International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page:www.iscientific.org/Journal.html

Assessment of peri-implant bone height with digital radiograph and digital subtraction images

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Abstract

Marginal bone level surrounding it is one of the most crucial elements that need to be checked in order to assess the success of the dental implant.This study used to evaluate digital subtraction images (DSI) and digital radiographs (DR) to assess the bone height surrounding endosseous implants before loading.12 dental implants from 8 patients were examined in this investigation. Using EMAGO software, standardised digital radiographs were taken two weeks and two months after surgery and subtracted. Next, using digital subtraction pictures and digital conventional radiographs, radiologist assessed bone height. Data were analysed using the MINITAB software programme version 16 and a paired t-test.The measurement of bone height revealed notably greater values on DR compared to DSI (p value = 0.001).Because the DSI technique can demonstrate smaller amounts and less variation in the measurement of bone height, it can be useful in predicting the effectiveness of dental implants.

Keywords: Bone height, dental implant, digital radiography, digital subtraction.

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1. Introduction

In dental implants, bone attachment loss can advance from crestal bone to severe bone loss leading to implant failure [1,2]. The alveolar bone height measures the distance, along a line parallel to the tooth's long axis, between the alveolar bone crest (ABC) and the cement-enamel junction (CEJ). This distance shows whether periodontal disease-related bone changes and alveolar bone loss (ABL) exist. Patients without periodontal disease are more likely to follow 2 mm spacing as the standard, despite research showing significant variation in this distance, which ranges from 0 to 3 mm [3].Serial radiographs are typically used to assess the quantity and quality of bone during the restorative phase of implants. Traditional methods for measuring bone height are unable to detect subtle variations in bone growth or loss [4]. An experienced radiologist can see the lesion on conventional radiographs if there is a shift in bone mineralization of about 30–60%.Determining the marginal alveolar bone levels in serial and standardised radiographs, as well as tracking alterations over time, is regarded as crucial characteristics [5]. Dental implant status is often evaluated using panoramic or periapical radiography modalities. These two-dimensional imaging modalities, however, have superimposition and only produce two-

dimensional images of three-dimensional (3D) structures. Furthermore, their resolution is insufficient, which may result in inaccurate measurements or misinterpretations [6].The computerised approach is thought to have a higher precision than traditional techniques. Marginal bone levels can be rather reliably depicted by conventional serial radiograph analysis. Small variations in bone density, however, are undetectable [2].As technology advanced, more crucial imaging techniques were introduced to dentistry, including digital radiography and cone-beam computed tomography (CBCT). Because digital radiography techniques do not require chemical processing and minimise radiation exposure, they make clinical practice easier [7].Since its introduction to dentistry, digital subtraction images (DSIs) have been extensively utilised as a diagnostic tool to gauge the amount of bone loss surrounding dental implants [2]. Since its introduction in 1980, the digital subtraction image (DSI) technology has proven to be a valuable tool for identifying subtle variations in serial radiographs. This method is an effective means of identifying minor lesions and evaluating variations in bone height [8].This study used direct digital subtraction imaging (DSI) and digital radiography (DR) to assess the bone height around endosseous implants before loading.

2. Materials and method

After receiving informed consent from each participant and ethical authorization from the relevant authorities, the study was carried out in the Department of Oral Implantlogy. 12 dental implants from 8 patients were examined in this investigation. Nobel Biocare implants measuring 11 mm in length were all submerged. The implants were placed as per the protocol. Each patient was summoned back for a follow-up appointment at two weeks and two months following the procedure. Using a digital system-X ray machine (Technomac Medical Systems Pvt Ltd, India) and the parallel technique, radiographs were collected from designated locations surrounding the dental implants at 0.03 seconds, 63 kVp, and 10 mA exposure settings. Two months after the procedure, the patient's documented occlusion was used to position the moulding material in a comparable location for the next follow-up radiograph. EMAGO/advanced 3.43 was the software used to subtract the images during the subtraction stage.Matching every grey pixel on the first and second radiographs using the "gamma correction" option was the first step in using the computer to perform subtraction. The "reconstruction" option was then used to coordinate the photos for the purpose of correcting minute geometric differences. For matching between the first and second radiographs, four reference locations surrounding every dental implant were taken into account. Subtraction was then done by lowering the grey level on both radiographs.Following the acquisition of DSIs, a qualified radiologist analysed the two images—linear DSI and DR. The "measuring device" in EMAGO was used to measure the height of bone surrounding the implants. The bone height was given as the mean length.Prior to performing any statistical analysis, the bone height, which was measured in pixels, was translated to millimetres. Using the Minitab Release Minitab Inc. version 16, Philadelphia software package, data was analysed using paired *t*-test.

3. Result

The DSI technique yielded a mean bone height around dental implants of 8.67 mm with a standard deviation of 0.26, while the DR technique produced a mean bone height around dental implants of 9.65 mm with a standard deviation of 0.463. There was a considerable difference ($P = 0.001$) between the findings in DSI and DR according to the paired *t*-test [Table 1].

4. Discussion

High precision technologies are needed to assess changes in bone level over time. Precise radiography techniques are crucial for accurately determining the height of bone surrounding dental implants. One of the newest techniques for measuring bone height is the DSI method. It may be argued that DSI had less image magnification because the reported measures of bone height around the implant in this investigation were higher than the true bone height and because DSI indicated bone height that was much lower than that shown by DR.Because the DSI technique can display smaller amounts and fewer discrepancies in the evaluation of bone height reported by different operators, it can be useful in predicting the effectiveness of dental implants. However, there are challenges with using subtraction procedures, such as their expense and time-consuming nature, which limits doctors' use of them [1],Mehdizadeh et al. [1] assessed bone height surrounding endosseous implants using direct digital subtraction imaging (DSI) and digital conventional radiography (DCR) prior to loading, which is consistent with our findings. They came to the conclusion that, DSI technique can display smaller amounts and fewer discrepancies in the evaluation of bone height, and it can be useful in predicting the effectiveness of dental implants [1], Bittar-Cortez et al. [2] investigated the variations in linear measures between interobserver variability and digitised radiographs (DR) and digital subtraction images (DSI) surrounding endosseous implants. They came to the conclusion that, in comparison to DR, DSI showed lower results for linear assessments of the bone height surrounding endosseous implants. Values from follow-up studies should be compared with consideration for interobserver variability [4]. It is possible that, to a lesser extent, DSI analysis would overestimate alveolar bone level [2]. Subtraction radiography (SR) was thought to be a trustworthy technique for measuring changes in bone over time at implant locations [9], Takeshita et al [3] concluded that the only procedure that was different from the controls was conventional periapical with Han-Shin film holder [3].The measurement of marginal bone changes following implant surgery could benefit from a clinical reference that uses computed tomograpy (CT) scan technology for three-dimensional assessment. A radiographic examination can be used to evaluate how well dental implants are working. For dental implant placement, computed tomography (CT) is an effective diagnostic tool. It is capable of assessing the quality of the surrounding anatomic structures, including the maxillary sinus [10]. Manja came to the conclusion that bitewing radiographs are more accurate in determining alveolar bone loss than panaraomic radiography [11].Digital radiographies have the ability to disclose more bone resorption sites than conventional radiographies, as demonstrated by Khocht et al. [12]. Digital equipment are clearly superior to conventional instruments in that they can

view anatomical features more clearly and provide more accurate diagnoses because of their noise reduction systems [13]. Dentists can improve image quality with digital software, and numerous studies have demonstrated that digital imaging is superior to conventional imaging in identifying the marginal bone level [12].

Table 1: Mean bone height assessment

Technique	Number	Mean±SD Bone height
DSI	12	8.43±0.245
DSI	12	9.08±0.253
DR	12	9.36±0.352
DR	12	10.22±0.365
DSI	22	8.67±0.26
DR	22	9.65±0.463

DSI: Digital subtraction image, DR: Digital radiographs

5. Conclusions

Because the DSI technique can demonstrate smaller amounts and less variation in the measurement of bone height, it can be useful in predicting the effectiveness of dental implants.

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