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## Effect of two different surface treatments on implant stability

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**Aim:** The purpose of this research was to compare the effects of two different implant surface treatments (Direct laser metal forming and Acid etching) on implant stability in All-on-4 implant retained mandibular overdentures.

**Materials and methods:** In this investigation, 14 male patients were chosen. For each patient, four implants were inserted in the inter-foraminal region using the All-on-4 concept. The patients have been randomly separated into 2 groups according to the surface treatment of the dental implants. In group I patients were rehabilitated with an upper complete denture and a lower retained overdenture using All-on-4 concept with Direct Laser Metal Forming surface treated dental implants, while in Group II patients were rehabilitated with an upper complete denture and a lower retained overdenture using All-on-4 concept with acid etched surface treated dental implants. Utilizing the osstell device, resonance frequency analysis was used to measure and compare primary and secondary implant stability at the time of implant placement and at 3, and 6 months later.

**Results:** Comparison was performed between the straight implants of both groups and revealed that implant stability of group I is significantly higher than group II after 3 months and after 6 months, while revealed insignificant difference between them at the time of insertion. Comparison was performed between the angled implants of both groups and revealed that implant stability of group I is significantly higher than group II after 3 months and after 6 months, while revealed insignificant difference between them in time of insertion.

**Conclusion:** Direct Metal Laser Forming surface treatment increases secondary stability of angled implants supporting All-on-4 temporary prosthesis.

**Keywords:** All-on-4, acid etching, laser metal, implant stability.

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## Introduction

The use of dental implants has improved the rehabilitation of edentulous patients. The usage of two implants to hold mandibular overdentures in place was suggested with favorable clinical results, but still, it doesn't accomplish the patients' in most cases.<sup>1</sup>

Placing more implants to improve the situation and allow the patient to have a fixed prosthesis was a hard task to achieve especially when treating patients with severely resorbed ridges, as they require complex surgical procedures before placing dental implants.<sup>2</sup>

The All-on-4 technique was introduced to rehabilitate severely resorbed ridges. It permits fast prosthetic rehabilitation of patients who seek a minimal surgery time with a decreased number of implants and without losing the expectations of success in the therapy, which is something that gives rehabilitation therapies with little morbidity and reduced costs. Cases with extensive resorption can be rehabilitated without the need for bone grafting treatments.<sup>3</sup>

Endosseous implants are traditionally placed after the bone has healed, which takes around 3 months for the mandible and 6 months for the maxilla. Modifications of this therapy procedure employing immediate loading of implants are now used as a therapy method for tooth-missing rehabilitation. Implant stability is important for using immediate loading protocol.<sup>4</sup>

While the secondary (biological) stability of the implant is determined by bone regeneration and remodelling processes, primary stability is related to an implant's mechanical engagement with the surrounding bone. A positive correlation exists between a secondary stability and a primary stability that is secure. The extent of implant stability could also be affected by the condition of surrounding tissues. Among the most important clinical factors that influence primary stability are bone quality and

quantity, the geometry of the implant, and the surgical technique used.<sup>5</sup>

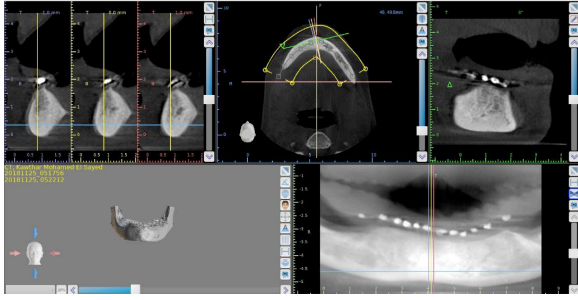
The most commonly used method for evaluating implant stability is currently resonance frequency analysis (RFA).<sup>6</sup> This study's goal was to compare the stability of porous implants constructed with direct metal laser forming (DMLF) with acid etched surface-treated implants regarding primary and secondary stability.

## Materials and methods

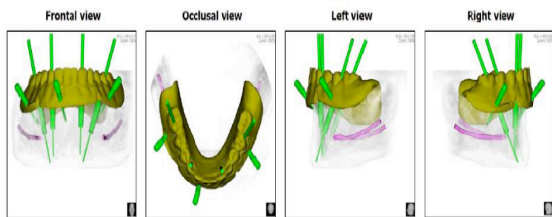
Fourteen male patients have been selected to participate in the current study from the oral and maxillofacial department's outpatient clinic at Ain Shams University's Faculty of Dentistry. Patients have been chosen according to certain inclusion and exclusion criteria to assess their eligibility for the study. To fulfill the predetermined criteria, thorough clinical and radiographic examinations were carried out for all patients.

Dual scan technique with CBCT was done for planning and fabrication of surgical stent Fig (1). Planning of 4 conventional implants was done for each patient, two of them were straight implants in the inter-canine region according to the available bone height and width preferably at the laterals, and two posterior implants were planned at the region of first or second premolar at 30° angulation according to the available bone parameters. For the posterior tilted implants, the planned distal screw access hole was located at the occlusal surface of the second premolar or first molar Fig (2).

Implants sizes were standardized in both groups. Group I implants with Direct laser metal forming surface treatment (Impianto Tixos MC Tixos neck, LEADERS Italia) were used Fig (3). Group II implants with acid etched surface treatment (Impianto Implus MC straight neck, LEADERS Italia) were used Fig (4). Straight implants had a diameter of 3.8 mm and a length of 12 mm, and 13.5 mm for angled implants.



**Fig (1):** The patient CBCT scan and CBCT of the denture were superimposed using radiographic markers



**Fig (2):** Different views of implant planning through the patient denture



**Fig (3):** DLMP surface treatment



**Fig (4):** Acid etched surface treatment

After surgical guide construction Fig (5), the surgical guide was seated guided by the rubber base bite index and the maxillary denture in centric relation and then was fixed using 3 anchor pins Fig (6). Drilling sequence protocol the drilling sequence protocol has been carried out in accordance with the manufacturer's instructions for every type of implant Fig (7). During drilling and implant placement, the drilled sites have been irrigated with saline, and implant insertion torque has been measured.

The maximum torque value (N/cm) attained after complete placement of the implant into the recipient site was used to determine the insertion torque values.

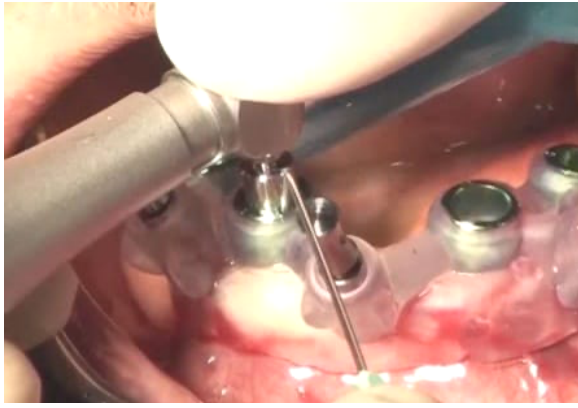
Resonance frequency analysis (RFA) was used to measure primary stability utilizing an Ostell Mentor device (Ostell/Integration Diagnostics, Goteborg, Sweden) Fig (8). The frequency transducer (SmartPeg) has been attached to the implants in a uniform manner perpendicular to the alveolar crest, and for every screw implanted (buccal, lingual, mesial, and distal), the implant stability quotient (ISQ) has been measured four times.



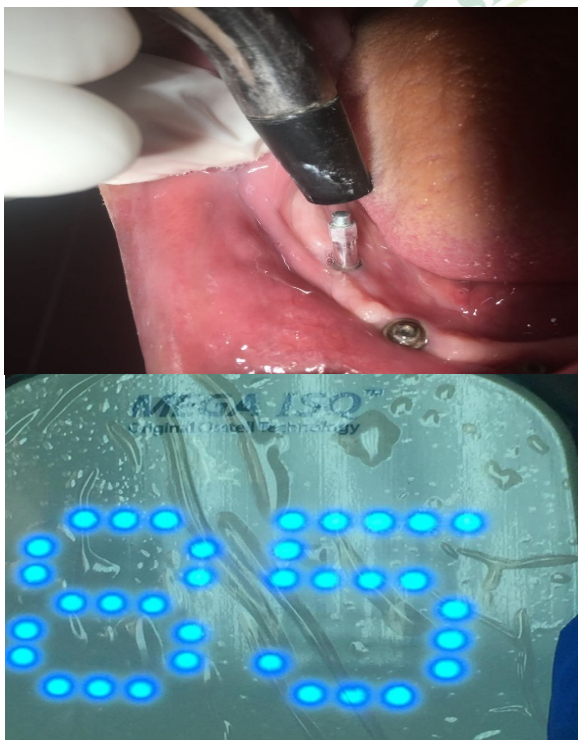
**Fig (5):** Surgical guide



**Fig (6):** Surgical guide was seated in place and was secured using 3 anchor pins



**Fig (7): Implant site drilling through surgical guide**



**Fig (8): Implant stability evaluation using Ostell**

30-degree multiunit abutments were placed at the posterior sites and 0-degree multiunit abutments were placed at the anterior sites Fig (9). Transformation of the lower complete denture into an implant retained overdenture immediately after the surgery. The titanium sleeves (temporary copings) were screwed to the multiunit abutments Fig (10). Adequate spaces were created by an acrylic bur

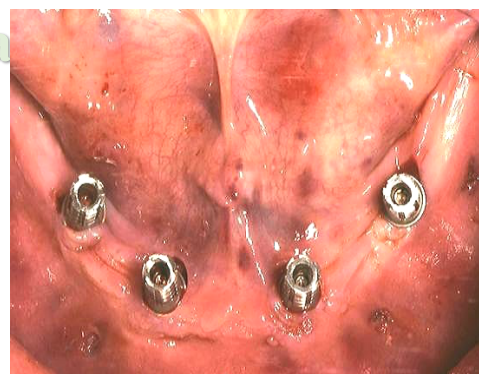
in the denture for the titanium sleeves. The temporary copings were picked up by the denture using Auto polymerized acrylic resin material. The acrylic provisional restoration was then screwed back to the implant multiunit abutments in the patient's mouth Fig (11).

Patients attended all the appointments of follow up in its time after 3 and 6 months during which data was obtained from their Ostell readings to evaluate changes occurred in implants stability in Group I (Direct Laser Metal Forming Surface Treatment) and in Group II (Acid etched surface treatment).

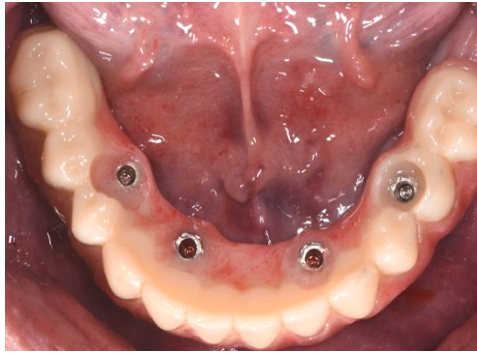
As a result, the independent t test has been used to compare two groups, while the Repetitive One-Way ANOVA was used to compare three follow-up periods, followed by Turkey's Post Hoc test for multiple comparisons.



**Fig (9): Multiunit abutments in place**



**Fig (10) Temporary copings secured to multiunit abutments.**

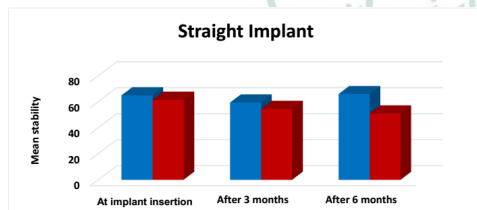


**Fig (11): Temporary prosthesis (patient own denture after pick up).**

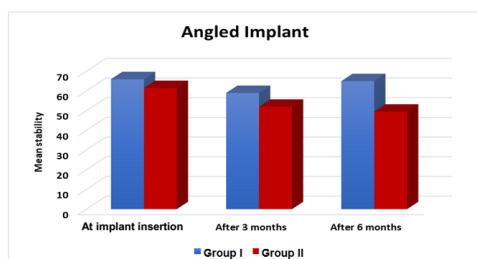
## Results

Comparison was performed between the straight implants of both groups and revealed that implant stability of group I is significantly higher than group II after 3 months and after 6 months, while revealed insignificant difference between them in time of insertion Fig (12).

Comparison was performed between the angled implants of both groups and revealed that implant stability of group I is significantly higher than group II after 3 months and after 6 months, while revealed insignificant difference between them in time of insertion Fig (13).



**Fig (12): Comparison of straight implant stability between both groups at implant insertion, after 3 months and 6 months.**



**Fig (13): Comparison of angled implant stability between both groups at implant insertion, after 3 months and 6 months.**

## Discussion

The implant morphology of the Direct Metal Laser Sintering technology has a relatively higher porosity at the surface and a higher density in the core, replicating the spongy geometry of bones. Due to its high mimicry, it promotes quicker osseointegration, 3D organisation of the fibrin network, adhesion of cells and migration, exchange of nutrients and fluids, and the growth of good vascularization for proper bone matrix organisation. These effects speed up bone healing. Micro-and macro-cavities with clearly defined shapes and sizes interconnected by micro-pores create a 3D geometry that encourages the formation of new bone. By penetrating the implant body to a depth of 250 microns, the concavities, which range in size from 2 to 200 microns, create interconnecting pits and pores, which have been inhabited by bone cells.<sup>7</sup>

Following laser therapy, there were no residues of chemicals on the material surface that could affect cell adherence and viability. In vivo studies have proven the positive effects of laser therapy, particularly robust bone attachment to the implant material as well as long-term material resistance to torsion strain.<sup>8</sup>

Dental implants were successfully osseointegrated in both groups due to positive response of surrounding host tissues to these alloplastic materials, in addition to selecting implants with suitable design and surface texture which enhances bio integration and bone regeneration process.<sup>9</sup>

The goal of the current research was to compare how two different implant designs affected the stability of the implants in an All-on-4 implant retained overdenture. The Direct laser metal forming titanium implants (DLMF) (Group I) achieved similar outcomes to Acid etched titanium implants (Group II) regarding implant primary stability at implant insertion. This could be explained by the presence of implant threads that increase the area of the

implant in contact with the bone and enhance load distribution at the implant/bone interface, enhancing primary stability.<sup>10</sup>

According to the manufacturer, both implant designs benefit from surface threads, which allow for more speedy installation with little trauma, as well as great cutting power, as many studies show that the shape and exterior properties of the screw have a strong influence on its biomechanics and primary stability.<sup>10,11</sup>

After 3 months follow up there is significant difference in mean ISQ values where immediate implant stability was higher than after 3 months in both groups. Sufficient implant stability is required to permit unhindered healing and formation of bone, allowing for optimum stress distribution of both masticatory and occlusal functional loads. However, the reduction in ISQ values from the time of implant insertion to 3-month follow-up for both groups was noted, indicating a decreasing primary stability.<sup>12,13</sup> Buser et al<sup>14</sup> hypothesized that the decreases in primary stability could be brought on by the bone damage brought on by recipient site preparations and the subsequent osteoclast metabolism surrounding an implant fixture.<sup>14</sup>

After 6 months follow up, there is significant difference in mean ISQ values where implant stability after 6 months was significantly higher than that at 3 months follow up in group I while in group II there was no significant difference between 3 and 6 months follow up.

Comparison between both groups revealed that implant stability in straight and angled implants of group I is significantly higher than group II after 3 months and after 6 months follow up.

Clear and significant differences have been found while comparing machined to laser-treated surfaces in a previously published study regarding the amount of bone and significantly better secondary

stability, explaining the increase in implant stability at 6 months follow up.<sup>15</sup>

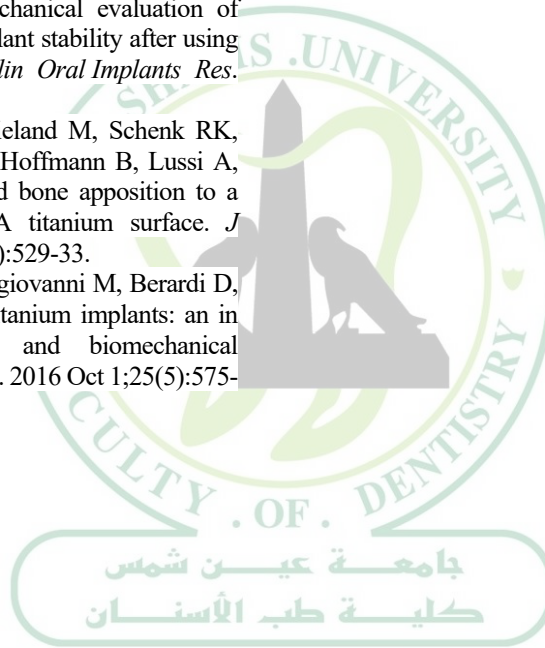
## Conclusion

Direct Metal Laser Forming surface treatment increases secondary stability of angled implant supporting All-on-4 temporary prosthesis.

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