implant site assessment, each technique has its strengths, weaknesses and specific indications.⁵

Following the extraction of teeth, the bony socket and adjacent soft tissue undergo a series of tissue repair processes. Histologic evidence of active bone formation at the bottom of the socket and bone resorption at the edge of the socket are seen as early as two weeks

after tooth extraction, and the socket is progressively filled with newly formed bone until about six months.⁶ Rapid bone remodeling subsides by this time but continuous bone resorption may persist at the external surface of the crestal area of the residual alveolar bone, resulting in considerable morphologic changes of the bone and overlying soft tissues over the years.⁷

The bone remodeling activity after tooth extraction is localized primarily at the crestal area of the residual ridges, resulting not only in reduced height of the ridge but also in the creation of various three-dimensional shapes of the residual ridge. If the bone resorption is greater at the crestal area than at the lingual or buccal areas, the residual ridges tend to be flat. In contrast, greater bone resorption at the lingual and buccal areas compared with resorption at the crestal area may result in the so-called knife-edge type of residual ridges.⁸

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The aim of this study was to evaluate the prevalence of knife-edge morphology of the residual alveolar ridge at proposed implant sites in partially and completely edentulous patients as seen in computed tomography (CT) cross-sectional images obtained with DentaScan® software which is specifically designed for pre-operative planning of implant placement.

MATERIALS AND METHODS

This study was based on a retrospective evaluation of CT cross-sectional images of 258 proposed implant sites. The examined sites comprised 109 proposed implant sites in the maxillae and 149 in the mandibles which belonged to 30 partially or completely edentulous patients, 21 females and 9 males, with age ranges of 17 to 67 years who had been referred to the Oral Maxillofacial Radiology Clinic of the College of Dentistry, King Saud University for pre-operative evaluation of the edentulous bone before implant placement. There were 5 completely edentulous patients who had been wearing full dentures for more than ten years. In one patient, the upper jaw was fully edentulous while the lower jaw was partially edentulous. The rest of the patients were partially edentulous with variable number of missing teeth either in the lower or upper jaw or in both of the jaws. None of the patients were known to have systemic disorders.

High-resolution axial CT images were made with spiral CT device (General Electric, USA) at the Department of Radiology at King Khalid University Hospital. The CT scans were performed with 1.25 mm slice thickness at 1.25 mm interval. DentaScan® software program (DentaScan® Software Program, General Electric, USA) was used to obtain reformatted images parallel (panoramic) and perpendicular (cross-sectional) to the curve of the dental arches. Thus, a

series of cross-sectional images of the examined jaw bone were obtained. The preoperative planning was performed by the prosthodontist for the evaluation of the residual alveolar ridge in the anterior and posterior area of the upper and lower jaw. Only the cross-sectional images were evaluated by the author for the purpose of this study. The implant sites were considered knife-edge if the crest width of the residual ridge is sharply pointed and less than 5 mm. The evaluation was performed at the work station under standard conditions of radiographic interpretation such as dim room lighting.

RESULTS

There were significant individual variations in the rate and amount of bone resorption as well as in the morphologic changes of the residual alveolar bone. Of the 258 proposed implant sites, 118 (45.73%) were found to be of favorable radiographic appearance for dental implant placement. One hundred and forty (54.3%) of the proposed implant sites were judged not suitable for dental implant placement, either due to knife-edge configuration or due to anatomic complication (Figs. 1, 2 and 3).

One hundred and twenty (46.5%) proposed implant sites had knife-edge configuration, 48 (40 %) of which were found in patients with completely edentulous ridges who lost their teeth more than ten years previously. In 20 (7.75%) proposed implant sites, the images revealed anatomic information regarding the ridge that precluded suitability for dental implant. Table 1 shows the number and percentage of different radiographic interpretation of the 258 proposed implant sites.

In the upper premolar-molar region, both residual ridge resorption and extension of the floor of the maxillary sinus inferiorly contributed to the reduction of the ridge height of the proposed implant

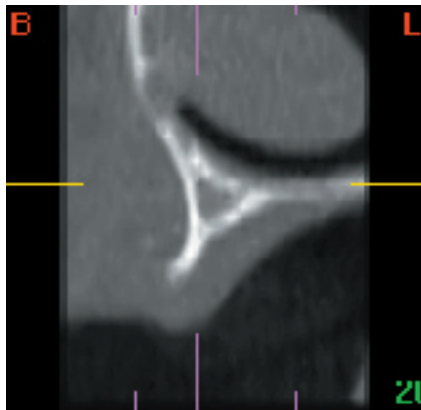


Fig. 1. CT cross-sectional image in upper anterior area of a completely edentulous patient showing the knife-edge configuration (B: buccal, L: lingual).

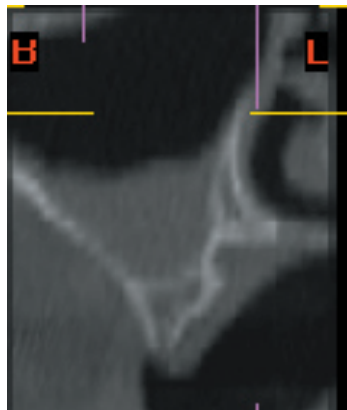


Fig. 2. Cross-sectional image of the upper molar area where the ridge height is reduced due to resorption of the ridge and extension of the floor of maxillary sinus (B: buccal, L: lingual).

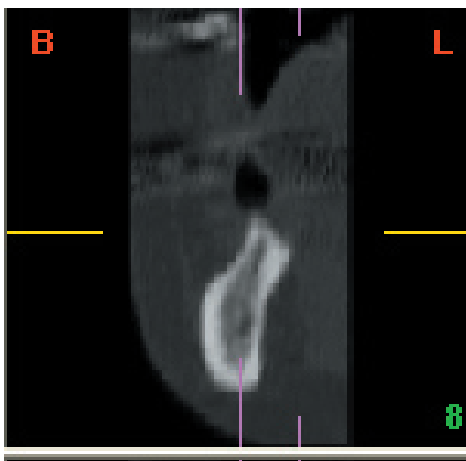


Fig. 3. Cross-sectional image in the mandibular molar area showing knife-edge configuration (B: buccal, L: lingual).

Table 1. CT image-determined suitability of 258 jaw sites for implant placement.

Proposed implant sites	Number	Percentage %
Suitable for implant	118	45.73
Knife-edge ridge	120	46.5
Not suitable due to anatomic complication	20	7.75
Total	258	100

sites (Fig. 2). Out of 59 (22.9%) proposed implant sites in the posterior upper area, it was found that 16 (27%) sites were not suitable for implant placement without sinus lifting and/or bone grafts.

DISCUSSION

Treatment modalities in dentistry changed markedly when osseointegration became the basis for a predictable outcome of oral implant treatment. Currently, the rehabilitation of partial or complete edentulism using implants can generally be regarded as the method of choice if there are no local or systemic contraindications. However, one of the most common problems in implant dentistry is bone atrophy after tooth loss that, in some cases, prevents implant placement or requires surgical intervention to re-establish the bone volume.⁹

In order to ensure accurate dental implant placement, a preoperative radiographic examination should be performed. Several clinical parameters must be considered, including height, thickness, inclination, density and quality of the remaining bone, as well as the relationship of the bone with nearby anatomic structures. Neither panoramic nor periapical views can display satisfactorily the bucco-lingual width or inclination of the bone.

Reformatted CT has been shown to be an effective aid in planning complex cases in oral implantology. This imaging modality allows the localization of anatomical structures and the precise determination

of the amount of bone available at the prospective implant sites.¹⁰⁻¹² The goal of computer-assisted programs is to provide the implantologist with 3-dimensional images, as well as an accurate picture of the configuration of the alveolar bone and its relationship with vital structures within and adjacent to it. The DentaScan® software program enhances conventional CT images by producing images specifically designed for preoperative analysis of the jaws during implant site assessment. Reformatted panoramic and cross-sectional CT images are produced along with the original axial images. Numerous authors have shown that CT is superior to other imaging techniques in visualizing the thickness and density of the bone, as well as the bone's relationship with the maxillary sinus and mandibular canal.^{4,13} Although CT has advantages over conventional tomography, it also has some disadvantages, such as higher radiation dose, prolonged exposure time, motion and metal artifacts, limited availability and higher cost.¹⁴

Following extraction, the socket heals by a physiologic remodeling process which results in the loss of alveolar bone height and width. If several years elapse after the extraction without placement of an implant, atrophy of the residual ridge ultimately results in a thin knife-edge ridge. The results of this study showed a high number of proposed implant sites that are considered unsuitable for implant treatment, especially in totally edentulous patients who lost their teeth and have been wearing dentures for more than ten years. In such cases, the loss of bone may require placement of short and thin implants or require bone grafting to provide adequate bone volume to accommodate the suitable implant size. This may cause complications and increase the cost to the patients.

In the posterior area of the maxilla, the pneumatization of the floor of the maxillary

sinus in the area of missing teeth prevent placement of the implant without sinus floor lifting to provide adequate height for residual alveolar ridge. In the lower jaws, however, the placement of implants in the area of knife-edge configuration requires osseous recontouring to provide adequate bone to surround the implant. Surgical removal of the knife-edge ridge shortens the height of the residual ridge and may endanger important anatomic structures in the area. So bone grafting is mandatory to provide sufficient volume of bone to support the implant while meeting the aesthetic needs of the patients.

In completely edentulous patients, the residual alveolar ridge will undergo continuous resorption due to the pressure applied on the ridges with function. Patients using complete dentures for more than ten years eventually develop problems in retention and stability of the dentures due to poor fit of the dentures. Therefore, prosthodontists should consider treatment plan strategies which involve using dental implant-supported overdentures or rehabilitating completely edentulous arches by implants.

CONCLUSIONS

The result of this study in 30 patients with 258 proposed implant sites showed high prevalence of knife-edge ridge in the proposed implant site among patients seeking implant treatment for replacement of missing teeth. It is recommended that (1) immediate implants should be placed after extraction as soon as possible to preserve height and width of the residual ridge and (2) prosthodontists and implantologist should consider rehabilitation of completely edentulous patients with implants, if possible, or with implant-supported overdentures to prevent further bone resorption and later complications.

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