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Gentile da Fabriano, *San Nicola salva una nave da un naufragio*, Tempera su tavola, (1425), Musei Vaticani *(detail)*.

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Original Article

SANDBLASTED AND ACID ETCHED SURFACES: AN XPS ANALYSIS AND MICRO-CT STUDY IN RABBITS

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ABSTRACT

Current literature reports that surface acid-etching can improve osteointegration. The aim of the present pilot investigation was to evaluate the bone-implant contact of sandblasted/acid-etched surface implants through micro-CT. Two white New Zealand mature rabbits were treated in the present study, while each rabbit received 2 implants. A total of 4 implants were positioned. The animals were euthanised at 30 days from the implant positioning. The micro-CT sandblasted/acid-etched showed a mature bone appearing in close contact with sandblasted/acid-etched surface of the implant. The sandblasted/acid-etched surface appears to improve bone-implant contact at a later stage of healing.

KEYWORDS: *bone, bone-to-implant contact, machined, sandblasted, acid-etched, surface, micro-CT*

INTRODUCTION

The application of osseointegrated dental implants has been extensively introduced to support dental prostheses (1). The research on surface modifications aims to increase the bone-implant contact percentage (BIC). The past two

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decades have witnessed the development of biomaterials with surface chemical or biomechanical properties that would be expected to promote bone formation (2). Although it is generally recognised that surface characteristics represent a key factor that can influence the bone-implant contact interface, few systematic studies about this property have been investigated (3, 4). For this reason, the design of many dental implants incorporates a rough or textured, porous surface. This technical choice is justified by the concept that the implant surface roughness has been reported as an important component in enhancing the fixture osseointegration. The surface quality seems to stimulate the osteoblasts responsible for depositing the mineralised matrix. The increase of the surface area associated with this particular fixture design can produce an enhanced potential for cell attachment and tissue ingrowth around the implant surface that would be expected to provide mechanical stabilisation of the device (5).

Rich and Harris (6) created a rough surface on tissue culture polystyrene by gently sliding the round fire-polished end of a glass rod across the surface. The fibroblast cell tends to avoid surface roughnesses and accumulate at the level of the smooth parts of the tissue culture dish. In contrast, the macrophage cells seem to prefer the rough surfaces to the smooth parts. This particular macrophage behaviour has also been defined (6) as "rugophile". Similar behaviour has been found in implants in vivo; Salthouse (7) observed an affinity of macrophages for abraded Teflon implants. This tendency of roughened surfaces to attract cells of the monocytic series raises some interesting questions. Implants in contact with bone should have surfaces that attract cells of the monocytic series when it is known that osteoclasts form from cells derived from the monocyte lineage (8). The surfaces available for cell attachment can directly influence several cell characteristics, such as shape and function. In this way, it was demonstrated that the cells grown on grooved substrata are more round than cells grown on flat, smooth substrata (9–11).

A vast quantity of cellular characteristics, including the growth (12), the secretion of proteinases (13) and the gene expression (9), are influenced and induced by cell shape. Moreover, the surface texture of a dental implant can provide the potential for the specific selection of a certain cell population and profoundly influence their behaviour and function. However, detailed studies on how implant surfaces affect the cells they are in contact still need to be carried out. Therefore, the present pilot investigation aimed to assess the surfaces of the sandblasted/acid-etched implants by XPS and evaluate, in a rabbit model, the bone implant contact (BIC), bone area inner threads (BAIT) and bone area outer threads (BAOT) by micro-CT.

MATERIAL AND METHODS

Threaded sandblasted/acid-etched implants surfaces screw-shaped implants (Isomed, DUE CARRARE, Padova, Italy) have been positioned in the present animal investigation. The fixtures were placed into the tibia of 2 white New Zealand mature male rabbits according to a previously described technique (14). Each rabbit received 2 implants 4 x 10 mm. A total of 4 implants were inserted. The animals were anaesthetised by an intramuscular infiltration of fluanisone (0,7 mg/kg.) and diazepam (1,5 mg/kg.) followed by a local anaesthesia administration through 1 ml of 2% lidocaine/adrenalin solution. Therefore, a skin incision with a periosteal flap was provided to expose the tibial plate.

The preparation of the surgical sites was performed by a series of drills under copious saline solution irrigation. The periosteum and fascia were sutured with catgut and nuvafill (Ethicon Inc. Johnson & Johnson Co, Somerville, NJ, USA) sutures. No postoperative complications or deaths occurred. The animals were euthanised after a total of 30 days from implant positioning surgery. An overdose of anaesthesia was administrated, an incision was made on the tibia, and a block section was taken. All 4 implants were retrieved. The specimens were immediately stored in 10% buffered formalin, dehydrated in an ascending series of alcohol rinses, and embedded in a glycolmethacrylate resin (Technovit 7200 VLC, Kulzer, Wehrheim, Germany). After polymerisation, the specimens were observed by Micro-computed tomography.

XPS Implant Surface

XPS analysed the sandblasted and acid-etched samples for detected surface composition. Briefly, the surface of titanium is covered by a thin (about 4 nm thick) oxide layer so that the maximum theoretical concentration of Ti on pure titanium is 33%, the rest being oxygen (the most stable oxide is TiO_2). Surface contamination by the adsorption of ubiquitous hydrocarbons from the atmosphere introduces a surface overlayer of carbon, readily captured by surfacesensitive techniques such as XPS, decreasing the concentration of Ti below the theoretical value (Fig.1).

Micro-CT analysis

Skyscan 1172G (Bruker, Kontich – Belgium) obtained the computed tomography scan data through a high-resolution 3D imaging system associated with an L7901-20 Microfocus X-ray Source (Hamamatsu). The radiographic volume data acquisition was obtained by a 0.5 mm Al filter applying an image pixel/size of 21.96 µm, a camera binning 4x4, a source voltage of 70 kV, a source current of 141 µA, and an exposure time of 500 ms. The final tomographic volume elaboration of the dataset scans was obtained through a built-in NRecon Skyscan dedicated software package (Ver.1.6.6.0; Skyscan Bruker). The 3D Visualisation Software package CTvox v. 2.5 and DataViewer v. 1.4.4 (Skyscan Bruker) obtained the three-dimensional reconstructions of the volume rendering and virtual sectioning views. The final analysis of the study samples was performed through the CT-Analyser (Ver. 1.13) dedicated software package.

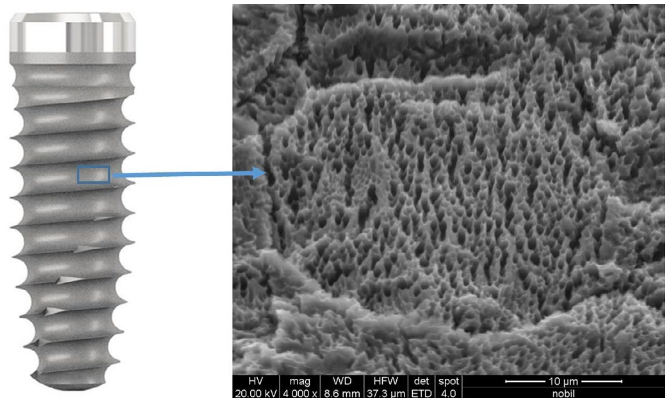

Fig. 1. *Detail of the sandblasted and acid-etched dental implant surfaces assessed in the present investigation.*

RESULTS

Micro-CT evaluation

The microtomography scans were assessed to measure the BIC, the BAIT, the BAOT and the tissue gaps at the level of the bone-to-implant interface. The micrographs reported evidence of new bone formation associated with the implant devices in intimate contact with the titanium surface. No evidence of gaps was reported after 30 days, while the BIC and BAIT measurements were more evident at the level of the implants used in this study. In addition, no aspect of local bone resorption or inflammation foci associated with evidence of osteolysis aspects were observed in the evaluated surfaces. The mean measurement of BIC percentage was 61.6±2.3%, bone area inner threads (BAIT) was 39±2.6%, and bone area outer threads (BAOT) was 43±1.3% (Fig. 2).

DISCUSSION

Endosseous dental implants positioned in the jaws with direct bone-implant contact have become a predictable option

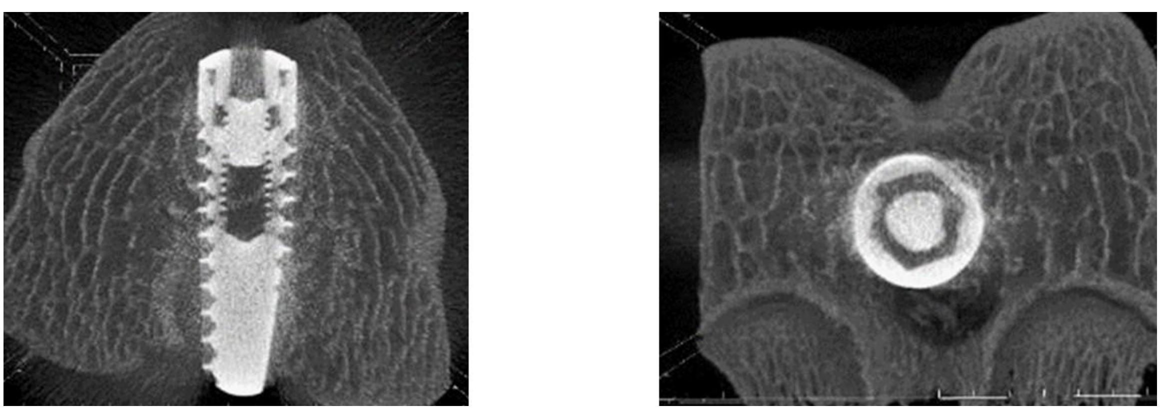

Fig. 2. *Detail of the micro-CT scans elaborated through the transection planes of the implant fixtures. The trabecular bone was in intimate contact with the implant surface.*

and widely adopted treatment for fully and partially edentulous subjects (1). The state-of-the-art includes several attempts adopted to improve the bone anchorage and mechanical stability of dental implants over time. For this scope, several variables that influenced the apposition of bone on implant surfaces have been examined. One of the most important components that could significantly affect the osseointegration of the dental implant is characterised by the surface (15). This evidence has been confirmed by Piattelli et al. (5, 16), that reported a positive correlation between the percentage of bone-implant contact and the roughness values of five different tested titanium surfaces.

The sandblasted and the acid-etched surfaces reported the best bone-to-implant contact. In this way, Martin et al. (17) have reported in an in vitro study that the marker of alkaline phosphatase activity of osteoblasts-like cells seems to be increased when associated with rough surfaces compared to smooth surfaces. The alkaline phosphatase activity is a strong indicator of bone cell maturation, while these study findings seem to suggest that the osteogenic cells in contact with an etched surface may be more differentiated than the smooth ones. These study findings suggested a significant advantage for the etched surface during the early healing period. They could also support the evidence of Kirsch and Donath (18), which reported on titanium disks with a microporous TPS surface a significantly faster bone-implant contact than smooth titanium surfaces. For this scope, the torque removal forces have been considered a biomechanical method to break the osseointegration anchorage of dental implants, and Klokkevold et al. (19) evaluated the resistance to removal forces in an animal study model on rabbits femur.

According to the present study findings, the authors concluded that the chemical acid etches treatment of the titanium fixture surface seems to potentiate the strength of the osseointegration relationship. This evidence seems to be confirmed by the reverse torque rotation values. On the other hand, Buser et al. (20) evaluated titanium implants' removal torque values in miniature pigs' maxillae. The authors compared different dental implant surfaces such as machined, sandblasted, acid etched sandblasted and acid-etched (SLA) implants. After 12 weeks of healing, the removal torque testing was performed. The authors reported that the removal torque value for SLA implants was 75% higher than the Osseotite acid-etched surface implant.

The removal torque means and histomorphometric assessment were also performed by Cordioli et al. (21) in the rabbit's tibia study model. The authors compared four different surfaces: machined, grit-blasted, sprayed, and acid-etched. After a healing time of five weeks, the histomorphometric measurements and the removal torque means were significantly higher for the acid-etched implant surface compared to the machined, blasted and plasma-sprayed surfaces. Moreover, the study findings reported that a micro-rough titanium surface submitted to an acid etching treatment procedure achieved a 33% higher bone-implant contact percentage compared to the machined surfaces. The rabbits were euthanised after 8 weeks.

The cortical bone formation was more advanced than the cancellous bone around the implant surface. A study on threaded hydroxyapatite-coated implants of commercially pure (CP) titanium was performed in an animal study on the rabbit tibial metaphysis (22). The uncoated CP titanium screw implants positioned at the contralateral leg's level were considered a control site. After 6 weeks and 1 year after the surgery, the semi-loaded implants were histomorphometrically retrieved and evaluated. While the study findings were insignificant, more direct bony contact was reported to be associated with the hydroxyapatite-coated implants after 6 weeks of follow-up. After one year from the implant's positioning, significantly more direct bone-to-implant contact was associated with the uncoated CP titanium controls. Wennerberg et al. compared the bone response of commercially pure titanium screws with two different degrees of surface roughness (23, 24).

The implants blasted with 25- and 250-µm aluminium oxide particles were positioned at the rabbit tibiae's level, and the implants' surface roughness was measured. Four weeks after the surgery, a significantly increased bone-to-implant contact for dental implants blasted with 25-µm particles was reported compared to the surfaces treated with 250-µm. This investigation indicates that a highly increased surface roughness compared to a moderately increased one is a short-term disadvantage for bone tissue. Therefore, the capability to contrast the removal forces was also compared (25, 26), considering two different surface designs of screw-shaped titanium implants.

The authors reported that the removal forces of rough implant surfaces were significantly increased compared to smooth machined implant surfaces after 6 weeks from the surgical positioning in rabbit bone tissue. Quantitative and detailed information about the orientation and shape of cells attached to the implant surface remains difficult to retrieve because the current histological techniques produce the most frequently applied thick sections (27). The tedious technique of taking serial sections and producing three-dimensional reconstruction to determine cell shape has not been employed to any great extent. Today, more studies are required to investigate how cells migrate and attach to implant surfaces and how cells would be expected to behave once they arrive there (28).

CONCLUSIONS

The results of the present investigation reported that the sandblasted/acid-etched surfaces have greater osteoconductive activity. In addition, the acid-sandblasted/etched surfaces promote increased bone-implant contact after 1 month. Concerning the early healing phase, more data have to be collected to reduce the rehabilitation time. However, further comparative animal studies are necessary to confirm the outcome of the present pilot study.

REFERENCES

1. Per-Ingvar Brånemark, George Albert Zarb, Albrektsson T. *Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry.* 1st ed. Quintessence Publishing Company; 1985.
2. Scarano A, Perrotti V, Artese L, et al. Blood vessels are concentrated within the implant surface concavities: a histologic study in rabbit tibia. *Odontology*. 2014;102(2):259-266. doi:https://doi.org/10.1007/s10266-013-0116-3
3. Brunette DM. The effects of implant surface topography on the behavior of cells. *The International Journal of Oral & Maxillofacial Implants*. 1988;3(4):231-246.
4. Scarano A, Degidi M, Perrotti V, Degidi D, Piattelli A, Iezzi G. Experimental Evaluation in Rabbits of the Effects of Thread Concavities in Bone Formation with Different Titanium Implant Surfaces. *Clinical Implant Dentistry and Related Research*. 2013;16(4):572-581. doi:https://doi.org/10.1111/cid.12033
5. Piattelli A, Scarano A, Corigliano M, Piattelli M. Effects of alkaline phosphatase on bone healing around plasma-sprayed titanium implants: a pilot study in rabbits. *Biomaterials*. 1996;17(14):1443-1449. doi:https://doi.org/10.1016/0142-9612(96)87288-7
6. Rich A, Harris AK. Anomalous preferences of cultured macrophages for hydrophobic and roughened substrata. *Journal of Cell Science*. 1981;50:1-7. doi:https://doi.org/10.1242/jcs.50.1.1
7. Salthouse TN. Some aspects of macrophage behavior at the implant interface. *Journal of Biomedical Materials Research*. 1984;18(4):395-401. doi:https://doi.org/10.1002/jbm.820180407
8. Göthlin G, Ericsson JL. On the histogenesis of the cells in fracture callus. Electron microscopic autoradiographic observations in parabiotic rats and studies on labeled monocytes. *Virchows Archiv B, Cell Pathology*. 1973;12(4):318-329.
9. Rovensky Y, Slavnaja I, Vasiliev J. Behaviour of fibroblast-like cells on grooved surfaces. *Experimental Cell Research*. 1971;65(1):193-201. doi:https://doi.org/10.1016/s0014-4827(71)80066-6
10. Hong HL, Brunette DM. Effect of cell shape on proteinase secretion by epithelial cells. *Journal of Cell Science*. 1987;87(Pt 2):259-267. doi:https://doi.org/10.1242/jcs.87.2.259
11. Scarano A, Piattelli A, Polimeni A, Di Iorio D, Carinci F. Bacterial Adhesion on Commercially Pure Titanium and Anatase-Coated Titanium Healing Screws: An In Vivo Human Study. *Journal of Periodontology*. 2010;81(10):1466-1471. doi:https://doi.org/10.1902/jop.2010.100061
12. Folkman J, Moscona A. Role of cell shape in growth control. *Nature*. 1978;273(5661):345-349. doi:https://doi.org/10.1038/273345a0
13. Ben-Ze'ev A. Cell shape, the complex cellular networks, and gene expression. Cytoskeletal protein genes as a model system. *Cell and Muscle Motility*. 1985;6:23-53. doi:https://doi.org/10.1007/978-1-4757-4723-2_2
14. Degidi M, Artese L, Piattelli A, et al. Histological and immunohistochemical evaluation of the peri-implant soft tissues around machined and acid-etched titanium healing abutments: a prospective randomised study. *Clinical Oral Investigations*. 2011;16(3):857-866. doi:https://doi.org/10.1007/s00784-011-0574-3
15. Thomas KA, Cook SD. An evaluation of variables influencing implant fixation by direct bone apposition. *Journal of Biomedical Materials Research*. 1985;19(8):875-901. doi:https://doi.org/10.1002/jbm.820190802
16. Piattelli A, Scarano A, Piattelli M. Detection of alkaline and acid phosphatases around titanium implants: a light microscopical

and histochemical study in rabbits. *Biomaterials*. 1995;16(17):1333-1338. doi:https://doi.org/10.1016/0142-9612(95)91049-5
17. Martin JY, Schwartz Z, Hummert TW, et al. Effect of titanium surface roughness on proliferation, differentiation, and protein synthesis of human osteoblast-like cells (MG63). *Journal of Biomedical Materials Research*. 1995;29(3):389-401. doi:https://doi.org/10.1002/jbm.820290314
18. Kirsch A, Donath K. Tierexperimentelle untersuchungen zur bedeutung der mikromorphologie von titanimplantatoberflächen. *Fortschritte der Zalindrälliclien Implantologie*. 1984;1:35-40.
19. Klokkevold PR, Nishimura RD, Adachi M, Caputo A. Osseointegration enhanced by chemical etching of the titanium surface. A torque removal study in the rabbit. *Clinical Oral Implants Research*. 1997;8(6):442-447. doi:https://doi.org/10.1034/j.1600-0501.1997.080601.x
20. Buser D, Nydegger T, Hirt HP, Cochran DL, Nolte LP. Removal torque values of titanium implants in the maxilla of miniature pigs. *The International Journal of Oral & Maxillofacial Implants*. 1998;13(5):611-619.
21. Cordioli G, Majzoub Z, Piattelli A, Scarano A. Removal torque and histomorphometric investigation of 4 different titanium surfaces: an experimental study in the rabbit tibia. *The International Journal of Oral & Maxillofacial Implants*. 2000;15(5):668-674.
22. Gottlander M, Albrektsson T. Histomorphometric studies of hydroxylapatite-coated and uncoated CP titanium threaded implants in bone. *The International Journal of Oral & Maxillofacial Implants*. 1991;6(4):399-404.
23. Wennerberg A, Ektessabi A, Albrektsson T, Johansson C, Andersson B. A 1-year follow-up of implants of differing surface roughness placed in rabbit bone. *The International Journal of Oral & Maxillofacial Implants*. 1997;12(4):486-494.
24. Wennerberg A, Albrektsson T, Andersson B. Bone tissue response to commercially pure titanium implants blasted with fine and coarse particles of aluminum oxide. *The International Journal of Oral & Maxillofacial Implants*. 1996;11(1):38-45.
25. Carlsson L, Röstlund T, Albrektsson B, Albrektsson T. Removal torques for polished and rough titanium implants. *The International Journal of Oral & Maxillofacial Implants*. 1988;3(1):21-24.
26. Gehrke SA, Marin GW. Biomechanical evaluation of dental implants with three different designs: Removal torque and resonance frequency analysis in rabbits. *Annals of Anatomy - Anatomischer Anzeiger*. 2015;199:30-35. doi:https://doi.org/10.1016/j.aanat.2014.07.009
27. Brunette DM. *Behaviour of Osteoblasts on Micromachined Surfaces. The Bone-Biomaterial Interface.*; 1991:170-180.
28. Gehrke SA, Taschieri S, Del Fabbro M, Coelho PG. Positive Biomechanical Effects of Titanium Oxide for Sandblasting Implant Surface as an Alternative to Aluminium Oxide. *Journal of Oral Implantology*. 2015;41(5):515-522. doi:https://doi.org/10.1563/aaid-joi-d-13-00019

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Retrospective study

CLINICAL OUTCOMES OF SPIRAL IMPLANTS INSERTED TO REPLACE CUSPIDS: A RETROSPECTIVE STUDY

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ABSTRACT

In the last decade, spiral implants were introduced as a new tool for oral rehabilitation. A retrospective study has been planned to verify the effectiveness of this system in replacing cuspids. A series of 26 spiral implants inserted to replace cuspids were analyzed. Several variables related to a patient, anatomic site, implant, and surgery were investigated. Implant failure and peri-implant bone resorption were considered predictors of clinical outcome. Cox regression was then performed to detect statistically associated variables with the clinical outcome. From June 2010 to June 2014, 234 spiral implants were inserted in patients. Specifically, 26 fixtures were inserted to replace missing cuspids. Fifteen were inserted in females and 11 in males with a median age of 55 (max-min 29-77, STD = 14 years). One failed (i.e., survival rate SVR =96%). The mean follow-up was 16 months (max-min 1-41, STD = 10 months). Among the studied variables, none reached a significant statistical value. In the present report, the SVR and SCR were 96% and 88.46%, respectively. Statistical analysis demonstrated that no studied variable impacts the survival (i.e., lost implants) and clinical success (i.e., crestal bone resorption), so SPI is a reliable device to replace cuspid.

KEYWORDS: *spiral, implant, fixture, bone, remodeling, resorption, ridge, alveolar*

INTRODUCTION

Few papers were published on implant-prosthetic rehabilitations (IPRs) inserted in the canine site, despite the esthetic

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playing an important role in rehabilitating the frontal zone. Of the many factors that influence the outcome of the IPRs to replace cuspids, the principal ones are 1) the bone and soft-tissue deficiencies, 2) the timing of implant insertion and 3) the management of regenerative procedures (1). Furthermore, IPR in the esthetic area is influenced by other outcomes, such as the correct three-dimensional position of the implant between the cuspid area and the abutment and the crown morphology regarding implant position (2). Immediate IPR can be a successful procedure in terms of aesthetics, but it is related to the surgeon's ability. Immediate IPR is less traumatic as fewer surgical procedures are involved, so patients prefer this clinical approach for better comfort (3). The diagnostic phase is very important: bone and soft tissue characteristics must be considered; skeletal growth, hard and soft tissue parameters, and the morphology of the roots adjacent to the edentulous area should be taken into consideration also (4). The correct position of the IPR should follow the guidelines; in particular, the abutment morphologies play a role in the vestibular/palatal position of the IPR (4).

For IPR in the canine site, we considered a new type of implant: spiral implant. A spiral implant (SI) is a new implant with a conical internal helix and a variable thread design that confers the characteristic of self-drilling, self-tapping, and self-bone condensing (5-7). These proprieties offer better control during SI insertion and high initial stabilization, even in poor-quality bone; small-diameter drilling of SI results in reduced trauma and minimal bone loss. The location and orientation of SI can be altered even after initial insertion without trauma to the surrounding tissues. The advantages of SI are particularly obvious in esthetic sites with minimal bone and low bone density, achieving high stabilization in freshly extracted sites. The self-drilling capability of SI allows it to be inserted into sites that have been prepared to a reduced depth. This ability of SI becomes very useful in situations of proximity to anatomic structures such as the mandibular nerve canal or the maxillary sinus and nasal cavity.

Because few reports have been published about implants inserted in cuspids, we conducted a retrospective study on 26 spiral implants (Alpha Bio LTD, Petah-Tikva, Israel) inserted in canine sites.

MATERIALS AND METHODS

Study design/sample

To address the research purpose, the investigators designed a retrospective cohort study. The study population comprised 26 patients (15 female and 11 male, median age 55 years, min 29 - max 77) for evaluation and implant treatment between June 2010 and June 2014.

Subjects were screened according to the following inclusion criteria: controlled oral hygiene, the absence of any lesions in the oral cavity, sufficient residual bone volume to receive implants of 3.75 mm in diameter and 10 mm in length; in addition, the patients had to agree to participate in a post-operative check-up program.

The exclusion criteria were as follows: insufficient bone volume to receive implants of 3.75 mm in diameter and 10 mm in length, bruxism, smoking more than 20 cigarettes/day and excessive consumption of alcohol (i.e., more than 2 glasses of wine per day), localized radiation therapy of the oral cavity, antitumor chemotherapy, liver, blood and kidney diseases, immune-suppressed patients, patients taking corticosteroids, pregnant women, inflammatory and autoimmune diseases of the oral cavity.

Variables

Several variables are investigated: demographic (age and gender), anatomic (upper/lower jaws, tooth site), implant (type, length, and diameter), surgical (CT-planned surgery, post-extractive, immediate loading) and prosthetic (type of prosthesis, number of prosthetic units, edentulness, dentition in the antagonist arch) variables.

Primary and secondary predictors of clinical outcome are used. The primary predictor is the presence/absence of the implant at the end of the observation period. It is defined as survival rate (i.e., SVR), the total number of implants still in place at the end of the follow-up period.

The second predictor of outcome is peri-implant bone resorption. It is defined as implant success rate (SCR) and evaluated according to the absence of persisting peri-implant bone resorption greater than 1.5 mm during the first year of loading and 0,2 mm/year during the following years (8).

Data collection methods and summary of operative methods

Before surgery, radiographic examinations were done using orthopantomograph and CT scans. Computer-guided surgery was performed as described elsewhere (9, 10).

Peri-implant crestal bone levels were evaluated in each patient by calibrating periapical X-rays. Measurements were recorded before, after, and at the end of the follow-up period. The measurements were carried out mesially and distally to each implant, calculating the distance between the implant platform and the most coronal point of contact between the bone and the implant. The bone level recorded just after the surgical insertion of the implant was the reference point for the following measurements.

A second CT could not be performed due to the amount of X-rays delivered. The measurement was rounded off to the nearest 0.1 mm. A periapical radiograph was impressed utilizing a customized Rinn holder device. This device was necessary to maintain the X-ray cone perpendicular to a film pieced parallel to the long axis of the implant. The endoral X-rays were taken using a long X-ray tube at 70 Kw of power, performed with a computer system, and saved in an uncompressed TIFF format for classification. Each file was processed with the Windows XP Professional operating system using Photoshop 7.0 and shown on a 17" SXGA TFT LCD with an NVIDIA GÈ Force FX GO 5600, 64 MB video card.

Each image was modified using the fit-on-screen function (maximized screen), and the necessary adjustments in contrast, brightness and magnification were made. The measurements were taken at the highest level of resolution possible through the "grid and ruler" program options using various metric scales. Knowing the known dimensions of the implant and having located various points of reference on the profiles of the x-rayed fixtures (edge of the platform, bone crestal level, total length of the implant), it was possible to take linear measurements on the computer and thus execute a proportional metric calculation comparing the known dimensions of the implant's geometric design with those of the examined x-ray images; this made it possible to establish the distance from the mesial and distal edges of the implant platform to the point of bone-implant contact plus the visible crown (expressed in tenths of a millimetre) as an expression of marginal bone resorption. The proportional calculation of the measurements also made it possible to establish, where present, any distortion in the X-ray images for further screening, thereby reducing the margin of error of the analysis to a minimum.

The difference between the implant-abutment junction and the bone crestal level was defined as the Implant Abutment Junction (IAJ) and calculated at the time of operation and during follow-up. The delta IAJ is the difference between the IAJ at the last check-up and the IAJ recorded after the operation. Delta IAJ medians were stratified according to the variables of interest. Peri-implant probing was not performed because a controversy exists regarding the correlation between probing depth and implant success rates (11).

All patients underwent the same surgical protocol. Antimicrobial prophylaxis was administered with 500 mg Amoxycillin twice daily for 5 days starting 1 hour before surgery. Local anaesthesia was induced by infiltration with articaine/epinephrine, and post-surgical analgesic treatment was performed with 100 mg Nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

After placing the surgical guide, mucotomy was performed, bone drilled, and implants inserted as previously planned with CT-guided protocol. No surgical guide was used for "free-hand" inserted implants. The implant platform was positioned at the alveolar crest level, and provisional restoration was immediately delivered or after 3 months (in 2 stages of surgery). After 8 weeks, the final restoration was usually delivered. All patients were included in a strict hygiene recall.

Data analysis

Cox regression analysis was applied to determine the single contribution of covariates on the survival/success rate. Cox regression analysis compares survival/success data while considering the statistical value of independent variables, such as age and sex, on whether or not an event (i.e. implant loss, crestal bone resorption value overcome) is likely to occur. The difference was considered statistically significant if the associated probability was less than 5% ($p<.05$). The odds ratio and 95% confidence bounds were calculated during the regression analysis. Confidence bounds did not have to include the value «1» (12). Stepwise Cox analysis allowed us to detect the variables most associated with implant survival and/or clinical success.

RESULTS

From June 2010 to June 2014, 234 spiral implants were inserted in patients. Specifically, 26 fixtures were inserted to replace missing cuspids. Fifteen were inserted in females and 11 in males with a median age of 55 (max-min 29-77, STD=14 years). Twelve were in post-extractive sites, and 14 were in native bone. Flapless surgery was performed in 10 cases. Computer-guided surgery was done in 6 cases. Nineteen were placed in the maxilla and 7 in the mandible. Seventeen were immediately loaded. All had fixed prostheses. One failed (i.e., survival rate SVR=96%), and 3 had a crestal bone resorption higher than 1.5 mm in the first year and an additional 0.2 mm in each following year of follow-up. (i.e., success rate SCR=88.46). The mean follow-up was 16 months (max-min 1-41, STD = 10 months) (Fig. 1, 2).

Implant lengths 10, 11.5, 13 and 16 mm in 2, 1, 13 and 10 cases, respectively. Implant diameter was 3.75, 4.2, 5 and 6 mm in 3, 14, 8 and 1 cases, respectively. Among the studied variables, none reached a significant statistical value (Table I).

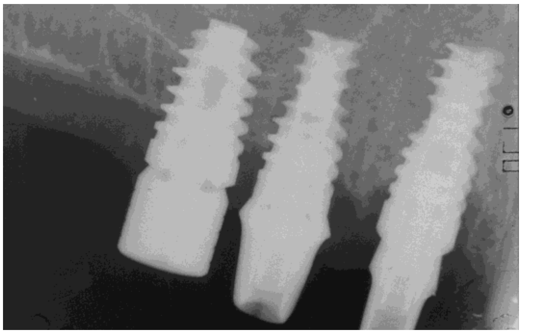

Fig. 1. *Periapical radiograph performed immediately after implant placement to replace a cuspid in the maxilla.*

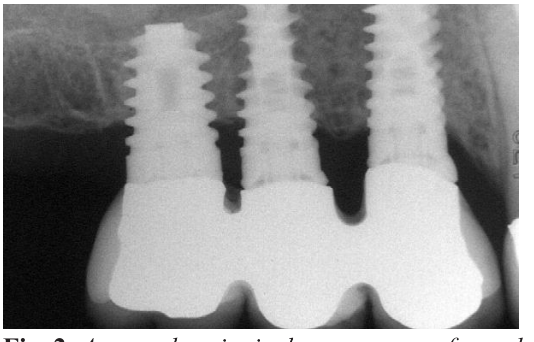

Fig. 2. *A second periapical x-ray was performed at the end of the period of follow up.*

DISCUSSION

Few articles focus on implants inserted in the canine site (13-16). Some recent papers studied prosthetic restorations. In a report about IPRs for replacing canines, Sailer et al. (13) analyzed if customized zirconium abutments and prosthetic rehabilitation exhibit the same survival rates in the canine and posterior regions as titanium abutments. Twenty-two patients with 40 IPRs in the posterior region were included, and the implant sites were randomly assigned to 20 customized zirconium and 20 customized titanium abutments. All IPRs were fabricated in all-ceramic and metal-ceramic materials. Probing pocket depth, plaque index, and bleeding on probing were assessed and compared with the natural teeth (control). The survival rate for IRPs and abutments was 100%. No technical or biological problems were observed at the test and control sites. Two crowns

Table I. *Statistical output of Cox regression analysis.*

Variabile	Degree of Freedom	Sig.	Exp (B)
Male/Female	1	.772	.000
Post-extractive/Native site	1	.753	14099568571596.158
Flapped / Flapless	1	.949	.899
Computer Guided Surgery	1	.853	.000
Mandible/Mandible	1	.770	1635066962386.072
Implant Type (SPI/SFB)	1	.764	128918416724235104.000
Immediate/Delayed Loading	1	.781	6256382053987044.000
Number of Prosthetic Units	1	.368	10.816
Type of Edentulous	1	.769	1810410595678.683

supported by titanium abutments were chipped. No difference in probing pocket depth, plaque index, and bleeding on probing was observed between the two groups. The authors concluded that IPRs with zirconium abutments exhibited the same survival outcome at one year as IPRs with titanium abutments.

Zembic et al. (14) tested whether IPRs with zirconium abutments exhibit the same survival and technical/biological outcome as IPRs with titanium abutments. Twenty-two patients receiving 40 single-tooth IPRs in the canine and posterior regions were included. The implant sites were randomly assigned to 20 zirconium and 20 titanium abutments. All-ceramic and metal-ceramic crowns were fabricated. Probing pocket depth, plaque index, and bleeding on probing were assessed at abutments (test) and analogous contralateral teeth (control). Standardized radiographs of the IPRs were made, and the bone level was measured regarding the implant shoulder on the mesial and distal sides. No abutment fracture or IPR loss was observed. Hence, both exhibited 100% survival. Two metal ceramic crowns supported by titanium abutments were chipped. No difference was observed in the biological outcome of IPRs with zirconium and titanium abutments: probing pocket depth, plaque index, and bleeding on probing were similar in both groups. Furthermore, the bone level was similar at IPRs supporting zirconium and titanium abutments. Thus, the authors concluded that at 3 years, IPRs zirconium and titanium abutments exhibited the same survival and technical, biological, and esthetical outcomes.

In 2011, Turkyilmaz and Shapiro (15) reported a clinical case in which a primary maxillary canine with mobility and root resorption was replaced successfully with an immediate IPR inserted into the fresh extraction socket.

Finally, in 2012 Carinci (16) reported a series of one-piece implants inserted to replace cuspids. Nineteen patients (10 females and 9 males) with a median age of 62 years (range, 43-80) were admitted at the Dental Clinic, University of Chieti (Italy), for evaluation and implant treatment, by one surgeon between January and December 2010. The survival rate (SVR) and success rate (SCR) were 96.8% and 100%, respectively. Statistical analysis demonstrated that no studied variable impacted the survival (i.e., lost implants) and clinical success (i.e., crestal bone resorption), thus showing that one-piece implants are reliable devices for oral rehabilitation in the cuspid sites.

CONCLUSIONS

The SVR and SCR were 96% and 88.46% in our series, respectively. Statistical analyses demonstrated that no studied variable impacted survival (i.e., lost implants) and clinical success (i.e., crestal bone resorption), so IPRs are reliable devices to replace cuspids.

REFERENCES

1. Esposito M, Grusovin MG, Maghaireh H, Coulthard P, Worthington HV. Interventions for replacing missing teeth: management of soft tissues for dental implants. *Cochrane Database Syst Rev*. Published online July 18, 2007. doi:https://doi.org/10.1002/14651858.cd006697
2. Bashutski JD, Wang HL. Common Implant Esthetic Complications. *Implant Dentistry*. 2007;16(4):340-348. doi:https://doi.org/10.1097/id.0b013e318159ca05
3. Belser UC, Grütter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome Evaluation of Early Placed Maxillary Anterior Single-Tooth Implants Using Objective Esthetic Criteria: A Cross-Sectional, Retrospective Study in 45 Patients With a 2- to 4-Year Follow-Up Using Pink and White Esthetic Scores. *Journal of Periodontology*. 2009;80(1):140-151. doi:https://doi.org/10.1902/jop.2009.080435
4. Buser D, Chen S, Weber HP, Belser UC. Early implant placement following single-tooth extraction in the esthetic zone: biologic rationale and surgical procedures. *Int J Periodontics Restorative Dent* . 2008;28(5):441-451.
5. Danza M, Fromovich O, Guidi R, Carinci F. The clinical outcomes of 234 spiral family implants. *The Journal of Contemporary Dental Practice*. 2009;10(5):E049-056.
6. Carinci F, Brunelli G, Danza M. Platform Switching and Bone Platform Switching. *Journal of Oral Implantology*. 2009;35(5):245-250. doi:https://doi.org/10.1563/aaid-joi-d-09-00022.1

7. Danza M, Riccardo G, Carinci F. Bone platform switching: a retrospective study on the slope of reverse conical neck. *Quintessence International (Berlin, Germany: 1985)*. 2010;41(1):35-40.
8. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *The International Journal of Oral & Maxillofacial Implants*. 1986;1(1):11-25.
9. Rebaudi A. The ray setting procedure: a new method for implant planning and immediate prosthesis delivery. *Int J Periodontics Restorative Dent* . 2007;27(3):267-275.
10. Quirynen M, Van Steenberghe D, Jacobs R, Schotte A, Darius P. The reliability of pocket probing around screw-type implants. *Clinical Oral Implants Research*. 1991;2(4):186-192. doi:https://doi.org/10.1034/j.1600-0501.1991.020405.x
11. Quirynen M, Naert I, Steenberghe D, Teerlinck J, Dekeyser C, Theuniers G. Periodontal aspects of osseointegrated fixtures supporting an overdenture. A 4-year retrospective study. *Journal of Clinical Periodontology*. 1991;18(10):719-728. doi:https://doi.org/10.1111/j.1600-051x.1991.tb00063.x
12. Cox DR, Oakes D. *Analysis of Survival Data*. Chapman & Hall; 1984.
13. Sailer I, Zembic A, Jung RE, Siegenthaler D, Holderegger C, Hämmerle CHF. Randomized controlled clinical trial of customized zirconia and titanium implant abutments for canine and posterior single-tooth implant reconstructions: preliminary results at 1 year of function. *Clinical Oral Implants Research*. 2009;20(3):219-225. doi:https://doi.org/10.1111/j.1600-0501.2008.01636.x
14. Zembic A, Sailer I, Jung RE, Hämmerle CHF. Randomized-controlled clinical trial of customized zirconia and titanium implant abutments for single-tooth implants in canine and posterior regions: 3-year results. *Clinical Oral Implants Research*. 2009;20(8):802-808. doi:https://doi.org/10.1111/j.1600-0501.2009.01717.x
15. Turkyilmaz I, Shapiro V. Immediate provisional restoration of an implant placed in a fresh primary maxillary canine extraction socket: a case report. *Gen Dent* . 2011;59(3).
16. Carinci F. Effectiveness of one-piece implants inserted in cuspid sites. *Dent Res J (Isfahan)*. 2012;9(s2). doi:https://doi.org/10.4103/1735-3327.109726.

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Case report

EXTERNAL AND INTERNAL RESORPTION ROOT BY A GIANT CYST: A CASE REPORT

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ABSTRACT

Root cysts are inflammatory odontogenic cysts related to the teeth. Most of these lesions involve the apex of the tooth and appear as well-defined radiolucency with clear margins without erosion of the neighbouring structures. Rhizolysis, defined as the process of resorption of the hard tissues of the dental element, appears to be physiological during tooth exfoliation, pathological in the permanent elements and is a possible consequence of many dental treatments. This case report documents a large root cyst associated with external root resorption. Based on the clinical, radiographic and histopathological findings, the present case was diagnosed as an infected root cyst. The lesion was surgically enucleated with the extraction of the associated tooth. Preservation of all other teeth and vital structures was achieved without postoperative complications and satisfactory healing.

KEYWORDS: *cyst, maxilla, jaw, bone, external radicular resorption*

INTRODUCTION

A radicular cyst is defined as a chronic inflammatory lesion of the periapical tissues of the tooth (alveolar bone and periodontal ligament) originating from infectious or degenerative pathologies of the internal tissues of the tooth (1). It is the most common form of cystic pathology of the jaw bones, most frequently affecting between thirty and fifty years of age.

The pathology usually remains asymptomatic for a long time and is typically diagnosable only by radiographic examination (2). In this phase, it is clinically and radiologically little distinguishable from the apical granuloma, from which it develops.

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However, over time it can tend to increase in size, causing bone deformation, thus manifesting a symptomatology linked to the process of expansion and compression of the neighbouring structures (3, 4). The aim of this study was to describe the clinical management of a giant root cyst in the upper jaw.

Case Report

A 33-year-old male presented with localized swelling on the left upper jaw (Fig. 1). According to the patient, the swelling was insidious onset, gradually progressive, and fistulized. Element 1.1, already endodontically treated for 20 years, presented external root resorption and evident discolouration. External examination revealed widespread swelling on the left side of the jaw. The overlying skin was normal and painless, with no associated lymphadenopathy. Intraoral examination revealed an intact permanent dentition, swelling in the left upper alveolus associated with lateral incisors and mild palatal swelling. On palpation, the surface was smooth, with no noticeable fluctuations. It showed a faint bony crepitus in both the buccal and palatal sides.

An orthopantomogram (OPG) and computed tomography (CT) were acquired (Fig.2-4). Lateral and axial sections of the CT scan were analyzed. On the OPG, the lesion appeared to have a rounded radiolucency with well-defined margins. CT revealed an expansive, primarily cystic lesion of maximum dimensions of 13.5 mm x 12.8 mm x 11.6mm that had led to thinning and erosion of the bone along the cystic walls in the anterior maxillary areas. Laterally, the lesion was well circumscribed to the lateral and central incisors region. The central incisor had significant root resorption, and the cystic lining was in direct contact with the lateral incisor. The patient's biochemical tests revealed normal serum calcium levels, phosphorus and alkaline phosphatase.

Based on the clinical and radiological data, a preliminary diagnosis of a root cyst was made. The differential diagnosis included odontogenic cyst, maxillary mucocele, giant cell tumor, odontogenic adenomatoid tumor, and uni- cistic ameloblastoma.

Since the involved bone had multiple cortical erosion involving the vestibular and palatal walls and the resorption of the associated tooth, enucleation of the lesion was planned with tooth extraction (Fig. 5, 6). After raising the flap, under local anaesthesia, the margins of the cyst were visualized and marked. The lesion was removed from the anterior maxillary wall. The defect was closed with a bone graft collected by the same patient (Fig.7, 8). The area was debrided entirely from the obtained hemostasis and closed in layers with resorbable sutures (Fig. 9, 10).

Appropriate antibiotics (Amoxicillin 875 mg + Clavulanic acid 125 mg), pain relievers (Naproxen 550 mg tablet) and dietary instructions were provided. The lesion healed well during the postoperative period, and the patient had no recurrence at the 3-year follow-up.

Fig. 1. *Frontal view of the oral cavity.*

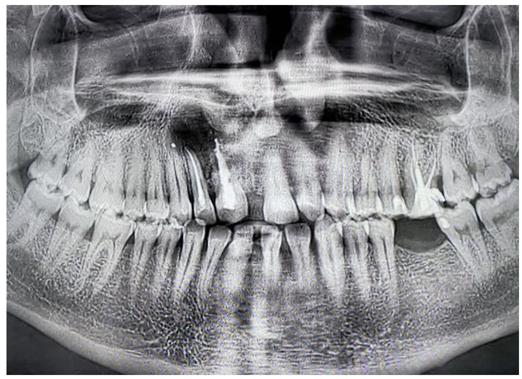

Fig. 2. *Orthopatomography.*

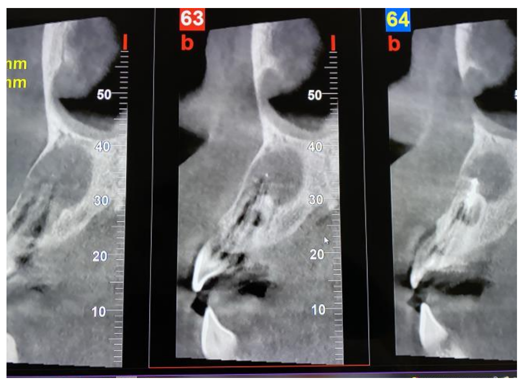

Fig. 3. *Lateral view of CT scan.*

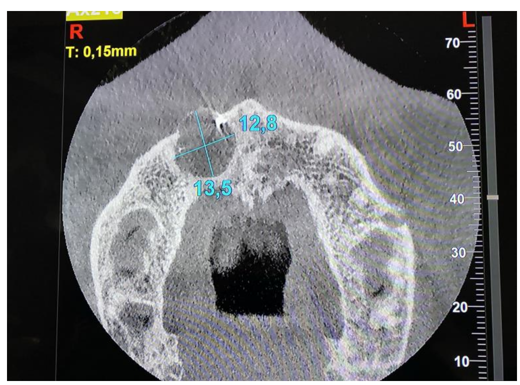

Fig. 4. *Axial view of CT scan.*

Fig. 5. *Surgical exposures of external maxillary wall.*

Fig. 6. *Alveolus after tooth extraction.*

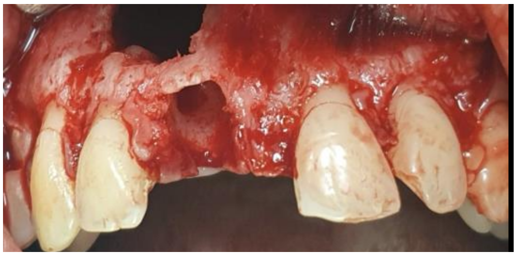

Fig. 7. *Bone empty space after cyst removal.*

Fig. 8. *Grafted bone.*

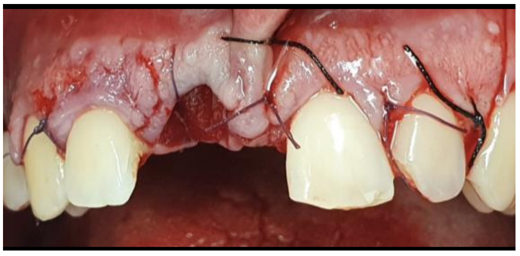

Fig. 9. *Sutures.*

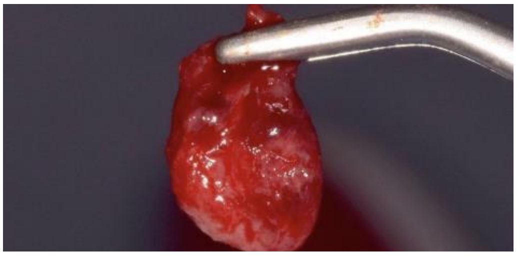

Fig 10. *Cyst.*

DISCUSSION

The most common cause for root cyst formation is infectious (5-11). Infections derived from bacteria, toxins and products of metabolism can reach the periapical tissues (periodontal ligament and alveolar bone) through the internal canals of the tooth (12-13). Sometimes the pathology develops from a tooth previously treated for a pulp pathology (devitalization). In these situations, the case is still bacterial due to the permanence of untreated canal areas (subsequently to lack of instrumentation or canal toot aberrant geometry).

One of the most common complications is empyema or infection of the cystic cavity. In this case is an acute infection with pain, swelling and body temperature increase (14, 15). In addition, fistulization can occur in the oral cavity or, more rarely, in the facial skin.

A root cyst is unlikely to cause significant erosion of the tooth or roots, even in very large lesions. However, if tooth erosion appears radiographically, the coexistence of internal resorptions must be suspected (16).

In large cysts, massive growth can lead to compression of local nervous structures, with the consequent appearance of paresthesia and deformation of the bone and facial structures, due to its progressive enlargement (17, 18).

Sometimes the cystic lesion can reach dimensions able to cause fracture of the affected bone for simple, functional stresses such as chewing. In addition, the development of ameloblastoma and squamous cell carcinoma from a root cyst has been reported. However, given the rarity of these reports, the probability is very low (19).

In order to remove the cyst, it is necessary to proceed with the surgical enucleation of the entire lesion (cystectomy or Partsch II intervention). Instead, when the cystectomy is not recommended due to the risk of damaging important structures such as vessels and nerves, a marsupialization (cystotomy or Partsch I intervention) is the best choice. The first type of intervention (cystectomy) aims to remove the cystic tissue altogether. The advantage of this procedure is the possibility of histological diagnosis of the entire lesion and the filling of the residual cavity with bone to reduce the recovery time (20, 21).

REFERENCES

1. Shear M, Speight P. *Cysts of the Oral and Maxillofacial Regions*. John Wiley & Sons; 2008.
2. Johnson NR, Gannon OM, Savage NW, Batstone MD. Frequency of odontogenic cysts and tumors: a systematic review. *Journal of Investigative and Clinical Dentistry*. 2013;5(1):9-14. doi:https://doi.org/10.1111/jicd.12044
3. Bernardi L, Visioli F, Nör C, Rados PV. Radicular Cyst: An Update of the Biological Factors Related to Lining Epithelium. *Journal of Endodontics*. 2015;41(12):1951-1961. doi:https://doi.org/10.1016/j.joen.2015.08.036
4. Joshi N, Sujan SG, MM Rachappa. An unusual case report of bilateral mandibular radicular cysts. *Contemp Clin Dent* . 2011;2(1):59-59. doi:https://doi.org/10.4103/0976-237x.79295
5. White SC, Sapp JP, Seto BG, Mankovich NJ. Absence of radiometric differentiation between periapical cysts and granulomas. *Oral Surgery, Oral Medicine, Oral Pathology*. 1994;78(5):650-654. doi:https://doi.org/10.1016/0030-4220(94)90180-5
6. Gibson GM, Pandolfi PJ, Luzader JO. Case report: a large radicular cyst involving the entire maxillary sinus. *General Dentistry*. 2002;50(1):80-81.
7. Estrela C, Bueno MR, Azevedo BC, Azevedo JR, Pécora JD. A New Periapical Index Based on Cone Beam Computed Tomography. Journal of Endodontics. 2008;34(11):1325-1331. doi:https://doi.org/10.1016/j.joen.2008.08.013
8. Araujo R.Z. , Vazquez Gomez R.S. , Castro W, Lehman LL. Pathology Differential diagnosis of antral pseudocyst, surgical ciliated cyst, and mucocele of the maxillary sinus. Ann Oral Maxillofac Surg . 2014;(2):10-16.
9. Zhang R, Wang H, Tian YY ., Yu X, Hu T, Dummer PMH. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. International Endodontic Journal. 2011;44(11):990-999. doi:https://doi.org/10.1111/j.1365-2591.2011.01904.x
10. Taschieri S, Del Fabbro M, Testori T, Weinstein R. Efficacy of Xenogeneic Bone Grafting With Guided Tissue Regeneration in the Management of Bone Defects After Surgical Endodontics. Journal of Oral and Maxillofacial Surgery. 2007;65(6):1121-1127. doi:https://doi.org/10.1016/j.joms.2006.10.022
11. Ricucci D, Mannocci F, Pitt Ford TR. A study of periapical lesions correlating the presence of a radiopaque lamina with histological findings. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2006;101(3):389-394. doi:https://doi.org/10.1016/j.tripleo.2005.08.026
12. Lin SK, Wang JT, Wu PH, et al. Apical periodontal cyst: a clinicopathologic study of 405 cases. China Journal of Oral and Maxillofacial Surgery. 1993;4(4):106-119.
13. Torres-Lagares D, Segura-Egea JJ, Rodríguez-Caballero A, Llamas-Carreras JM, Gutiérrez-Pérez JL. Treatment of a large maxillary cyst with marsupialization, decompression, surgical endodontic therapy and enucleation. Journal (Canadian Dental Association). 2011;77:b87.
14. Koseoglu BG, Atalay B, Erdem MA. Odontogenic cysts: a clinical study of 90 cases. Journal of Oral Science. 2004;46(4):253-
15. 257. doi:https://doi.org/10.2334/josnusd.46.253
16. Vesna Koželj, Sotošek B. Inflammatory dentigerous cysts of children treated by tooth extraction and decompression—report of four cases. Br Dent J . 1999;187(11):587-590. doi:https://doi.org/10.1038/sj.bdj.4800339a
17. Motamedi MHK, Talesh KT. Management of extensive dentigerous cysts. British Dental Journal. 2005;198(4):203-206. doi:https://doi.org/10.1038/sj.bdj.4812082
18. Pradel W, Eckelt U, Lauer G. Bone regeneration after enucleation of mandibular cysts: Comparing autogenous grafts from

tissue- engineered bone and iliac bone. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2006;101(3):285-290. doi:https://doi.org/10.1016/j.tripleo.2005.06.001

19. Ettl T, Gosau M, Sader R, Reichert TE. Jaw cysts – Filling or no filling after enucleation? A review. Journal of Cranio- Maxillofacial Surgery. 2012;40(6):485-493. doi:https://doi.org/10.1016/j.jcms.2011.07.023
20. Schramm A, Rücker M, Sakkas N, Ralf Schön, Düker J, Nils-Claudius Gellrich. The use of cone beam CT in cranio-maxillofacial surgery. International Congress Series. 2005;1281:1200-1204. doi:https://doi.org/10.1016/j.ics.2005.03.224
21. Chiapasco M, Rossi A, Jones Motta J, Crescentini M. Spontaneous bone regeneration after enucleation of large mandibular cysts: A radiographic computed analysis of 27 consecutive cases. Journal of Oral and Maxillofacial Surgery. 2000;58(9):942-948. doi:https://doi.org/10.1053/joms.2000.8732

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BPI

Clinical trial

CLINICAL OUTCOME OF SPIRAL IMPLANTS INSERTED IN THE MOLAR REGION

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ABSTRACT

In the last decade, spiral implants were introduced in the market as a new tool for oral rehabilitation. A retrospective study has been planned to verify this system's effectiveness in replacing missing molars. A series of 67 implants inserted to replace molars were analyzed. Several variables related to the patient, such as anatomic site, implant, and surgery, were investigated. Implant failure and peri-implant bone resorption were predictors of clinical outcome. Cox regression was then performed to detect statistically associated variables with the clinical outcome. From June 2010 to June 2014, 234 spiral implants were inserted in patients. Specifically, 67 fixtures were inserted to replace missing molars. Forty-six were inserted in females and 21 males with a median age of 51 (max-min 32-80, STD = 14 years). Two failed (i.e., survival rate SVR =97%), and 9 had a crestal bone resorption higher than 1.5 mm in the first year and an additional 0.2 mm in each following year of follow-up. (i.e., success rate SCR = 86.56%). The mean follow-up was 14 months (max-min 1-41, STD = 9 months). Among the studied variables, none reached a significant statistical value. SVR and SCR were 97% and 86.56% in our series, respectively. Statistical analysis demonstrated that no studied variable impacted survival (i.e., lost implants) and clinical success (i.e., crestal bone resorption). Spiral implants are reliable devices to replace molars.

KEYWORDS: *spiral, implant, fixture, bone, remodeling, resorption, ridge, alveolar*

INTRODUCTION

Researchers have always studied new types of implants to improve the quality of implant-prosthetic rehabilitations. A new type of implant is a spiral implant (SI) with a conical internal helix and a variable thread design that confers the characteristic of self-drilling, self-tapping, and self-bone condensing (1–3). These proprieties offer better control during SI insertion and high initial stabilization, even in poor-quality bone. Small-diameter drilling of SI results in reduced trauma and minimal bone loss. The location and orientation of SI can be altered even after initial insertion without trauma

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to the surrounding tissues. The advantages of SI are undeniable in compromised situations with minimal bone and low bone density, achieving high stabilization in freshly extracted sites and thin sinus floors without prior bone augmentation. The self-drilling capability of SI allows it to be inserted into sites that have been prepared to a reduced depth. This ability of SI becomes very useful in situations of proximity to anatomic structures such as the mandibular nerve canal or the maxillary sinus and nasal cavity.

The spiral implants are composed of 2 types of implants, the SI and the spiral flare bevel (SFB). The latter has a reverse conical head that allows for an increased volume of crestal bone around the implant neck, accounting for additional benefits, such as a closer placement of adjacent implants without compromising health tissues and esthetic outcome.

The effectiveness of SI and SFB was demonstrated in several clinical situations. However, we decided to perform a retrospective study because no reports specifically focus on the clinical outcomes of SI inserted in molars sites.

MATERIALS AND METHODS

Study design/sample

To address the research purpose, the investigators designed a retrospective cohort study of patients treated with spiral implants (Alpha Bio LTD, Petah-Tikva, Israel) as previously reported (1-3). The study population comprised 67 patients (46 female and 21 male, median age 51 years, min 32 - max 80) for evaluation and implant treatment between June 2010 and June 2014.

Subjects were screened according to the following inclusion criteria: controlled oral hygiene, the absence of any lesions in the oral cavity, sufficient residual bone volume to receive implants of 3.75 mm in diameter and 6 mm in length; in addition, the patients had to agree to participate in a post-operative check-up program.

The exclusion criteria were as follows: insufficient bone volume to receive implants of 3.75 mm in diameter and 6 mm in length, bruxism, smoking more than 20 cigarettes/day and excessive consumption of alcohol (i.e., more than 2 glasses of wine per day), localized radiation therapy of the oral cavity, antitumor chemotherapy, liver, blood and kidney diseases, immune-suppressed patients, patients taking corticosteroids, pregnant women, inflammatory and autoimmune diseases of the oral cavity.

Variables

Several variables are investigated: demographic (age and gender), anatomic (upper/lower jaws), implant (length and diameter), surgical (CT-planned surgery, post-extractive, immediate loading) and prosthetic (type of prosthesis, number of prosthetic units, edentulness, dentition in the antagonist arch) variables.

Primary and secondary predictors of clinical outcome are used. The primary predictor is the presence/absence of the implant at the end of the observation period. It is defined as survival rate (i.e., SVR), the total number of implants still in place at the end of the follow-up period.

The second predictor of outcome is peri-implant bone resorption. It is defined as implant success rate (SCR), and it is evaluated according to the absence of persisting peri-implant bone resorption greater than 1.5 mm during the first year of loading and 0.2 mm/year during the following years (4).

Data collection methods and summary of operative methods

Before surgery, radiographic examinations were done using orthopantomography and CT scans. Computer-guided surgery was performed as described elsewhere (5, 6).

Peri-implant crestal bone levels were evaluated in each patient by calibrating periapical X-rays. Measurements were recorded before, after, and at the end of the follow-up period. The measurements were carried out mesially and distally to each implant, calculating the distance between the implant's platform and the most coronal point of contact between the bone and the implant. The bone level recorded just after the surgical insertion of the implant was the reference point for the following measurements. We were not allowed to perform a second CT because of the number of X-rays delivered. The measurement was rounded off to the nearest 0.1 mm.

A periapical radiograph was impressed using a customized Rinn holder device. This device was necessary to maintain the X-ray cone perpendicular to a film pieced parallel to the long axis of the implant. The endoral X-rays were taken using a long X-ray tube at 70 Kw of power, performed with a computer system, and saved in an uncompressed TIFF format for classification. Each file was processed with the Windows XP Professional operating system using Photoshop

7.0 and shown on a 17” SXGA TFT LCD with an NVIDIA GÈ Force FX GO 5600, 64 MB video card. Each image was modified using the fit-on-screen function (maximized screen), and the necessary adjustments in contrast, brightness and magnification were made. The measurements were taken at the highest level of resolution possible through the “grid and ruler” program options using various metric scales. Knowing the known dimensions of the implant and having located various points of reference on the profiles of the x-rayed fixtures (edge of the platform, bone crestal level, total length of the implant), it was possible to take linear measurements on the computer and thus execute a proportional metric calculation comparing the known dimensions of the implant’s geometric design with those of the examined x-ray images; this made it possible to establish the distance from the mesial and distal edges of the implant platform to the point of bone-implant contact plus the visible crown (expressed in tenths of a millimetre) as an expression of marginal bone resorption.

The proportional calculation of the measurements also made it possible to establish, where present, any distortion in the X-ray images for further screening, thereby reducing the margin of error of the analysis to a minimum.

The difference between the implant-abutment junction and the bone crestal level was defined as the Implant Abutment Junction (IAJ) and calculated at the time of operation and during follow-up. The delta IAJ is the difference between the IAJ at the last check-up and the IAJ recorded after the operation. Delta IAJ medians were stratified according to the variables of interest. Peri-implant probing was not performed because a controversy exists regarding the correlation between probing depth and implant success rates (7, 8).

All patients underwent the same surgical protocol. Antimicrobial prophylaxis was administered with 500 mg Amoxycillin twice daily for 5 days starting 1 hour before surgery. Local anaesthesia was induced by infiltration with articaine/epinephrine, and post-surgical analgesic treatment was performed with 100 mg Nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

After placing the surgical guide, mucotomy was performed, bone drilled, and implants inserted as previously planned with CT-guided protocol. No surgical guide was used for “free-hand” inserted implants. The implant platform was positioned at the alveolar crest level, and provisional restoration was immediately delivered or after 3 months (in 2 stages of surgery). After 8 weeks, the final restoration was usually delivered. All patients were included in a strict hygiene recall (Fig. 1, 2).

Data analysis

Cox regression analysis was applied to determine the single contribution of covariates on the survival/success rate. Cox regression analysis compares survival/success data while considering the statistical value of independent variables, such as age and sex, on whether an event (i.e., implant loss, crestal bone resorption value overcome) is likely to occur. The difference was considered statistically significant if the associated probability was less than 5% (p<.05). The odds ratio and 95% confidence bounds were calculated during the regression analysis. Confidence bounds did not have to include the value «1» (9). Stepwise Cox analysis allowed us to detect the variables most associated with implant survival and/or clinical success.

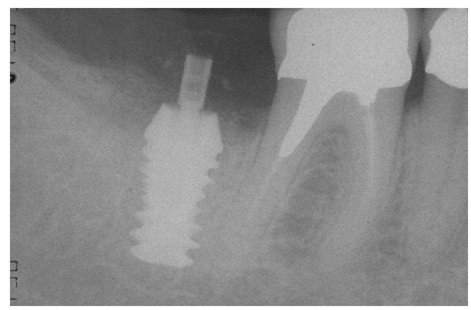

Fig. 1. *Periapical radiograph performed immediately after implant placement to replace a molar in the mandible.*

RESULTS

From June 2010 to June 2014, 234 spiral implants were inserted in patients. Specifically, 67 fixtures were inserted to replace missing molars. Forty-six were inserted in females and 21 males with a median age of 51 (max-min 32-80, STD = 14 years). Twenty-nine were in post-extractive sites and 28 in native bone. Flapless surgery was performed in 25 cases. Computer-guided surgery was done in one case. Thirty were placed in the maxilla and 37 in the mandible. Thirty-eight were immediately loaded. All had fixed prostheses. Two failed (i.e., survival rate SVR =97%), and 9 had a crestal bone resorption higher than 1.5 mm in the first year and an additional 0.2 mm in each following year of follow-up. (i.e., success rate SCR = 86,56%). The mean follow-up was 14 months (max-min 1-41, STD = 9 months). Implant lengths 6, 8, 10, 11.5 and 13 in 1, 1, 16, 24 and 25 cases,

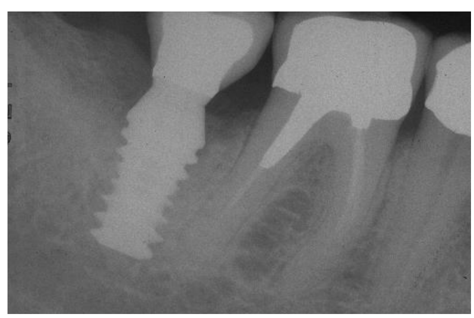

Fig. 2. *A second periapical impression was performed at the end of the period of follow-up.*

respectively. Implant diameter was 3.75, 4.2, 5 and 6 mm in 4, 15, 24, and 24 cases, respectively. Among the studied variables, none reached a significant statistical value (Table I).

Table I. *Statistical output of Cox regression analysis.*

Variables	Degree of Freedom	Sig.	Exp(B)
Male/Female	1	.293	1.020
Post-extractive/Native site	1	.811	1.112
Flapped / Flapless	1	.690	1.186
Computer Guided Surgery	1	.993	.000
Mandible/Mandible	1	.182	1.878
Implant Type (SPI/SFB)	1	.106	.281
Immediate/Delayed Loading	1	.238	.594
Number of Prosthetic Units	1	.271	.449
Type of Edentulous	1	.985	.000

DISCUSSION

New studies are necessary to demonstrate the high success of SI. Investigators have studied several aspects of the surgical and prosthetic protocol of SI, discovering the relative importance of each variable and their influence on osseointegration, such as anatomic site (upper/lower jaws), the implant (length and diameter), surgical (CT-planned surgery, post-extractive, immediate loading) and prosthetic (type of prosthesis, number of prosthetic units, etc.). However, the guidelines of SI for the long-term SVR (i.e., total implants still in place at the end of the follow-up) and SCR (the absence of persisting peri-implant bone resorption greater than 1,5 mm during the first year of loading and 0,2 mm/years during the following years) are the principal goals to achieve a good clinical outcome of SI.

All variables that influence the result of SI are grouped as factors related to surgery, host, implant, and occlusion-related factors (10-14). Surgery-related factors comprise several variables, such as excess surgical trauma, bone thermal injury, and insufficient irrigation during SI insertion. The host-related factors are the quantity and quality of bone. The most important implant-related factors are surface coating, design, length, and diameter of SI. The intensity of force and type of prosthetic restoration are the variables of interest among the occlusion-related factors. All these variables may affect the clinical outcome of SI (10-14).

Flapless implant surgery of SI has been suggested as one possible treatment option for enhancing implant esthetics because it is easy to perform and is beneficial for patient morbidity (15). However, by performing this blind procedure, one should be aware of the risk of deviating SI and that accurate positioning of each implant is extremely important for fixed restorations (16). Using radiographic images is necessary to evaluate the surgical site of placing SI underneath the soft tissue, and CT images provide an accurate 3D picture of the surgical field (17-21). In addition, several authors have advocated using drill guides (22-24) to link the virtual preoperative treatment plan based on the CT images to the situation encountered during surgery. CT-planned and free-hand surgery have shown no differences in clinical outcomes.

Few articles focus on implants inserted in molar sites. Annibali et al. (25) reported a series of patients treated consecutively for first molar replacement according to unconventional (immediate = Group 1, early = Group 2) or conventional (late = Group 3) surgical protocols. The authors concluded that short-term implant survival and success rates and marginal bone loss values for immediate, early, and conventional implants appear similar for maxillary and mandibular first molar sites.

SVR and SCR were 97% and 86.56% in our series, respectively. Statistical analysis demonstrated that none of the studied variables impacted survival (i.e., lost implants) and clinical success (i.e., crestal bone resorption). Spiral implants are reliable devices to replace molars.

No statistical difference was detected about anatomic sites (mandible vs maxillae) or surgery-related factors (i.e., surgeon, flapless surgery, CT- planned, and post-extractive sites).

CONCLUSIONS

In conclusion, spiral implants are reliable for complex cases of oral rehabilitation. They have a high SVR and SCR, which means stable results over time. Flapless and CT-planned surgery does not significantly increase the clinical outcome in implant rehabilitation.

REFERENCES

1. Danza M, Fromovich O, Guidi R, Carinci F. The clinical outcomes of 234 spiral family implants. *The Journal of Contemporary Dental Practice*. 2009;10(5):E049-056.
2. Carinci F, Brunelli G, Danza M. Platform Switching and Bone Platform Switching. *Journal of Oral Implantology*. 2009;35(5):245-250. doi:https://doi.org/10.1563/aaid-joi-d-09-00022.1
3. Danza M, Riccardo G, Carinci F. Bone platform switching: a retrospective study on the slope of reverse conical neck. *Quintessence International (Berlin, Germany: 1985)*. 2010;41(1):35-40.
4. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *The International Journal of Oral & Maxillofacial Implants*. 1986;1(1):11-25.
5. Rebaudi A. The ray setting procedure: a new method for implant planning and immediate prosthesis delivery. *The International Journal of Periodontics & Restorative Dentistry*. 2007;27(3):267-275.
6. Danza M, Zollino I, Carinci F. Comparison Between Implants Inserted With and Without Computer Planning and Custom Model Coordination. *Journal of Craniofacial Surgery*. 2009;20(4):1086-1092. doi:https://doi.org/10.1097/scs.0b013e3181abb322
7. Quirynen M, Van Steenberghe D, Jacobs R, Schotte A, Darius P. The reliability of pocket probing around screw-type implants. *Clinical Oral Implants Research*. 1991;2(4):186-192. doi:https://doi.org/10.1034/j.1600-0501.1991.020405.x
8. Quirynen M, Naert I, Steenberghe D, Teerlinck J, Dekeyser C, Theuniers G. Periodontal aspects of osseointegrated fixtures supporting an overdenture. A 4-year retrospective study. *Journal of Clinical Periodontology*. 1991;18(10):719-728. doi:https://doi.org/10.1111/j.1600-051x.1991.tb00063.x
9. Cox DR, Oakes D. *Analysis of Survival Data*. Chapman & Hall; 1984.
10. Degidi M, Piattelli A, Iezzi G, Carinci F. Wide-Diameter Implants: Analysis of Clinical Outcome of 304 Fixtures. *Journal of Periodontology*. 2007;78(1):52-58. doi:https://doi.org/10.1902/jop.2007.060139
11. Degidi M, Piattelli A, Iezzi G, Carinci F. Retrospective study of 200 immediately loaded implants retaining 50 mandibular overdentures. *Quintessence International (Berlin, Germany: 1985)*. 2007;38(4):281-288.
12. Degidi M, A. Piattelli, Iezzi G, Carinci F. Do longer implants improve clinical outcome in immediate loading? *Int J Oral Maxillofac Surg* . 2007;36(12):1172-1176. doi:https://doi.org/10.1016/j.ijom.2007.05.014
13. Degidi M, Adriano Piattelli, Carinci F. Immediate Loaded Dental Implants. *Journal of Craniofacial Surgery*. 2007;18(4):965-971. doi:https://doi.org/10.1097/scs.0b013e3180a7724e
14. Degidi M, Piattelli A, Carinci F. Clinical Outcome of Narrow Diameter Implants: A Retrospective Study of 510 Implants. *Journal of Periodontology*. 2008;79(1):49-54. doi:https://doi.org/10.1902/jop.2008.070248
15. Linkow LI, Cherchève R. *Theories and Techniques of Oral Implantology*. C. V. Mosby Company; 1970:74-76.
16. Piattelli A, Paolantonio M, Corigliano M, Scarano A. Immediate Loading of Titanium Plasma-Sprayed Screw-Shaped Implants in Man: A Clinical and Histological Report of Two Cases. *Journal of Periodontology*. 1997;68(6):591-597. doi:https://doi.org/10.1902/jop.1997.68.6.591
17. Søballe K, Hansen ES, B.-Rasmussen H, Jørgensen PH, Bünger C. Tissue ingrowth into titanium and hydroxyapatite-coated implants during stable and unstable mechanical conditions. *Journal of Orthopaedic Research*. 1992;10(2):285-299. doi:https://

doi.org/10.1002/jor.1100100216

18. Søballe K, Brockstedt-Rasmussen H, Hansen ES, Bünger C. Hydroxyapatite coating modifies implant membrane formation. *Acta Orthopaedica Scandinavica*. 1992;63(2):128-140. doi:https://doi.org/10.3109/17453679209154808
19. Gapski R, Wang HL, Mascarenhas P, Lang NP. Critical review of immediate implant loading. *Clinical Oral Implants Research*. 2003;14(5):515-527. doi:https://doi.org/10.1034/j.1600-0501.2003.00950.x
20. Satomi K, Akagawa Y, Nikai H, Tsuru H. Bone-implant interface structures after nontapping and tapping insertion of screw-type titanium alloy endosseous implants. *The Journal of Prosthetic Dentistry*. 1988;59(3):339-342. doi:https://doi.org/10.1016/0022-3913(88)90187-4
21. Eriksson AR, Albrektsson T, Albrektsson B. Heat caused by drilling cortical bone: Temperature measuredin vivoin patients and animals. *Acta Orthopaedica Scandinavica*. 1984;55(6):629-631. doi:https://doi.org/10.3109/17453678408992410
22. Eriksson RA, Albrektsson T, Magnusson B. Assessment of bone viability after heat trauma. A histological, histochemical and vital microscopic study in the rabbit. *Scandinavian Journal of Plastic and Reconstructive Surgery*. 1984;18(3):261-268. doi:https://doi.org/10.3109/02844318409052849
23. Piattelli A, Ruggeri A, Franchi M, Romasco N, Trisi P. An histologic and histomorphometric study of bone reactions to unloaded and loaded non-submerged single implants in monkeys: a pilot study. *J Oral Implantol* . 1993;19(4):314-320.
24. Piattelli A, Corigliano M, Scarano A, Quaranta M. Bone reactions to early occlusal loading of two-stage titanium plasma-sprayed implants: a pilot study in monkeys. *The International Journal of Periodontics & Restorative Dentistry*. 1997;17(2):162-169.
25. Annibali S, Bignozzi I, Iacovazzi L, La Monaca G, Cristalli MP. Immediate, early, and late implant placement in first-molar sites: a retrospective case series. *The International Journal of Oral & Maxillofacial Implants*. 2011;26(5):1108-1122.

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Letter to the Editor

ORAL MANIFESTATIONS OF GLYCOGEN STORAGE DISEASES

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Glycogen storage disease was described as autosomal recessive, and sixteen different mutations have been identified in the gene that encodes hepatic glycogen synthase. Glycogen storage disease type I (GTI) is a rare autosomal recessive disorder that leads to deficiencies of glucose-6-phosphatase catalytic activity (Type Ia) and glucose-6-phosphate translocase (Type Ib) (1); this reduces glycogen storage in the liver of GTI patients, due to a lack of glycogen synthase activity, which causes a marked decrease in liver glycogen content. The characteristic element in GTI is the absence of the hepatic isoform of the glycogen synthase enzyme, and it is responsible for the liver transformation of glucose-6-phosphate in the form of a deposit: glycogen (2).

Unlike other forms of glycogen storage diseases, GTI does not involve the storage of excessive or abnormal glycogen: the glycogen stores are moderately decreased in the liver. The symptoms range from asymptomatic hyperglycaemia to recurrent hypoglycaemic seizures. GTI has an extremely low prevalence, currently around 40 cases documented worldwide.

The clinical history in patients with GTI is that of an infant or child who begins to sleep for an uninterrupted night when he or she no longer receives evening or night meals. Patients with GTI also show acute gastrointestinal disorder or other periods of low food intake. Hypoglycaemia is the primary manifestation of hepatic GTI and can have different degrees, from subclinical to sometimes seizures in the morning before breakfast, even though most of the time, children may be asymptomatic. Mild hypoglycaemic episodes may be clinically unrecognized in patients with GTI; other symptoms of subclinical hypoglycaemia are pallor, drowsiness, sweating, and lack of attention. Uncoordinated eye movements, disorientation, seizures, and coma may accompany severe episodes of GTI. Since glucose cannot be stored as liver glycogen, dietary carbohydrate is converted to lactate, and this results in postprandial hyperglycemia and hyperlactacidemia, alternating with fasting hypoglycaemia and hyperketonemia. The liver is not enlarged, and the short stature of GTI patients is common. Gluconeogenesis from amino acids (alanine) and lipid (glycerol) precursors is also altered in GTI patients, contributing to the prolongation and exacerbation of glycemic imbalance (3).

Under prolonged fasting, the patient with GTI can manifest lethargy, loss of consciousness, nausea, vomiting, seizures, and hypoglycaemic coma. The biochemical profile of GTI patients is represented by the specific fasting

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hypoglycaemia accompanied by hyperketonemia and normal lactate, hyperglycaemia (with glucosuria) and postprandial hyperlactacidemia. In addition, GTI patients show incapacity to transform glucose into glycogen and redirection to lactate conversion but also hyperlipidemia. After prolonged fasting, the increased concentration of free fatty acids lowers the alanine concentration of GTI patients.

In clinical examination, the only distinctive element of patients with GTI is growth retardation and, consequently, short stature. In addition, discrete hepatomegaly (liver steatosis) and osteopenia were recorded in GTI patients. Recurrent hypoglycaemic episodes can cause developmental delay, cognitive deficits, personality deformities and mental retardation in GTI patients.

Diagnosis methods of GTI are the administration of glucose or galactose and observed elevation of blood lactate and lipid after intake for the definitive diagnosis of GTI liver biopsy that has been replaced by gene mutation analysis, a non-invasive diagnosis method (3).

The management of GTI is simple, accessible, and effective in preventing symptoms and acute and chronic complications. Treatment of GTI consists in keeping a balanced and diversified diet and an organized meals program, with breaks no longer than 2 to 4 hours, rich in complex carbohydrates with low glycemic index and proteins during the day and low in simple carbohydrates, accompanied by a meal of unpacked starches before sleeping or during the night (4)

Oro-maxillo-facial aspects

Oro-maxillo-facial aspects of patients with GTI show a physically and psychologically balanced patient, a slight mismatch between biological and chronological age, with the first dental eruption in deciduous teeth at a normal age but with normal development and a slight delay in the occurrence of 6-year-old molars correlated with delayed bone age. Oral manifestations of the GTI disease present extensive generalized inflammation of the gingiva, erythema, ulceration, and generalized deep periodontal pocketing with bleeding on probing. Generalized severe horizontal bone loss could be noted radiographically. Current evidence indicates that the neutrophil is protective in the periodontium (5). Thus, GTI patients with aberrant neutrophil production or behaviour often have early-onset, severe forms of gingivitis and/or periodontitis, particularly evident in patients whose neutrophils are chemotactically defective. In patients with GTI, dental care should be focused on primary prevention and early recognition of dental and periodontal diseases. Understanding the pathophysiology of GTI will enhance the ability for its clinical management and, hopefully, for the future development of a cure.

Primary prophylaxis of GTI patients involves observing rigorous oral hygiene by performing a dental brush with an electric brush and fluoride kinds of toothpaste (over 1000ppm F) at least twice daily, the duration of a brush being 2 minutes. Antiseptic mouthwashes, dental floss, interdental brushes, or other antimicrobial drugs are also recommended. Considering the child's feeding habits during the night, it is recommended to rinse the oral cavity with clean water immediately after the meal. With the eruption of 6-year-old molars, dental sealings and local fluoridation are indicated to prevent cavities. In conclusion, since children with GTI are much more susceptible to developing periodontal disease, prevention is an effective tool for maintaining good oral health.

REFERENCES

1. Hicks J, Wartchow E, Mierau G. Glycogen Storage Diseases: A Brief Review and Update on Clinical Features, Genetic Abnormalities, Pathologic Features, and Treatment. *Ultrastructural Pathology*. 2011;35(5):183-196. doi:10.3109/01913123.2011.601404
2. Chen Y, Burchell A. *Glycogen Storage Diseases. In the Metabolic and Molecular Bases of Inherited Disease*. (Scriver C, Beaudet, A, Sly W, Valle D, eds.). McGraw-Hill, Inc.; 1995:935-965.
3. Özen H. Glycogen storage diseases: New perspectives. *World Journal of Gastroenterology*. 2007;13(17):2541. doi:10.3748/wjg.v13.i18.2541
4. Heller S, Worona L, Consuelo A. Nutritional Therapy for Glycogen Storage Diseases. *Journal of Pediatric Gastroenterology and Nutrition*. 2008;47(Suppl 1):S15-S21. doi:10.1097/mpg.0b013e3181818ea5
5. Ley K, Laudanna C, Cybulsky MI, Nourshargh S. Getting to the site of inflammation: the leukocyte adhesion cascade updated. *Nature Reviews Immunology*. 2007;7(9):678-689. doi:10.1038/nri2156