CLINICAL CONSIDERATIONS OF DENTAL IMPLANT SYSTEM IN IMMEDIATE LOADING IMPLANT CASES

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Abstract

Immediate loading of dental implant has been researched intensively in the development of Branemark's early concept of 2 stages implant placement. This was embarked from both patients and practitioners' convenience towards a simpler protocol and shorter time frame. Many recent researches later found that micromotions derived from occlusal loading for a certain degree, instead of resulting a fibrous tissue encapsulation, can enhance the osseointegration process. Dental Implant system enhancement towards maximizing the primary stability held a key factor in Branemark's concept development. Surgical protocol and implant design was found to give a significant contribution to the prognosis of immediate-loading implants. *Indonesian Journal of Dentistry 2006; Edisi Khusus KPPIKG XIV: 338-342.*

Introduction

Dental implant has been widely considered as a predictable rehabilitation treatment since osseointegration concept was introduced by Dr. IV Branemark et al in 1977. His 2-stage implant placement protocol comprises 4-6 months non-loading time frame which became a prerequisite in Dental Implant treatments.¹ The rationale for such a delay is that premature loading may lead to fibrous tissue encapsulation instead of direct bone apposition. Furthermore, necrotic bone which is derived from surgical trauma at the implant bed border is not capable of load-bearing and must be first replaced by a new bone.² Rapid remodeling of dead bone layer compromises the strength of osseous tissue supporting the bone-implant site which leads to implant failure. However, 80 % of their patients have advanced bone resorption, 10% with extreme resorption, and the remaining 10% moderate resorption. All patients have poor bone quality offering unfavorable conditions for the mechanical retention of fixation which provides primary stability.^{3,4} These limitations accounted for the need to delay loading for such a long period.

Later studies were then carried out to shorten the non loading time period through production of new implant designs, development of new technique, and implementation of recently gained knowledge. Based on the theory that mechanical stimulation under bone physiological threshold can have a profound effect on differentiation and development of mesenchymal tissue, immediate loading was then vastly studied. The histological study by Piatelli showed that 60-70 % bone implant contact with immediate loading had no fibrous encapsulation which confirmed the above theory.^{5,6} The ultimate goal of an immediate loading protocol is to reduce the number of surgical interventions and shorten the time frame between surgery and prosthetic delivery, without sacrificing implant success.

Many studies have shown high success rate in immediate loading implants, both clinically⁷⁻¹⁰ and experimentally.^{2,5,11} Ledermann pioneered the clinical studies on 138 patients with 476 dental implants, and showed 91.2% success rate.³ Piatelli's histological study on monkeys confirmed a good bone-implant contact in immediate implant cases which has lead to an assumption that controlled

immediate loading stimulates bone formation at the implant site.¹² This was supported by Henry et al. who found mature and dense cortical bone around immediate loading implants.¹³ Nonetheless all the authors agree that the protocol must be carried out cautiously with strict patient selection. Furthermore, most of the studies conducted also came to the conclusion that primary stability is the most important factor for a good treatment prognosis.

Primary stability alone has 3 factors: bone, implant placement technique, and implant design. With so many dental implant varieties available on the market today, practitioners must have a sound knowledge on the principle of implant morphology, material, and surface treatment suitable for immediate loading cases. The aim of this paper was to review dental implant systems used in clinical immediate loading studies and get a clear picture of the principles in operating a dental implant system for such cases.

Literature Studies

Ledermann utilized Titanium Plasma Sprayed (TPS) endosteal screw implants (Straumann Institute, Waldenburg, Switzerland) in anterior mandible to stabilize overdentures. The protocol called for 3-4 rough self-tapped implants, long enough to get bicortical anchorage, which was immediately splinted and loaded on the same day. His up to 81 months follow up report showed 91.2% success rate based on 476 implants placed in 138 patients, 81% of the failures occurred during the first year. Failures were related to the lack of primary stability, lack of at least 11 mm of available bone, buccal and lingual perforation, too early insertion in an extraction socket, and insufficient hygiene.³

Ledermann's study brought a significant change in implant treatment perspective. Babbush et al. replicated the Ledermann protocol on implant retained overdentures in 129 patients rehabilitated with 514 implants. Four TPS implants were placed in the interforaminal area of mandible and splinted within 2-3 days by the mean of a dolder bar and loaded. The 5 years follow up showed 96.1% success rate. All failures occurred during the first year, whereas 80% happened during the first 6 months. Failures were related to delayed splinting and perforation of the inferior border with secondary infection.¹⁴

Chiapasco et al. conducted a multicenter study on the similar protocol as Ledermann's. The study

incorporated 194 patients with 4 different systems: TPS and ITI screw implants (Straumann Institute, Waldenburg, Switzerland), NLS screw implants (Friatec, Mannheim, Germany) and Ha-Ti screw implants (Mathys Dental Implants, Bettlach, Switzerland). Immediately after the implants placement, a U-shaped gold bar was fabricated and implants were immediately loaded with an overdenture. The study was monitored from a minimum of 2 years to a maximum of 13 years, with a mean follow up of 6.4 years. The overall success rate was 96.9%, whereas the failure rate of bars was 1.5 %. No statistically significant difference was found between different implant systems, although performed in 4 different centers.¹⁵

Current researches using different dental implant systems showed similar results. Lorenzoni et al. reported 100% success rate on their 6 month study on Frialit-2 implants. The implants were placed in interforaminal region located at positions 34, 33, 32, 42, 43, and 44. In order to obtain an in-patient comparison of immediate loading and non-loading implants, the ones at 33 and 43 were chosen to be immediately loaded by a dolder-bar retained overdenture. A high intimate bone apposition was seen in the immediate loading implants although with a lower coronal bone level and clinical stability.¹⁶ Siddiqui et al. also found a good result in immediate loading cases with AdVent Screw dental implants (Zimmer, Germany). The system came with an intraosseous body, self-tapping, triple-lead threads and a combination of HA-coated and blasted surface.¹⁷

Another study on immediate loading implant in anterior mandible region was conducted by Steenberghe et al., using Branemark Novum protocol (Nobel Biocare, Gothenburg, Sweden) in 50 patients. The protocol called for 3 implants inserted in the symphyseal area, connected by a very rigid horse shoe-shaped titanium bar. A final screw retained prosthetic framework was placed on top of it immediately or within 2 days after surgery. They found 92.7% success rate on 12 months follow up study, which is lower than the expected rate criteria proposed by Albrektsson and Sennerby (95%).^{18,19}

Immediate loading protocol has also been studied for fixed prosthetic rehabilitations, one of which was a 3 years study conducted by Testori et al. Their study was carried out in 62 patients using the total of 325 dual acid-etched cylindrical screw shaped Ossotite implants (31, West Palm Beach, FL, USA). Five to six implants were inserted in the interforaminal area of mandible with 10 to 18 mm in length and 3.75 to 6 mm in diameter utilizing a 32

Nm torque. Hybrid prostheses were then delivered within 48 hours of implant placement. During the follow up, two implants were lost within the first 2 months which was related to poor bone quality, leaving a 99.4% success rate.²⁰

Similar protocol was conducted by Randow et al. using 5 to 6 MkII fixtures (Nobel Biocare, AB, Goteborg, Sweden) with a minimum length of 10 mm implanted in the mandible to support a cross arch bridge which was loaded within 20 days following implant installation. During the 18 months follow up, no fixtures have been lost and no clinical complications have been reported or recorded. Peri-implant soft tissues revealed impeccable conditions at all observations.²¹

Whilst Testori and Randow et al. limited their immediate loading treatment strictly in the anterior mandible, Bischof et al. studied such cases in both jaws. The study incorporated 63 ITI screw dental implants with 4.1 to 4.8 mm in diameter, 8 to 13 mm in length, and SLA surface treatment inserted in 18 patients. The implants were connected and loaded with a cross arch bridge within 2 days. At the one year control, the survival rate of immediate loading implants was 98.4%. This study showed no difference in implant stability compared to the delayed loading implants over the first 3 months. The failure was observed in short implants inserted in type 3 bone.²²

Coincided with Bischof's result, Ericsson et al. found 86% success rate in his study comparing immediate loading and 2-stage loading protocol to support cross arch bridge in the maxilla and the mandible. Both protocols were carried out employing Branemark implants of 3.75 mm in diameter and 13 to 18 mm in length. Two fixtures were lost up to 5 months in function and were subsequently removed, both were in the Maxilla.²³

Discussion

The basic principle of immediate loading implant protocol is primary stability, which depends on two factors, host (bone), and external factor (surgical procedure, implant design, and surface treatment).

It has been recommended to perform immediate procedure in dense homologous bone, which can be generally found in the anterior part of the mandible. The cortical lamellar bone may heal with little interim woven bone formation, ensuring good bone strength while healing next to an

endosteal implant. Its fine porosity (<10%) favors better mechanical interlocking compared to soft cancellous bone that has 80-95% porosity, which subsequently provides a better stability to withhold any force from immediate loading in maximizing the physiological threshold to accommodate the osseointegration process.²⁴⁻²⁷ On the contrary, the lack of initial stability in type 4 bone results in lower success rates, varying from 50% to 94%,²⁸⁻³² which was also found by Testori, Bischof, and Ericsson in their studies.

Almost all of the studies on immediate loading implants recommended the use of screw threaded implants which not only minimize the micromotion of the implant due to the increasing surface area, but also to improve initial stability. With a proper surgical procedure, the implant threads ensure the initial interlocking which is essential in immediate loading cases.

Another implant design related factor is the implant length. The benefit of increased length is needed in providing vertical retention to support initial stability of the bone-implant interface. This is more crucial in immediate loading cases since in the early phase of function, dental implant must withstand the forces by itself prior to bone-implant integration. Additionally it also benefits from the increasing of surface area as concluded by Misch that for every 3 mm increase in length, the surface area of a cylinder-shaped implant increases by an average of 20-30%.^{33,34}

Implant diameter, though critical to withstand the occlusion force concentrated at the crestal bone, does not contribute as much in initial stability. The main benefit of using wide diameter implant is the increasing surface area as each 0.25 mm increase in diameter improves functional area support to more than 5-10%.³⁵

Surface treatment has been proven to improve initial stability and bone healing process.³⁶⁻³⁸ It benefits from both the rough implant surface and the osteoconductive media given on the surface. An appropriate micro-roughened surface is proven to engage and hold the fibrin strands which are formed during the initial clotting process following the insertion of implant fixtures. The stabilization of the initial clot is mandatory as the fibrin strands form a bridge for the migration of osteoblastic cells from the surrounding osteotomy onto the implant surface. Favorable surface characteristic have also been shown to aid the absorption of proteins, accumulate and activate platelets in providing platelet derived growth factors, thus promoting angiogenesis, and

differentiate progenitor cells into mature osteoblasts.

In principle, there are 2 kinds of surface treatment: additive and reductive surface. Implants with Titanium Plasma Sprayed (TPS) and HA Coating fall into the first category. Pure Titanium particle which is sprayed through a plasma flame at 25,000°C is shown to increase the surface area by 6-10 times by the apposition of a porous layer 20-50 µm thick. On the other hand HA coating has been proven to accelerate osseointegration. TPS implants are still widely used for immediate loading cases since they showed a very high success rate. The main concern for both surface treatment is the eventual detachment with subsequent periimplantitis showed in some studies with HA coating.^{33,38-40}

Reductive surface treatment is the development of the two surfaces discussed to minimize the risk of surface detachment. The micro-roughening process of the titanium implant surface is done by electropolishing, acid-etching, titanium oxide blasting and blast-etching method.^{39,40} Studies on implants with reductive surface showed a high success rate, though doesn't differ significantly with the additive.

Surgical protocol plays an important role since dental implant procedure is technique sensitive. Proper surgical protocol in an implant system should include adequate cooling to avoid the heat generated during bone drilling. It is recommended to keep the temperature below 47°C to avoid bone necrosis, which could detriment the osseointegration process following a good primary stability. This can be achieved by increasing the speed and torque together to allow a more efficient cutting with no significant increase in temperature.³³

A proper orientation of osteotome instruments to create an undersized preparation of implant site prior to placement is also essential in immediate loading cases. Shallabi proposed the theory supporting this protocol that a lot of small bone fragments are created and pressed in between the trabecular voids and between the screw threads during implant installation, hence ensuring a good primary stability and inducing new bone formation.⁴¹

Conclusion

Dental implant systems used in immediate loading cases must have the properties that support maximum primary stability. This is to ensure that micromotion can be controlled under physiological

threshold to induce a mechanical stimulation on mesenchym tissue. The properties must include screw threaded cylindrical implants, with maximum length and diameter, adequate surface treatment, atraumatic and undersized implant bed preparation.

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