

**Clinical and radiographic evaluation of
immediately loaded dental implants placed
immediately post-extraction in aggressive
periodontitis patients.**

Thesis

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INTRODUCTION AND REVIEW OF LITERATURE

Replacement of the missing teeth had been an elusive goal for all who practiced dentistry over thousands of years. A fine, dark stone shaped like a tooth, was found implanted in a Mayan skull in Central America from 600 AD. Implant attempts in ancient Egypt and Middle East were also reported (**Peppas and Langer, 1994**).

Loss of teeth was usually replaced by the use of conventional prosthesis; however, in some cases, edentulism is not suitably counterbalanced by conventional prosthesis either due to physical reasons (lack of retention) and/or psychic inability to accept prosthesis. In these cases dental prosthesis retained by an implant has been a successful alternative to conventional prosthesis (**Rasmussen 1997**).

Success of osseointegrated implants has been validated for over more than 30 years as a viable alternative to fixed or removable prosthetic restorations. An increasing number of well-controlled studies have demonstrated that osseointegrated oral implants are a predictable therapy for the replacement of missing teeth (**Adell et al. 1981, Albrektsson et al. 1984, Adell et al. 1990, Buser et al. 1997 and Szmukler-Moncler et al. 2000**).

During the 1960s it had been shown by Brånemark that chambers made of the metal titanium could become permanently incorporated with bone. It was observed that the living bone could become so fused with the titanium oxide layer of the implant that the two could not be separated without fracture. Osseointegration was originally defined as "a direct structural and functional connection between ordered living bone and the surfaces of a load-carrying implant" (**Brånemark et al. 1977**).

At electron microscopic level, bone has been shown to be approximately 50 nm from the implant surface. This space is filled with proteoglycans which is the ground substance that forms the ECM. An oxide layer (5 to 10 Å), formed of titanium oxide, and is found on metal implant surface (*Listgarten et al. 1991*).

Osseointegration was at last defined as "contact established without interposition of nonbony tissue between normal remodeled bone and an implant at the light microscopic level, entailing a sustained transfer and distribution of load from the implant to and within the bone tissue." (*Glossary of implant terms 1997*).

Following more than 50 years of both experimental and clinical studies, Per-Ingvar Brånemark concluded the following recommendations to create osseointegration:

- Minimal tissue injury should be produced.
- A minimal amount of remaining bone should be removed, and the basic topography of the region should not be changed.
- The use of fixture with its outer diameter 5.5 mm and a length of 10 mm to allow its use in almost every edentulous jaw, regardless of the volume and topography of the remaining bone tissue.
- Healing time for bone tissue requires that fixtures implanted in carefully prepared sites in the jaw bone left in situ without load bearing for a period of 3 to 6 months.

- The placement of the fixtures can be limited to the area between the mental foramina in the lower jaw and between the anterior sinus recesses in the upper jaw (**Brånemark 1982**).

In order to obtain a predictable outcome of implant dentistry, the traditional protocol of Brånemark group recommended a 12-month healing period between tooth extraction and placement of implant (**Adell et al. 1981**).

Regarding the events that occur in a healing extraction socket, five stages have been described. In the first stage, an initial blood clot forms as a coagulum of white and red blood cells derived from the circulation. In the second stage, granulation tissue replaces the clot over a 4- to 6-day period. Cords of endothelial cells are associated with budding capillaries. In the third stage, connective tissue gradually replaces granulation over 14 to 16 days. The connective tissue is characterized by the presence of spindle-shaped fibroblasts, collagen fibers, and ground substance. In the fourth stage, calcification of osteoid is apparent, commencing at the base and periphery by 7 to 10 days. Bone trabeculae almost completely fill the socket by 6 weeks. In the fifth stage, complete epithelial closure of the socket is achieved after 24 to 30 days. By 16 weeks, bone fill is complete, with little evidence of osteogenic activity (**Amler 1984**).

Maximum osteoblastic activity, seen as a proliferation of cellular and connective tissue elements, with osteoblastic laying down osteoid around immature islands of bone, occurs between 4 and 6 weeks after extraction. After 8 weeks, the osteogenic process appears to slow down (**Evian et al. 1982**).

Investigations showed that significant bone volume changes of the alveolar process take place following tooth extraction. It was shown that as much as 3 to 4 mm of resorption can occur during the first 6 months post-extraction without the intervention of tissue regeneration techniques (**Atwood and Coy 1991**). This resorption can significantly affect the position and prognosis of a dental implant as well as the hard and soft tissue esthetics in the area. The most significant loss of tissue contour takes place during the first month after tooth extraction. A reduction of 40% of the width of the alveolar ridge at 12 months was reported (**Schropp et al. 2008**).

It was also reported that resorption of the buccal plate of bone significantly higher than the lingual or palatal. The resorption of both buccal and lingual walls of the extraction site occurred in two overlapping phases. During phase 1, the bundle bone was resorbed and replaced with woven bone. Since the crest of the buccal wall was comprised solely of bundle, this remodeling results in substantial vertical reduction of the buccal crest. Phase 2 included resorption that occurred from the outer surfaces of both bone walls due to osteoclasts present in lacunae on the surface of both bone walls. The reason for this additional bone loss was reported to be not understood at time (**Araujo and Lindhe 2005**).

Immediate implant placement in fresh extraction sockets was reported to reduce alveolar bone resorption. Better esthetic outcomes were achieved including the prosthetic crown length in harmony with the adjacent teeth, natural scalloping and easier distinct papillae to achieve and maximum soft tissue support (**Gelb 1998**). Moreover, this surgical procedure also allows a better final rehabilitation, because it facilitates

both morphological ridge contour preservation with accurate prosthetic implant installation and maintaining the natural tooth angulation (**Wheeler et al.** 2000).

Other advantages of immediate implant placement in fresh extraction socket include the reduction of the surgery time, since prosthodontic therapy is initiated as early as 3 to 6 months after extraction. Also, less dental chair-time and more patient satisfaction is achieved by combining the both procedures of natural tooth extraction and implant placement at the same visit (**Bianchi and Sanfilippo** 2004).

Several classifications have been postulated for the timing of dental implant placement following tooth extraction. **Mayfield** 1999 used the terms immediate, delayed, and late to describe the timing of placement of immediate postextraction, 6 to 10 weeks, and 6 months or more after extraction respectively. Most of the studies used the term immediate postextraction to describe immediate placement of dental implants immediately following tooth extraction at the same surgery.

The exceptions were **Schropp et al.** 2003 who described the immediate implantation as implants placed up to 10 days following tooth extraction, and **Gomez-Roman et al.** 1999 who described immediate implantation as implants placed between 0 and 9 days following extraction.

Surgical procedures for immediate post extraction implant placement include: patient management including peri-operative measures to prevent infection and control of pain and to support the healing process. The measures included antibiotics which were prescribed post surgically (**Yukna** 1999), and prior to surgery in case of

combinations of implant placement and bone regeneration procedures (**Becker et al. 1994**). **Wagenberg and Forum 2007** concluded that, patients who were not able to utilize postsurgical amoxicillin due to allergy, were 3.3 times as likely to experience implant failure as patients who received amoxicillin. Postsurgical NSAIDs are also prescribed to control pain as any other surgical procedure.

During extraction every possible step should be taken to keep trauma and bone loss to a minimum during extraction. Multirooted teeth must be sectioned and the remaining roots gently removed with mesiodistal luxation. After extraction, the socket should be thoroughly degranulated by careful curettage (**Kan et al. 2000**).

Implant site preparation included the steps to be taken preparatory to insert dental implants are system specific. In most cases, placement at 3 to 6 mm beyond the apex or the use of wide diameter implants is sufficient to gain the critical element of stability, in case of multirooted teeth; the implant should be placed in the interseptal bone (**Scwartz-Arad and Chaushu 1996**).

Regarding the implant design, almost all designs of the rootform dental implants are being used in the available literature (**Ashman 1990**, **Lang et al. 1994**, **Gomez-Roman et al. 1996**, **Schropp et al. 2003** and **Wagenberg and Forum 2007**).

Concerning the apicocoronal implant location, **Ashman 1990** reported the placement of implants at crest level. **Yukna 1991** placed the implants at or slightly below alveolar crest level. Others placed implants 2 mm below the alveolar crest level (**Knox et al 1993**). **Lang et al. 1994** placed implants 1-2 mm supracrestally. In 1996, **Rosenquist and**

Grenthe positioned the superior surface of the cover screw of the dental implants approximately 1 mm below the level of the CEJ of the adjacent teeth.

Use of a variety of grafting materials to fill the possible gap produced between the implant body and the surrounding socket walls was reported. There was no recommended material to do such a function in relevance to post operative results. **Ross et al.** 1989 used autogenous bone to fill the gap around the implant. In 1993, **Ettinger et al.** used porous Hydroxyapatite in combination with ePTFE. **Coatoam and Mariotti** 2000 left the implant's cover cap exposed. **Maksoud** 2001 used bovine bone graft mixed with DFDBA and covered the whole site with collagen membrane.

In 1996, **Rosenquist and Grenthe** studied the survival rate of immediate implants with a follow up period varied from 1 year and 60 months. In 51 patients, 109 implants were placed. No grafting material was used to fill the gap between the implants and surrounding socket walls and ePTFE membranes were used with only 5 patients. Osseointegration was determined by clinical stability, lack of symptoms, and lack of peri-implant pathology based on radiographic examination. The implant survival rate was 93.6%. The success rate was 92% for implants replacing teeth extracted because of periodontitis and 90.8% for implants replacing teeth extracted for other reasons. Complications included the exposure of 12 cover screws and infection development in 5 cases. The incidence of infection was higher in periodontitis group.

A 5-year follow-up of 90 implants placed immediately after tooth extraction into fresh extraction sites was performed. Small autogenous

bone chips (from bone adjacent to implant sites) were grafted into the defect between the implant and the socket walls when needed and no membranes were used. Implant mean 2-year cumulative survival rate was 90%. There was no implant loss after loading (**Schwartz-Arad and Chaushu 1994**).

Wilson et al. 1994 had compared wound healing following implant placement performed immediately postextraction in a human volunteer. Four implants were placed in immediate extraction sockets and then they were biopsied 6 months later. All implants were osseointegrated but with varying degrees of bone-to-implant contact. A mean bone-to implant contact was 80% in implants placed with horizontal defect dimension of 1.0 mm. the lowest mean bone-to-implant contact was 14% was observed for implants placed with horizontal defect dimension of 4mm. it was concluded that immediate implants integrate properly with different degrees of bone-to implant contact according mainly to the horizontal component of the peri-implant defects.

An animal study was performed to evaluate the effect of gap width on bone healing around implants placed into simulated extraction socket defects of varying widths in 10 subjects. A total of 40 implants were placed into osteotomy sites prepared to 3 different diameters, simulating extraction sockets. Three experimental sites, with gap sizes of 0.5 mm, 1.0 mm, and 1.5 mm, were created; the control sites had no gap. Percentages of bone-to-implant contact were measured histologically 12 weeks after implant insertion. No statistically significant differences in bone-to-implant contact were found between the sites when the apical 4 mm of implants were compared. Within the limits of this study, the simulated extraction socket defects healed clinically, with complete bone

fill, regardless of the initial gap size. However, the width of the gap at the time of implant placement had a significant impact on the histologic percentage and the height of bone-to-implant contact (*Akimoto et al.* 1999).

Another animal study was performed to evaluate the reaction of peri-implant tissues to immediately placed titanium plasma-sprayed implants into extraction sockets. Six monkeys were used in the study. A total of 36 implants were inserted in both arches (18 in the posterior maxilla and 18 in the posterior mandible). No barrier membranes were used, and the only graft material used was autogenous bone chips. The implants were loaded after 3 months. Six months after implant loading, a block section was carried out. A histomorphometrical analysis was done. All implants were covered by compact, mature bone under examination in light microscopy. A very high bone-implant contact percentage (90–95%) was observed. No bone loss was present after the loading period. These results indicate that implants placed into fresh extraction sites grafted with autogenous bone chips will heal in a predictable way (*Scarano et al.* 2000).

Paolantonio et al. 2001 reported human clinical and histologic data from an implant placed into fresh extraction socket without barrier or graft material and an implant placed in mature bone on the contralateral side. At 6-months, both implants were clinically integrated and removed for microscopic evaluation. A comparable degree of bone-to-implant contact was observed for both implants. The author concluded that the clinical outcome and the degree of osseointegration did not differ for screw-type implants when placed in mature bone or an extraction socket with a bone to implant gap of 3 mm or less.

Regarding the immediate implantation in sites of molar teeth, a study was performed on 60 immediate implants, placed in 43 patients following extraction of 21 molars. The mean follow up period was 10 months. The 5-year cumulative survival rate was 98%. It was 90% among non-smokers compared to 83% among smokers and cumulative survival rate in maxilla was 82% and in the mandibular 92%. It was concluded that immediate implantation in the molar area is an alternative and predictable surgical technique (**Schwartz-Arad et al. 2007**).

A study was carried out to evaluate immediate versus non-immediate implantation for full-arch fixed reconstruction following extraction of all residual teeth. The immediate implants had a higher 5-year cumulative survival rate (96%) versus non-immediate implants (89.5%). It was concluded that immediate implantation does not carry additional morbidity than non-immediate implantation (**Schwartz-Arad et al. 2007**).

In 2006, **Wagenberg and Forum** performed a retrospective study of 1920 immediately placed implants in 891 patients. The overall implant survival rate was 96% with a failure rate 3.7% before restoration and 0.3% after restoration. Machined surface implants were twice as likely to fail as rough surface implants (4.6% versus 2.3%). Men were 1.6 times more likely to experience implant failure.

A study was performed to analyze bone healing and vertical bone remodeling for implants placed immediately after tooth extraction without any grafting techniques. Twenty patients received 20 implants immediately after 20 teeth removal. All peri-implant bone defects had healed completely 6 months after implant placement. The presence of

moderate vertical bone resorption was not associated with any negative esthetic implications. It was concluded that placing dental implants into fresh extraction sockets with circumferential defects not more than 3 mm, could heal with good predictability without using a regenerative procedures (*Covani et al.* 2004).

Regarding aesthetics outcome of immediately placed implants, a study was performed using 11 implants placed in 10 patients. The implants were placed without incisions or flap elevation. The implants were provisionalized 3 months after placement and finally restored after 4 months of placement. The overall success of implant survival was 96.6% and all failures occurred prior to restoration. It was concluded that immediate implantation in fresh extraction sites even without an incision or flap reflection, is a surgical procedure that appears to preserve gingival architecture contributing to a satisfactory aesthetic final results. The most important aspect to obtain predictable aesthetic results seems to be the height and thickness of the buccal bone wall, which remain after immediate placement of the implant (*Sammartino et al.* 2004).

Meanwhile, certain problems remain when this 3-stage surgical protocol was used. These problems include avoiding any removable prosthesis for minimum of 3 weeks to promote uneventful healing, loose denture, pain, difficulty with chewing during transitional removable prosthesis wearing period, and the necessity of additional surgery to expose implant fixtures (*Schnitman et al.* 1994). These problems have commonly caused physiological, psychological, or sociological challenges for patients who underwent implants treatment. Those inconveniences are sometimes the reasons for not choosing implant-supported restorations at all.