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Influence of titanium and titanium-zirconium alloy as implant materials on implant stability of maxillary implant retained overdenture: a randomized clinical trial

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Abstract

Background Long-term success of implant restoration depends on many factors one of them is the sufficient implant stability which is lowered in compromised bone density sites such as the maxilla as it is categorized as type III & IV bone, so searching for a new innovation and updates in implant material and features is very mandatory. So, the aim of this study was to compare between two implant materials (roxolid and traditional titanium) on the primary and secondary stability of implant retained maxillary overdenture.

Methods Eighteen completely edentulous patients were selected. All patients received maxillary implant-retained overdentures and lower complete dentures; patients were divided equally into two groups according to the type of implant materials. Group A received a total number of 36 implants made of roxolid material and Group B received a total number of 36 implants made of traditional titanium alloys. Implant stability was assessed using ostell device, the primary implant stability was measured at the day of implant installation however, secondary implant stability was measured after six weeks of implant placement. Paired t-test was used to compare between primary and secondary stability in the same group and an independent t-test was used to compare between the two groups with a significant level < 0.05.

Results Independent t-test revealed a significant difference between the two groups with p -value $= 0.0141$ regarding primary stability and p-value < 0.001 regarding secondary stability, as roxolid implant group was statistically higher stability than titanium group in both. Paired t- test showed a statistically significant difference in roxolid implant group with p-value $= 0.0122$ however, there was non-statistically significant difference in titanium group with p-value $= 0.636$. Mann Whitney test showed a significant difference between the two groups regarding amount of change in stability with p value $= 0.191$. roxolid implant group showed a higher amount of change in stability than the titanium implant group.

Conclusion Within the limitation of this study, it could be concluded that: Roxolid implants showed promising results regarding primary and secondary stability compared to conventional Titanium implants and can be a better alternative in implant retained maxillary overdentures.

Trial registration Retrospectively NCT06334770 at 26–3-2024.

Keywords Implant Stability, Roxolid, Ostell

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Background

Implant-supported prostheses have superior durability and longevity compared to traditional removable prostheses. It offers numerous advantages in terms of functionality, bone preservation, longevity, oral health, and improved quality of life. it provides a stable and long-term solution for missing teeth, contributing to the overall well-being and satisfaction of patients [1].

Implant placement in the maxilla presents several challenges compared to the mandible due to anatomical, physiological, and biomechanical reasons. Some of the common challenges associated with implants in the maxilla include: Bone quality and quantity as the maxillary bone is often less dense and has poorer quality compared to the mandibular bone, which can compromise initial stability and osseointegration of implants, also the upper jaw tends to undergo more bone resorption over time, especially after tooth extraction, which can further reduce the volume and quality of the available bone for implant placement. The maxillary sinuses are susceptible to pneumatization, which might result in lack of bone height in the posterior maxilla, Also, achieving harmonious gingival esthetics can be challenging, especially in cases with thin biotype or compromised soft tissue quality [2–4].

Titanium is the most commonly used material for dental implants because of its biocompatibility, strength, and corrosion resistance. It works well with the human body and integrate easily with the surrounding bone tissue. With long-lasting property and of low maintenance [5, 6].

While titanium implants are widely used and have a high success rate, they present some limitations in certain cases such as severe bone loss or complex oral anatomy, which are challenging for titanium implants as they require a certain amount of bone for successful placement and integration [7].

New technologies are emerging in dental implant material and surface treatment hold great potential for improving the success and longevity of dental implants, such as; nanostructured surfaces that have shown promise in promoting faster and stronger osseointegration or laser surface treatment that modify the surface roughness and chemistry. Also, titanium-zirconium alloys (roxolid), are gaining attention as an alternative to traditional titanium implants. Better mechanical qualities, such as increased strength & decreased elastic modulus, are offered by these alloys [8].

The Roxolid Bone Level implant achieve optimal crestal bone preservation & soft tissue stability, as it is made of Roxolid material, which is composed of eighty-five percent titanium & fifteen percent of zirconia. Roxolid is a revolutionary substance that was developed uniquely for the purpose of being utilized in the field of dental implantology. Compared to pure titanium, the titanium-zirconium alloy is significantly more robust & possesses exceptional osseointegration capabilities. Furthermore, in addition to its remarkable biological quality, it possesses a high mechanical strength, superior tensile & fatigue strength compared to pure titanium, and excellent osteoconductivity. For all indications, the implant surface is made of SLActive, which greatly speeds up the osseointegration process & enables a more secure and expedient healing process occurring in three to four weeks [9].

It was mentioned by Ayna et al. [10] that roxolid material has demonstrated a higher resistance to loading stresses in comparison to the standard, pure titanium implants. Additionally, roxolid material has demonstrated superior corrosion resistance in comparison to titanium and a strength that is up to forty percent higher than titanium. This ensures that roxolid material will become the dominant implant material of the day.

In the situation of restricted inter-dental space in the anterior region, Alsharif [11] discovered that a narrow-diameter 2-piece roxolid implant was a reliable treatment option. As, it offers a stable gingival tissue & marginal bone that supported the implant & there were no signs of peri-implant illness.

According to the definition of primary stability (PS), the absence of mobility in the bone bed following the placement of the implant is what is meant. It influences the longevity of dental implants & the success of their osseointegration. PS can be affected by several factors, including the drilling speed that is utilized during osteotomy, the torque that is applied to the implant throughout insertion, & the density of the bone that is being treated. In addition, when compared to cylindrical dental implants, tapered dental implants exhibit a mechanical stability that is significantly higher. PS can also be affected by other factors, including the size of the implant (length & diameter), the surface features (moderately rough or smooth), & the number and shape of the threads that are present on the surface of the implant [12].

Primary stability, bone formation, remodeling, interference-free healing phase, in addition to material-dependent variables as implant surface, design, & appropriate biocompatible material have an impact on secondary stability, which is developed through the process of regeneration, remodeling of the bone and tissue surrounding the implant after it has been inserted. The secondary stability of the implant is determined by the surface of the implant, in conjunction with the use of materials that are biocompatible [13].

After the first osseointegration phase, which for most implant systems typically lasts 4–6 months, secondary stability is frequently evaluated. several innovative implant technologies and materials—such as aggressively

double threaded and roxolid implants—can allow secondary stability evaluation two to three weeks following implant implantation [14].

According to a number of studies, the earliest time to verify implant stability is usually six to eight weeks following surgery. The right time to evaluate secondary implant stability depends on the type of implant, where it is placed, and whether there are any other factors, such as smoking or systemic illnesses. According to a report, the dentist should finally decide on this based on the patient's traits, the implant system that is being used, and their expertise [15, 16].

There are numerous devices available to evaluate implant stability. These devices can be applied at different points in time throughout the implant loading and healing processes. Techniques for these operations can be divided into invasive & non-invasive categories. Pull-out and pushout attempt as well as the evaluation of removal torque were the only intrusive techniques available for the quantitative testing of primary stability in the past. Implant stability can be evaluated in clinical settings using non-invasive vibration analysis techniques, which can employ either transient or continuous excitation [17].

Resonance frequency analysis (RFA), a novel technique for assessing implant stability, was released in 1996. This RFA technique is a simple way to measure quantitative stability that can be utilized in both surgical and non-surgical settings. On a scale that ranges from one to one hundred, an implant stability quotient (ISQ) is estimated, and used to assess the implant's health. An implant's complete integration is typically measured between 45 and 85 ISQ. Implant failure is indicated by measurements of less than 45, whereas success is indicated by an ISQ value of 60 to 70 [18].

Semenzin et al. [19] conducted a study to evaluate the sensitivity & reliability of Osstell in comparison to Periotest. They concluded that RFA is more reliable & sensitive than Periotest.

Objectives

This research was carried out with the purpose of analyzing & contrasting the effects of two different implant materials on the stability of implant retained maxillary overdentures.

Methods

This study was performed following the consort guidelines on eighteen completely edentulous patients that were selected from the out-patient clinic of Prosthodontics Department, Faculty of Dentistry, Ain Shams University. Patients were rehabilitated with implant retained maxillary overdentures and mandibular complete dentures.

On the basis of the findings of previous research conducted by Mañes Ferrer et al. [20], a calculation of the sample size was carried out with the help of G*Power version 3.1.9.7. For the purpose of rejecting the null hypothesis that there is no distinction among the groups, a power analysis was constructed to have sufficient power to apply a statistical test with two sides. By using an alpha level of 0.05 & a beta level of 0.2, which means that the power is equal to eighty percent & the effect size (d) is equal to 1.90, respectively, which was determined based on the findings of a prior research. It was anticipated that there would be a total of (18 cases) with (9 cases) belonging to each group.

The nature of the research & the purpose of the research were explained to each patient in a comprehensive manner. They gave their agreement to take part in the research & signed a paper indicating that they were aware of all the procedures that were going to be carried out. Every participant received information regarding their rights, legal responsibilities, & privacy policies that they were required to follow. According to the principals, the research was carried out in accordance with the guidelines that were accepted by the Faculty Ethical Committee of the Faculty of Dentistry at Ain Shams University (FDASuRecD032136). Individuals were informed to have a well-fitting replacement complete denture in the event that the implant therapy was unsuccessful.

The research was retrospectively registered on the website www.clinicaltrials.gov with the registration number NCT06334770 at 26–3-2024.

The same skilled oral & maxillofacial prosthodontist was responsible for carrying out each & every one of the interventions that were performed and has finished the prosthetic treatments for every one of the participants.

Patient selection

Inclusion criteria included patients whose ages ranged from forty-five to sixty years old, individuals who were completely edentulous (meaning that their last extraction should have occurred at least six months prior to implant placement), individuals who had good oral hygiene, had sufficient inter-arch space (at least 11 mm) that was diagnosed by mounted diagnostic casts, mucosa that was firm & healthy covering the residual alveolar ridge, without any signs of inflammation, individuals who had the following criteria were excluded from the study such as: people who smoked heavily, had parafunctional habits, had TMJ illnesses, individuals who had systemic diseases that could interfere with implant placement or affect bone healing, such as thyroid and uncontrolled diabetes, and individuals who were undergoing chemotherapy and radiotherapy.

A direct interview and a questionnaire sheet were used specifically for this trial (uploaded as a supplementary file) to collect exact information on the individuals' personal, medical and dental histories. Questions were posed to individuals regarding the reasons for teeth extraction.

In order to identify any facial abnormalities, tempro mandibular joint abnormalities, symptoms of inflammation, or pathology, an extra-oral examination was carried out to follow the protocols that were considered to be standard. Evaluation of vertical dimension of the face and determination of Angle's classification were also carried out.

Intra – oral examination was performed following routine procedures to examine denture bearing mucosa, border tissues, abnormal soft tissues this was objectively tested by finger palpation and the residual ridge was checked by CBCT to exclude any abnormal ridge condition [21, 22] (Fig. 1A).

Preoperative CBCT using Planmeca Ultra Low dose imaging machine (Fig. 1B): was obtained to ensure presence of adequate bone height and width to accommodate a standard size implant for restoring the maxilla. Evaluation of the quality, amount of the bone, looking for any pathological lesions at the edentulous ridge as well as any teeth that have impacted or roots that were still present were done. A provisional jaw relation was established, and diagnostic casts were mounted on the articulator. A trial set-up of artificial teeth was performed on the mounted diagnostic casts at the same time in order to evaluate the interocclusal distance and class I maxillomandibular relationship.

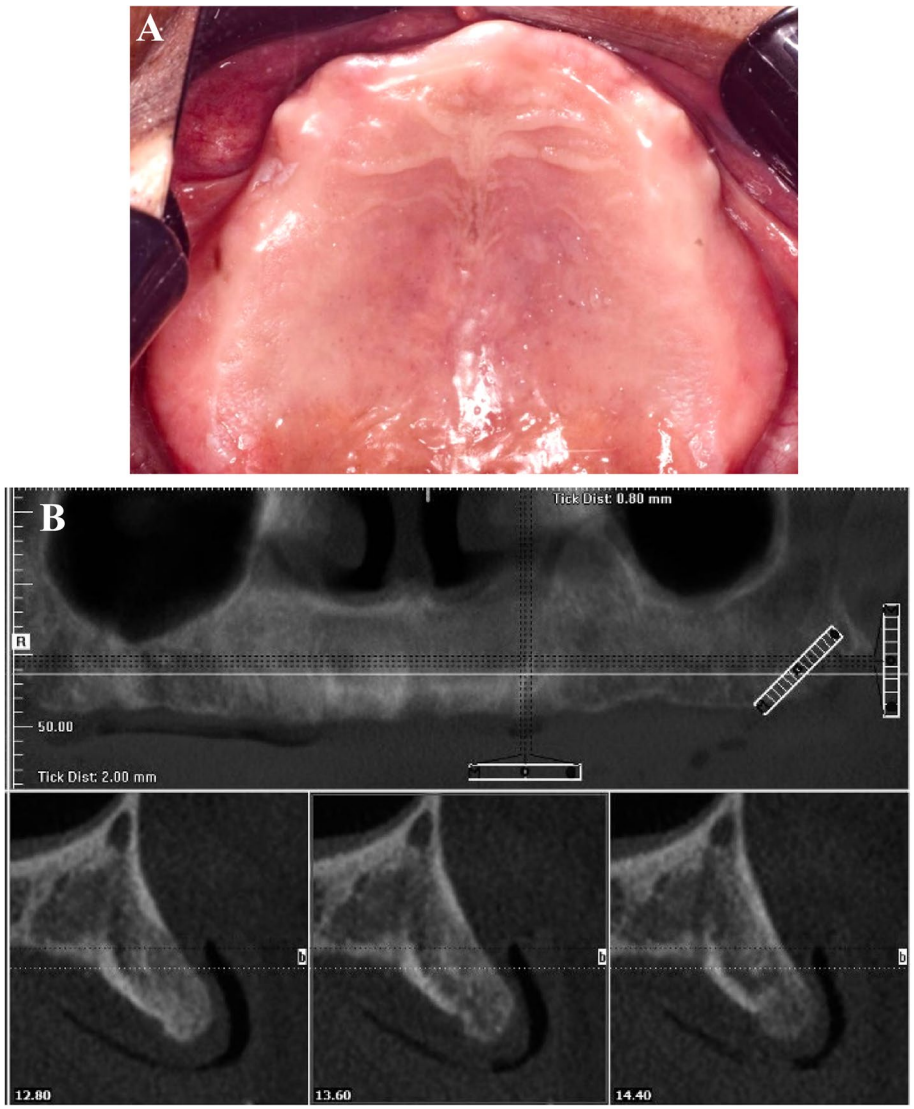

Fig. 1 **A** Completely edentulous maxilla, **B** Preoperative CBCT

The presurgical steps

Fabrication of upper and lower complete dentures was done following the conventional technique. The upper complete denture was used as a radiographic stent upon which four cones of gutta percha were attached in the planned positions of implants (canines and second premolars). A cone beam computed tomography (CBCT) scan was performed on each patient while they were wearing the maxillary & mandibular dentures (Fig. 2A).

For each patient, a surgical guide was fabricated as follows; patient's CBCT while wearing the denture with the markers was superimposed over a CBCT of the denture, and proper planning for the exact implant position and designing the surgical guide was made using a special software (Bluesky bio, planning software, Spanich). Then printing of the surgical guide with holes for three anchor pins (one long and two short) using clear acrylic resin material (Clear SG- GUIDE – Resin,USA) has been done using a 3Dprinter (Phrozen sonic mighty 3D printer 4 K, India) (Fig. 2B and C).

Patients grouping

The individuals were allocated randomly into two equal groups using special software clinstat randomization software as follow: Group A(Roxolid): nine patients were rehabilitated with implant retained maxillary overdenture using four Roxolid implants (Straumann AG, Basel, Switzerland) and Group B(Titanium): nine patients were rehabilitated with implant retained maxillary overdenture using four conventional titanium implants (JD Revolution Plus, JD Care).This randomized clinical trial was double blinded as all the participants and the data collector were blinded while the oral & maxillofacial prosthodontist who was responsible for carrying out each & every one of the interventions that were performed and has finished the prosthetic treatments for the participants were informed about the type of the implant used.

For both groups, implants were selected with the following criteria: tapered, self-tapping, threaded with the same dimensions (3.7 mm diameter and 10 mm length).

The surgical steps

All instruments used during surgery were adequately sterilized. The diagnostic instruments, surgical instruments, implant surgical guide kit and hand piece were autoclaved at 135 C for 30 min. Patients were given infiltration anesthesia in anterior, canine, and premolar areas of the maxilla and palatal infiltration. Surgical guide was placed in individual's mouth with the lower denture and the squash bite was taken to ensure correct position of the guide and then fixed in the individual's mouth using the three anchor pins (Fig. 3).

A soft tissue punch was used then the guide was removed to wipe out punched excess tissues by Adson tissue forceps and the guide was reseated again (Fig. 4A). The requisite depth was achieved through the utilization of a pilot drill (clockwise drill speed of 800–1500 revolutions per minute with ample watering) (Fig. 4B). Sequential drilling was made respectively until finishing the osteotomy (Fig. 4C, D). Utilizing both internal & exterior irrigation (the handpiece) with saline, regular irrigation was performed on the plant. Suction was carried out using a high-volume suction machine. As the procedure was being fully directed and rotated clockwise with the finger driver, a sterile vial that contained the implant was opened, and the implant was placed through the guide into the osteotomy site by means of the guide. The ratchet wrench was then used until the implant was fully seated (Fig. 5A and B). The procedure was carried out once more for each implant.in each group according to its unique surgical kit.

Assessment of primary and secondary stability

For both groups implant Stability Quotient (ISO) was measured using ostell mentor (Integration Diagnostics AB third generation). The magnetic transducer (smart peg type 32 diagnosis AB, Sweden) was screwed directly on the implant. The probe was held perpendicular to the alveolar crest for the measurement, and the smart peg must maintain approximately 1-3 mm, angle of 90 degrees, and 3 mm above the soft tissue, as advised by OSSTELL (Fig. 6A, B). After assessment, the smart peg was removed and replaced by a cover screw (Fig. 6C). Patients were instructed to apply extra-oral ice bags after surgery, to follow post-surgical medications (Antibiotics, analgesics, and antiseptic mouth wash) and proper oral hygiene measures. After seven days, the denture was relieved and lined by soft liner. The denture was finished, polished, and inserted into the patient's mouth. After six weeks of implant placement, secondary stability was measured for both groups as follow (Fig. 6D). The implant position was located by the tip of the probe using the surgical guide, then infiltration anesthesia was given to the patient, top of the implant was exposed through small incision then the cover screw was removed, and the smart peg was screwed on the implant to measure the secondary stability. Data of primary and secondary stability for both groups were collected, tabulated, and sent for statistical analysis.

Implant loading and attachment pick up

After a period of six months, the implant fixtures were exposed, and attachments were affixed to the implants. Following this, a recess was created in the fitting surface

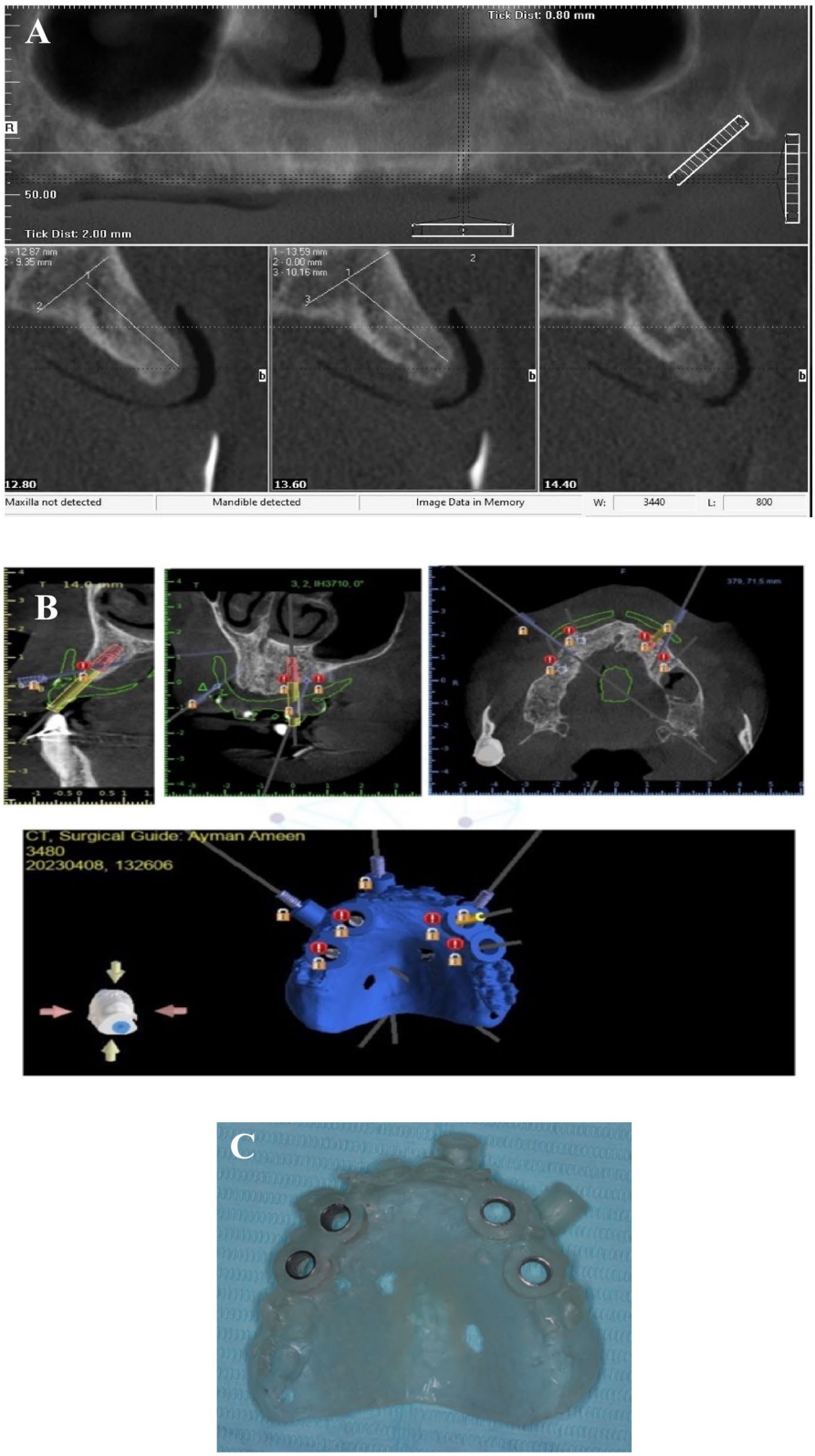

Fig. 2 **A** CBCT of patient with the maxillary denture, **B** Digital implant planning and guide designing, **C** Printed Guide from clear acrylic resin

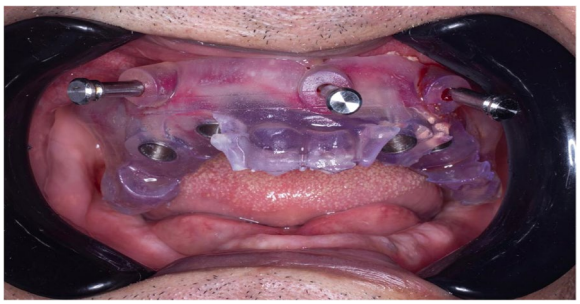

Fig. 3 Surgical guide stabilized intraorally using stabilizing pins

of the denture base by means of a round bur. The lining material bonding agent was then applied into the recess of the denture base. Finally, hard pickup material (GC America, Inc. GC hard liner, il60803, USA) was added, and the denture was fully seated in the mouth of the patient. The individual was instructed to keep their mouth in a centric relation until the hard denture liner had completely cured. After the excess acrylic resin was removed, the denture was completed & polished to a beautiful shine. The denture was rechecked for its fit and occlusion while it was in the centric relation position. The instructions for the individual's home care were provided to patients.

Statistical analysis

A Kolmogorov–Smirnov test was performed on the data, & the results indicated that the data followed a normal distribution. A comparison between two groups with quantitative data and parametric distribution was carried out with the use of independent t-test. It was determined that paired t-test was the most appropriate method for the comparison within the same group using quantitative data and parametric distribution. Mann Whitney test was used to compare between amount of change in stability between the two groups. Version 23 of the Statistical Package for the Social Sciences (IBM SPSS) was utilized to conduct the statistical analysis. The quantitative data were presented in the form of means and standard deviations. An accepted margin of error of five percent was established, along with a confidence interval of ninety-five the *p*-value was deemed substantial in the subsequent manner.

Results

Group A (Roxolid implants) exhibited a significant difference between primary & secondary stability (after 6 weeks), as indicated by a p value = 0.0122. However, in group B (Titanium implants) there was a non-significant difference between primary and secondary stability with p value = 0.636. Mean and standard deviation values are listed in Table 1.

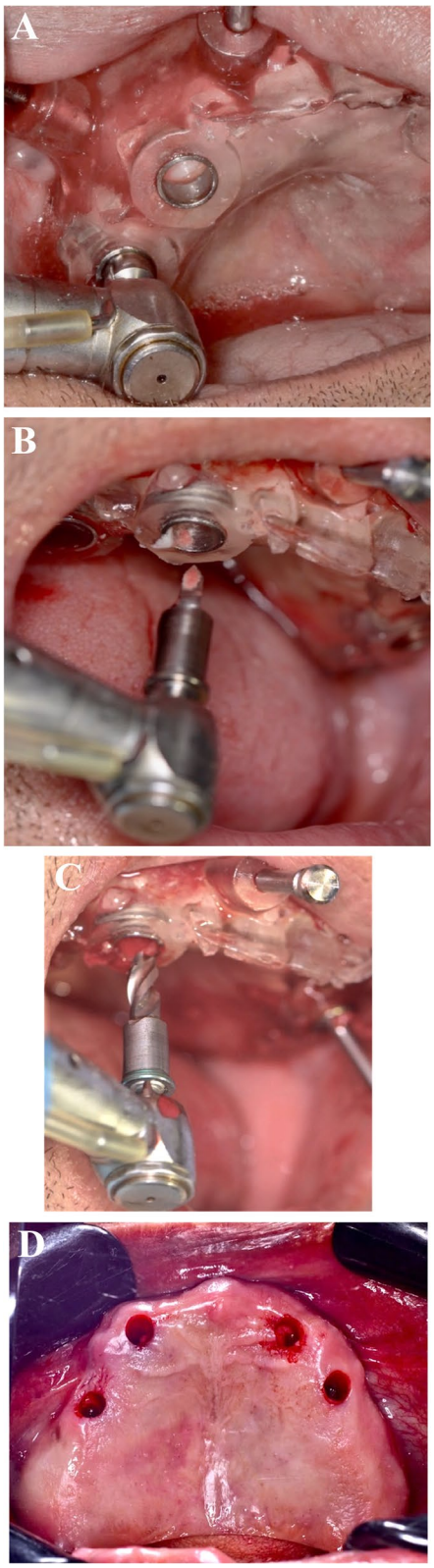

Fig. 4 **A** Soft tissue punch, **B** Point of entry after tissue punch, **C** Sequential drilling starting the narrowest diameter and gradually increase, **D** Prepared four osteotomies

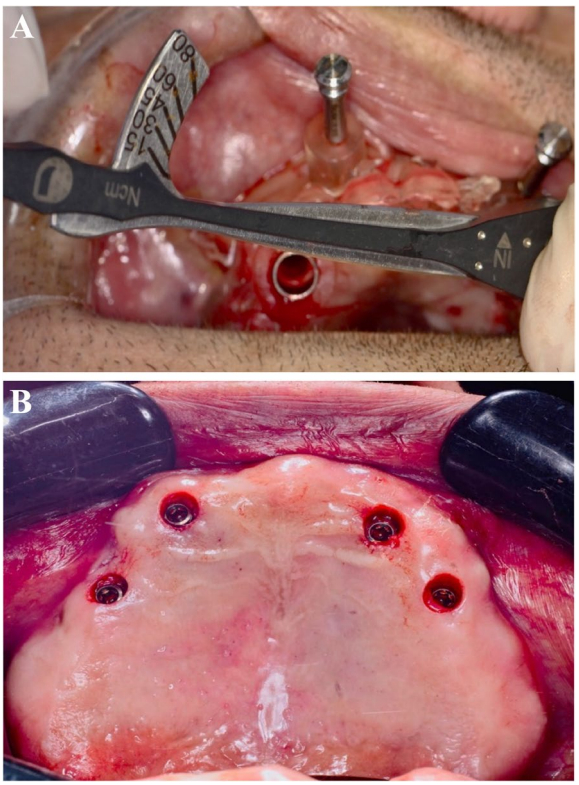

Fig. 5 **A** Implant inserted using ratchet wrench,**.** Four implants fully seated in the osteotomies

Statistical analysis for comparison among the two groups concerning mean values of primary stability showed a significant difference between them, p value = 0.014 and upon comparing the mean values of secondary stability between the two groups, a highly significant difference was found, p value < 0.001. The higher primary and secondary stability values were found in group A (Roxolid). Mean and standard deviation values are listed in Table 1.

Mann Whitney test demonstrated a significant difference between the two groups regarding amount of change in stability with p value = 0.0198. Roxolid implant group showed a higher amount of change in stability as shown in Fig. 7.

Discussion

Patients in this study were chosen as completely edentulous arches to be sure that we have sufficient inter-arch space for implant placement. Maxilla was chosen for implant placement for its bone nature and inter trabecular space of the maxilla as bone density of maxilla was D3 and D4 with wide inter trabecular space. So, we have chosen the maxilla to show the effect of this new alloy in this bone type [23, 24].

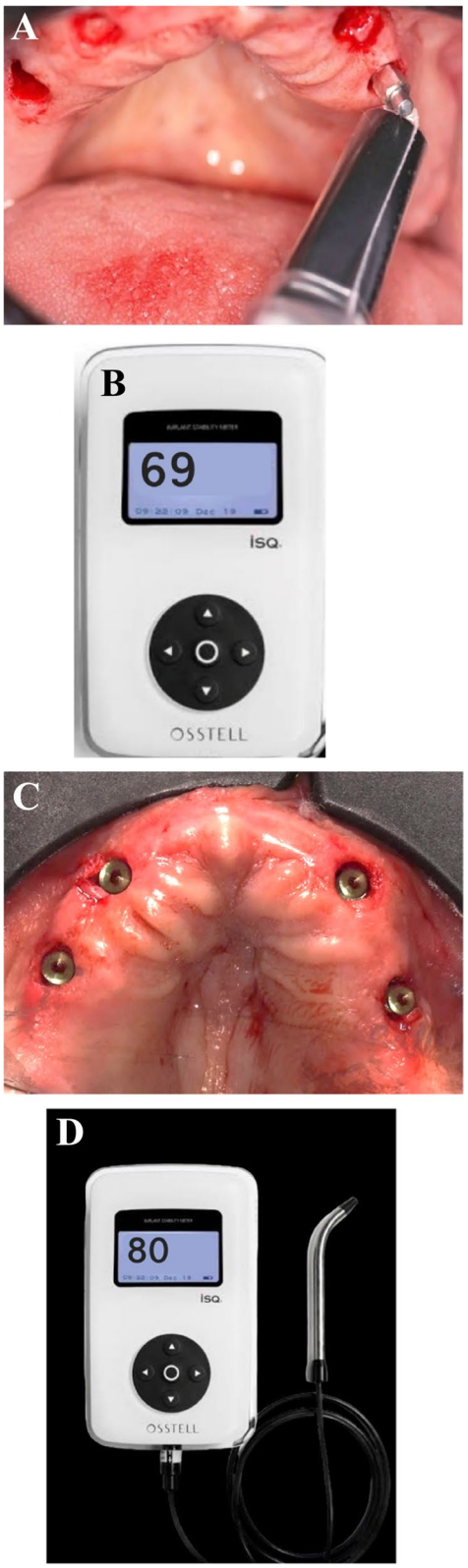

Fig. 6 Measurements of stability: **A** OSSTELL probe & smart peg, **B** Reading assessment of Primary Stability, **C** Implants covered by cover screw, **D.** Reading assessment of secondary stability

Table 1 Mean and standard deviation of primary and secondary stability in group A (Roxolid implants) and group B (Titanium implants)

	Group A (Roxolid)	Group B (Titanium)	*P*-value	Sig
Primary stability	**Mean ± SD** 77.1 ± 4.21	**Mean ± SD** 70.22 ± 6.20	0.0141*	S
Secondary stability	**Mean ± SD** 81.66 ± 2.39	**Mean ± SD** 71.55 ± 5.50	< 0.001**	HS
P-value	0.0122*	0.636		
Sig	S	NS		

P-value > 0.05, Non significant (NS), *P*-value < 0.05, Significant (S), *P*-value < 0.001, highly significant (HS)

Preoperative CBCT using Planmeca Ultra Low dose imaging machine was used as this method provides an optimal balance between image quality and low dose, making it ideal for wide range of clinical cases as implant planning [25].

Gutta-per cones were placed in the denture with known sizes; as it appears on radiation images. This radiopacity helps in distinguishing the Gutta-percha cones from other structures in the CBCT images, such as bone, teeth, and soft tissues and acts as radiographic markers [26].

The benefits of roxolid implants have been demonstrated in a number of studies. These advantages include the ability to be placed in edentulous spaces that are both small & in-adequate in bone width, placement in severely resorbed ridges due to their shorter height, minimally invasive surgery, excellent primary stability, faster osseointegration & increased resistance to peri-implantitis [27, 28].

Threaded implants were selected to be used in this study with standard size implants 3.7 mm in diameter, and 10 mm in length as implants shorter than 10 mm present a hight risk of failure and the threads increase the area of contact between the implant and the surrounding bone to gain higher primary stability during the initial healing period [29–31].

Cover screws were used to preserve the natural of the soft tissues surrounding implant site, promoting healthy tissue healing and good aesthetics. Cover screws typically flush the surrounding gum tissue, thus reducing risk of occlusal interference it is easier for patients to clean [32].

Ostell device was used for measuring implant stability as its effectiveness was proved by many studies before,as it provides accurate, repeatable and reliable measurements of implant stability, helps to assess the osseointegration process, allows for early detection of implant stability and osseointegration [33, 34].

Secondary stability was evaluated in the same manner as primary stability after the implant had been in place for a period of six weeks. According to Meiyao et al. [35], the ISQ fluctuates along the course of osseointegration between the implant and the bone. During the process of osseointegration, the initial mechanical stability is eventually replaced by the biological stability of the bone. It is a widely held belief that the ISQ will go through a phase of decreasing and then increasing as a result of the drop in initial stability and the increase in secondary stability. Approximately four to five weeks following the operation, the ISQ value reaches its lowest point [36].

This coincides with the result of Mahmoud et al. [37] that stated that all implants with SLActive surface showed sufficient secondary implants stability after six weeks of implant placement.

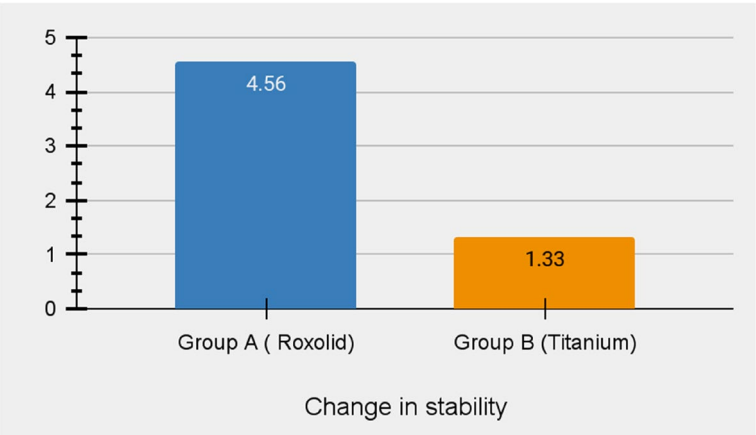

Fig. 7 Bar chart showing comparison between the two groups regarding amount of change in stability

In different researches, the stability of the main implants was evaluated at the time of surgery. Subsequently, the secondary stability was evaluated after three & six weeks of preparing the implant sites using two distinct methods. The results of this research revealed that the lowest values for implant stability were found to be at three weeks following placement for all bone types, and there was a considerable increase in the stability after six weeks [38, 39].

Results of this study showed that in group A (Roxolid implants) there was a significant difference between primary and secondary stability, this may be attributed to that the BLX implant is a combination of Roxolid® alloy and SLActive® surface. This provides an elevated mechanical property of the Roxolid® alloy. In addition, the excellent behavior of the SLActive® surface allows for shorter osteointegration time which provides a higher secondary stability in short time, better results in immediate loading protocols and better healing of peri-implant defects in cases of immediate implant placement [40].

Roxolid implants have shown to have excellent osteointegration, which is the process by which implant fuses with surrounding bone. Producing a strong bond between the implant and bone, allowing for successful integration of the implant into jawbone. Roxolid implants have lower levels of bone resorption compared traditional titanium implants. So that there is less loss of bone surrounding the implant over time, and better corrosion resistance these properties can maintain the stability and longevity of the implant [41].

Titanium-zirconium alloy used in Roxolid implants has been shown to biocompatibility, meaning that it is well-tolerated and does not elicit an inflammatory response. This can help reduce the risk of implant failure and promote better healing and integration of the implant [42].

On the other hand, results of this research demonstrated that in group B (Titanium implants) there is non-significant difference between primary and secondary stability this may be attributed to that the existing acid etched conventional titanium implants, which has a hard structure and a higher strength that is 5–10 times stronger than bone. It is worth noting that a significant mismatch between implant strength and bone strength can contribute to overloading, also the acid etched surfaces are not enhancing the early osteointegration due to lack of hydrophilicity [43, 44].

The outcomes of this research also demonstrated that when comparing the two tested groups, group A (Roxolid implants) was significantly higher than group B (Titanium implants) in both primary and secondary stability. This may be due to different factors such as, the aggressive sharp double threads of Straumann implants. This design allows for efficient and fast insertion. It also provides ideal primary stability and optimized insertion torque in all types of bone through uniform and controlled compaction and densification of the peri-implant bone and due to combination between the roxolid material and SLActive surface that enhances the osteointegration and the mechanical properties [45–47].

Adding titanium to zirconium alloy has been shown have higher mechanical strength than pure titanium. This increase in strength can result in better resistance to fractures or failures under stress, making Roxolid implants more durable., Roxolid implants have lower modulus of elasticity that reduce the "stress shielding" effect and eventually lead to implant failures., allowing for better adaptation to the surrounding bone tissue. can result in improved stability and reduced stress on the implant-bone interface [48].

The improved mechanical properties of Roxolid may lead to reduced micro-movements at the bone-implant interface, which help prevent bone resorption over time. Surface characteristics of Roxolid implants have been designed to promote faster and more efficient osteointegration, this can result in quicker healing times and improved implant stability [49].

These results come in agreement with many investigations, Marković et al. [50] that found that SLActive dental implant surfaces had a successful functional loading at 6 weeks in the posterior maxilla as they are chemically active and hydrophilic SLActive surfaces significantly promote the initial healing reaction allowing early loading in the maxilla due to fast osseointegration process and high implant stability.

In the absence of cortical bone at the implant recipient location, Marie et al. [51] suggested that the design of BLX implant systems might function as a suitable alternative. When it comes to implant insertions at the posterior maxilla, this fact is more likely to be of clinical significance, and it may be favored in situations when type IV bone is present.

Imai et al. [52] found that BLX implants group showed the highest values of stability compared to different designs due to its aggressive, wide threads and roxolid material. According to these findings, the choice of implant is an important factor in achieving primary stability, particularly in regions where soft bone is present.

Fernandes et al. [53] who concluded that BLX (titanium, zirconium) implants provide high strength with excellent osseointegration and stability in narrow interdental spaces when compared with pure titanium and pure zirconium implants, as they are used in narrow diameters and preserve vital structures and vascularization.

Conclusion

Within the limitations of this study, it could be concluded that: Roxolid implants showed promising results regarding primary and secondary stability compared to conventional Titanium implants and can be a better alternative in implant retained maxillary overdentures.

Recommendation

Based on the results of this study it was recommended to:

- Evaluate primary and secondary stability after using different types of attachments.
- Evaluate primary and secondary stability with different special ridge cases as single dentures, flat ridge and thin wiry ridge.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-024-04692-x.

Supplementary Material 1.

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Authors' contributions
H.E. Conceptualization. A.I. Methodology, writing original draft, review, editing and data curation. SH. L. Conceptualization, reviewing original draft and editing. S.M. reviewing original draft, methodology and editing.

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Availability of data and materials
The data will be available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate
Ethical approval was granted by the ethical committee in (Ain shams university, cairo, Egypt) (FDASURecD032136). All methods were carried out in accordance to relevant guidelibes. Informed consent was obtained from the patients in the removable prosthodontics department in Ainshams university and a sample of these consents was uploaded in the supplementary files.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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