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"Immediate Implant Placement in Maxillary Posterior Region: A Systematic Review"

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Abstract

Background: *According to the original protocol proposed by Brånemark, dental implant can be installed in a complete healing state after tooth extraction. However, it was reported that the alveolar bone loss occurred in 23% during the initial 6 months after extraction. Immediate implantation was suggested as a complementary procedure against this sequelae. Although many studies report on immediate implant placement with considerable success, the literature regarding survival rate in posterior maxilla is sparse.*

Purpose: *The purpose of this study was to systematically evaluate the publications concerning immediate implants placed in the maxilla.*

Materials and Methods: *A Medline and manual search was conducted to identify studies concerning immediate implants published between 1990 and April 2020. The articles included in this study report data on demographic variables, implant type, location in jaws, observation time, prostheses and complications.*

Results: *The success rate for immediate implant placement in maxillary posterior region was average 88.6%. Currently, the literature notes a nonrandomized pattern of techniques related to immediate placement protocols pertaining to timing of placement as well as augmentation techniques.*

Conclusion: *Immediate implantation into a maxillary molar socket raises an extra challenge for the clinician but immediate implant placement can be successful.*

Key words: *Immediate implant; dentulous maxilla; survival rate; osseointegration.*

Key Message: *Posterior maxilla is mainly composed of cancellous bone surrounded by very thin cortical bone may also pose a challenge to place implants. Current literatures suggest advancements implant design and surgical techniques has made possible to restore posterior maxilla with immediate implants.*

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I. Introduction:

As endosseous dental implant therapy rapidly becomes the prosthetic standard of care for a vast array of clinical applications, we faced with the challenge of developing dynamic treatment planning protocols. The most frequently cited reasons for underutilization of endosseous implant therapy are that treatment cost is perceived to be too high and treatment takes too long (Branemark's original treatment protocols required one to two years to complete treatment). Original protocols required the placement of implants into healed edentulous ridges. It is well accepted by the scientific community that physiological dimensional changes occur in the alveolar ridge after tooth extraction and that most of these changes will occur within the first 3 months of socket healing. These height (apicocoronal) and width (bucco-lingual) alterations in the alveolar ridge may therefore influence subsequent implant placement. Immediate implantation was suggested as a complementary procedure against this sequela.

This therapeutic concept was introduced in 1976 as an alternative protocol to the classical delayed implant surgical protocol. Lazzara[1] was first to report on implants placed into fresh extraction sites. Since then, implant placement in extraction sockets in combination with bone grafts and barriers has been well documented.[2-4] This procedure reduces the number of surgical interventions and preserves the alveolar ridge.[5] In addition; it is easier to determine the location of implant without surgical guide. However, immediate implantation is limited to the cases of sufficient bone quantity and good soft tissue condition. Indications of immediate placement are; it must not have acute infection and any bone resorption around a fresh extraction socket. In addition, it should not have endodontic failure, root fracture and resorption.[6] The bone loss,

particularly in the maxilla, combined with age, muscle hypotonia, and inversion of the lips, results in facial changes in shape and appearance. Immediate implant insertion in maxillary molar extraction sockets poses a number of unique challenges to the clinician including the need to preserve the interradicular bone at the time of tooth removal, the often problematic position of the maxillary sinus around the roots of the tooth to be extracted, the compromised nature of the residual interradicular bone when faced with periodontally hopeless maxillary molars, and the difficulty in placing and ideally positioning the implant to accept future prosthetics as a result of the position of the residual interradicular bone.[7] Becker et al.[8,9] reported a 93.3% 5-year implant survival rate with clinically insignificant crestal alveolar bone loss for immediate implants. Over the years numerous studies have confirmed the reliability of implants placed at the time of tooth extraction. Thus, the aim of this review is to present a comprehensive view of immediate implant studies in posterior maxilla.

II. Materials and Methods

Studies to be included in this structured review had to fulfil the following inclusion criteria:
1. Relevant data on reason for extraction and morphology of the extraction socket,
2. Implant survival rates were either clearly indicated or calculable from data reported in the paper or as percentage basis,
3. Criteria for implant failure clearly defined,
4. Implant placement in maxillary molar regions with or without sinus lift procedure,
5. Human and animal studies derived data were reported,
6. Complications after immediate placement of implants,
7. Implant placement in combination with or without bone graft materials,
8. Total number of implants with their lengths and diameters.

No restrictions were placed concerning study design, and randomized and nonrandomized clinical trials, cohort studies, case control studies and case reports all considered for inclusion in the review. Only unicortical implant studies were included Studies on All on four implants, Bicortical implants, Zygomatic implants, subperioosteal implants were excluded. Medline search was performed to identify clinical articles published between January 1990 and December April 2020. The following search terms were used: 'dental/oral implants', 'immediate implants placement', 'implant placement after extraction', 'immediate implants in posterior regions', 'immediate implant placement in posterior maxillary region', 'immediate implant placement in maxillary molar area', 'implant placement in reduced alveolar height', 'implant placement in maxillary bone quality'. In addition a manual search of the following journal from 1990 to April 2020 was performed: Clinical Oral Implant Research, International Journal of Oral and Maxillofacial implants, Clinical Implant Dentistry and Related Research, Journal of Periodontology, Journal of Clinical Periodontology, International Journal of & Restorative Dentistry. A further manual search was conducted through the bibliographies of all relevant papers and review articles. The review looks on certain key aspects of immediate implants in maxillary posterior regions which will be helpful in deciding whether to use or not when they are really indicated. Thus, the data obtained from each article was divided into six tables:
• A demographic data and the type of study [Table 1]
• Total number used and their dimensions [Table 2]
• Type of surgery, bonegraft/augmentation, and complications [Table 3]
• Type of prosthesis, loading, follow-up and survival rate [Table 4]
• Time of failure, crestal bone loss, and total immediate implants success/failure [Table 5]
• Overall success rate of short implants as per each article [Table 6]

III. Results:

The success rate for immediate implant placement in maxillary posterior region was average 88.6%. Currently, the literature notes a nonrandomized pattern of techniques related to immediate placement protocols pertaining to timing of placement as well as augmentation techniques.

IV. Discussion:

This review presents a comprehensive view of immediate implants from 1991 to April 2020. In the present study, data on immediate implants from 6 prospective, non-randomized, non-controlled trials, 4 retrospective, non-randomized, non-controlled trials and the rest from clinical follow-up studies are presented. The data in this review has been published in peer-reviewed scientific journals and are therefore judged reliable. A met-analysis was not performed as data from the included reports were not standardized and, therefore, a descriptive analysis is presented. In a prospective study, immediate implants were placed in maxillary first premolar region. The presence of a tapered interradicular osseous septum complicates any attempt to attain a stable baser for site preparation in the presence of interradicular septum. Authors of this study have suggested

the removal of the interradicular bone prior to site preparation to get a broader and stable base for implant placement. In addition to that removal of septa provides a source of autogenous bone for placement in the residual socket defect around the implant. Authors have also utilized wide-bodied implant and concluded that a 4.8mm or 5.0 mm wide implant is easily restored in a highly esthetic manner in maxillary first premolar region. Conventional delayed loading was performed not to disturb the osseointegration.[10] In another prospective study, A round bur was used at 550 rpm under copious irrigation with sterile water to make a notch in the most crestal aspect of the residual interradicular bone. A tapered-end osteotome with a maximum diameter of 2.2 mm was utilized to compress and implode the interradicular bone beneath the tip of the osteotome and to spread the interradicular bone lateral to the osteotome. If additional height was not needed to ensure placement of the complete roughened surface of the implant within the confines of the expected regenerated bone, the osteotome was malleted to a depth that allowed placement in the aforementioned position. If additional length was required to place the implant at the desired position, the osteotome was malleted to the appropriate depth, lifting the floor of the sinus. A tapered-end implant† with an apical diameter of 4.1 mm and a neck diameter of 6.5 mm was inserted into the prepared osteotomy site. Authors of this study claims that using this surgical approach helps eliminate many clinical compromises those include non-ideal implant positioning in one of the three extraction sockets, loss of ideal alveolar ridge morphology in an effort to attain soft tissue closure, compromises in regenerative material selection due to the aforementioned soft-tissue concerns, and a high degree of exposure of regenerative materials in the early stages of healing.[11] As implant designs and surfaces improved, immediate placement of implants into single rooted teeth was performed with excellent success. This was attributed to being able to obliterate the extraction site during implant preparation and choosing a diameter of the implant that would minimize gaps between the bone and implants. Premolar teeth then were added to the immediate implant procedures because the mesial to distal dimension allowed for excellent implant stability and small voids were easy to graft. For molars, Walker's work[12] provides evidence-based data confirming that, if the insertional torque of the implant is high, providing initial implant stability and a lack of mobility, then the bone heals as a normal extraction site integrating the implant.[13] A Clnical study[14] evaluated the outcome of an 8 - 9 mm diameter tapered implant, designed to be placed in molar extraction sockets. Peri-implant bone level was determined on peri-apical radiographs and compared to baseline. Over 1 year follow up Implant success rate was 97.9%. Implants demonstrated good primary stability, when placed in molar extraction sockets, with limited bone loss over time.

There is one prospective study[15] when the gap between the immediate implant and the alveolar bone was less than 2 mm, no graft material was placed. Several studies have been performed in which graft material was not placed in immediate implants with a gap of less than 2 mm, showing that small circumferential defects could heal spontaneously and demonstrating that the degree of bone–implant contact did not differ from that of implants placed into mature bone. 2 failures in this study was explained by poor density of bone in posterior maxilla region but the success rate of the 292 implants was 96.9%. The results of this study have demonstrated that immediate implant osseointegration can be as, or more, successful than non immediate implantation during the same healing period. In a retrospective study, survival rate was 100 percent. Moreover, the implants positioned in fresh extraction sites had the same high survival rate as did those positioned in edentulous sites. Biomechanical advantages may have played a fundamental role in this outcome—that is, the positioning of two tilted implants not only enhanced the distribution of the occlusal forces but also offered excellent support for the fixed prosthesis. In addition, primary stability was achieved owing to the underpreparation of the implant tunnel that was tailored to the bone quality of the site[16]. In this retrospective study, we immediately loaded post extraction dental implants. The advantages of this treatment protocol lie not only in reducing time and the number of procedures but in ensuring esthetics and immediate function. In another retrospective study,[17] implants placed into immediate extraction sockets exhibited a 21.5% (14 of 65) higher bone loss rate than implants placed into existing healed edentulous sites (11 of 107). The presence of circumferential gaps around implants body at the time of placement into extraction sockets may account for the majority of implants (21 of 172) that exhibited the traditional 1 mm saucerization. Other Implants exhibited excellent long-term outcomes with little or no bone loss. In a prospective study,[18] supports the use of the rough surface neck and microthreading for immediate implants suggesting that a roughened surface facilitates crestal bone tissue stability around the implant neck and keeps the biologic width in place. This prospective study found minimal marginal bone loss and a 100% implant survival rate over a 3-year follow-up of immediate implants with rough surface neck and microthreads subjected to immediate non-occlusal loading. In one retrospective study,[19] horizontal gaps larger than 1.5 mm between the bony wall and immediately placed implants surface were filled with b-TCP without the use of a barrier membrane. This resulted in no bone loss in 72.1% of the implants, which was very similar to the nongrafted cases in which implants were placed in favorable conditions. Comparison of immediate Implantation group with delayed implantation did not show a statistically significant difference regarding the amount of bone loss after 10 years of follow-up. These results are in agreement regarding the effectiveness of bone fill following immediate implantation, resorption of bone ridges over time,

and success of bone augmentation procedures combined with immediate implant placement. In a clinical study,[20] at the time of maxillary molar extraction, a modified trephine and an osteotome procedure were performed to implode the interradicular bone following maxillary molar extraction. Particulate material and a membrane were then placed to increase regeneration of alveolar bone. The localized management of sinus floor procedure provides implant placement and sinus lifting simultaneously. The delicate, careful displacement of Schneiderian membrane and cortical bone tissue into the sinus cavity was performed to create a new horizontal and vertical intraosseous space with complete preservation of the original bone. The results of this study demonstrated the Localized management of sinus floor procedure in fresh molar sockets, allowed to expand the dimensions of resorbed posterior maxillary alveolar bone both vertically and horizontally with a success rate of 100% of implant osseointegration over time. In a case report [21] implant drilling was done in the inter radicular bone before extraction of molar tooth, using roots as guide to obtain a correct three dimensional position of the implant and primary insertion torque. At 6 months and one year follow up stable bone levels were observed also prosthetic structure displayed optimal estheics and functional results. Author considers this procedure as simple and useful modification to traditional drilling for beginners. However care should be taken not to alter the socket wall morphology while extracting roots and also not to increase the temperature of bone while drilling tooth because of increased hardness. In another Case Series[22] a regular diameter implant was placed after immediate atraumatic extraction of molar tooth. Imlpant was placed in after inter radicular bone was prepared using surgical template. The final twist drill was placed in the prepared socket. Remaining space was filled with 1:1 ratio of autogenous bone and xenograft At 1 year follow up the success rate was only 73.3% which was in contrast to studies by Cafiero et al[23], Tallarico et al[24] Chechhi et al[25] with 100%, 100% and 89.4% respectively. Author attributed this failure to the use of regular diameter implants of 4.3 mm where as above studies used 4.8 mm , 7mm and

6-8 mm respectively. Wide or ultra wide diameter implants can overcome primary stability where inter radicular bone is thin and increases initial contanct between implant and bone surface. Also present study used immediate provisional restoration in contrast to above studies. Author also reported that large thread depth with sharp edges and a small thread pitch may positively influence the early post operative implant stability.

Table 1: A demographic data and the type of study

Year	**Type of study**	**No. of patients/gender**	**Age**
2002[10]	Prospective clinical study	57 (36 males and 21 females)	-
2006[11]	Prospective clinical study	83 (39 males and 44 females)	38 to 68 years
2011[13]	Prospective study	35	-
2011[14]	Prospective clinical study	89	-
2011[15]	Prospective observational study	38	-
2012[16]	Retrospective study	65 (32 females, 33 males)	average age of 60.5 years, range (43-83 years)
2012[17]	Retrospective clinical study	46 (males 19 and females 27)	mean age 50.54, range (18–75)
2013[18]	Prospective study	53 (30 males and 23 females)	mean age 37.85 ±7.09 years, range (27–60)
2013[19]	Retrospective study	58 (33 females, 25 males)	Average age 54.78 years
2013[20]	Retrospective study	53 33 (females and 20 males)	the mean age was 54.3±19.2 years,.
2018[21]	Case Report	1	35 years
2020[22]	Case Series	15	59.7 years

Table 2: Total number used and their dimensions

Year	Total no. of implants	Length of implants (mm)	Diameter of implants (mm)
2002[10]	63	9-13	5
2006[11]	83	11.8	an apical diameter of 4.1 and a neck diameter of 6.5
2011[13]	35	Chosen to results in a 2-mm distance superior to the nerve canal or to engage the floor of the sinus	6
2011[14]	98	7 to 10	7, 9 or 11
2011[15]	292	8.5, 10, 11.5, 13, 14.5, or 16	3.6, 4.2, or 5.5
2012[16]	334	11.5, 13, 15	4
2012[17]	173	10	3.7, 4.7
2013[18]	71	11.5, 13	4.20, 5
2013[19]	254	10, 13, 16	3.7, 4.7
2013[20]	68	13, 15	4.5, 5.5, 6.5
2018[22]	3	10 mm	5.3
2020[22]	7	8.5 -10mm	4.3

Table 3: Type of surgery, bonegraft/augmentation, complications

Year	Type of surgery	Bonegraft/augmentation	Complications
2002[10]	Removal of interradicular bone osteotomy site was prepared for implant. After placement of implant, removed interradicular bone was added around it.	Autogenous, interradicular bone graft of the socket	-
2006[11]	most crestal aspect of the interradicular bone was notched with a round bur after trisection and extraction of a maxillary molar. A 2.2-mm wide tapered osteotome was used to spread the interradicular bone and lift the floor of the sinus if necessary.	demineralized freeze dried bone allograft (DFDBA) and/or osseous coagulum, and bioabsorbable or non resorbable membranes	two sites that exhibited loss of primary closure demonstrated partial exposure of the implant healing screws
2011[13]	implant placed into the interseptal bone and the palatal root because of thin buccal bone on the mesial and distal buccal roots of maxillary molars	small buccal defects are grafted with allograft	-
2011[14]	Patients with intact coronal bone and thick biotype were chosen. Piezo surgery was often utilized to assist with removal of the roots	If the residual space exceeded 2 mm, a bone graft was used to fill the residual space	-
2011[15]	Atraumatic extraction and implants were placed using a combination of drills with osteotomes	Autogenous or beta-tricalcium-phosphate	-
2012[16]	Patients with intact coronal bone and thick biotype were chosen. Piezo surgery was often utilized to assist with removal of the roots	-	-
2012[17]	Atraumatic extraction technique and wide diameter implant without sinus lift	Coronal gaps greater than 1mmwere grafted with autogenous bone or b-tricalcium phosphate mixed with blood and covered with a resorbable barrier membrane	No surgical adverse events but prosthesis-related adverse events 4 cases.
2013[18]	After each failing tooth was extracted, a seven-model implant with retention grooves	-	-
2013[19]	Criteria for immediate placement of implants included initial implant stability and 4-walled selfcontained immediate extraction sites	b-tricalcium phosphate	Minor pain and swelling
2013[20]	a progressive in diameter bone expander starting form smallest instruments were inserted in the previous hole created with the small surgical bur; the bone expanders are pushed deep in the bone, by mallet forces, leaving 1 to 2 mm before the estimated sinus floor level	small piece of collagen that was inserted below the borders of the soft keratinized mucosa that lines the extraction socket was used to cover the surgical field	four patients experienced minor nasal bleeding, which disappeared within the first 24 to 48 hours
2018[21]	Implant Placement was done by Inter Radicular Bone drilling before Molar extraction, using a root as guide for implant positon	Guided Bone REGENERATION with Xenograt and PRF membrane.	--
2020[22]	Implant was placed in the inter radicular bone which was prepared after tooth extraction using surgical template.	Circumerntial space was filled by Autogenous graft and Bone substitute(Bio-Oss) with 1:1 ratio.	--

Table 4: Type of prosthesis, loading, follow-up and survival rate

Year	Type of prosthesis	Immediate loading	Delayed loading	Follow up
2002[10]	Single unit porcelain fused to metal crown	-	Yes	2 years
2006[11]	single porcelainfused-to-precious metal crowns	-	Yes	18 months
2011[13]	single crowns	-	Yes	after 4 months of integration
2011[14]	single crowns, fixed partial prosthesis and fixed full prosthesis.	-	Yes	12-18 months
2011[15]	Prostheses given but not mentioned	-	Yes	1 year
2012[16]	FPD (full and partial)	Yes	-	2years
2012[17]	Provisional and fixed restorations	Yes	Yes	119 to 121 months
2013[18]	Fixed prostheses	Yes	-	3 years
2013[19]	Single crowns, FPD and overdentures	-	Yes	2 years
2013[20]	Fixed prostheses	-	Yes	13-years

2018[21]	Fixed partial Metal – Ceramic denture	-	Yes	1 year
2020[22]	Full Zirconia	Yes	-	1 year

Type 5: Time of failure, Crestal bone loss, Total immediate implants success/failure

Year	Time of failure	Crestal bone loss	Total immediate implants success/failure
2002[10]	-	0.2 mm	(46) all were successful
2006[11]	-	-	(83) all were successful
2011[13]	1 implant did not integrate after 4 months	-	(35) 34/1
2011[14]	1 prior to loading	Mean 0.38 mm	(98) 97/1
2011[15]	1 year	0.63 ± 0.18	(173) 169/4
2012[16]	2 years	The mean bone loss was 1.40 mm after one year and 0.53 mm after two years.	(334) 327/7
2012[17]	-	-	(65) all were successful
2013[18]	-	-	(71) all were successful
2013[19]	-	-	(79) all were successful
2013[20]	-	-	(68) all were successful
2018[21]	--	--	1(all)
2020[22]	--	0.73mm	71.4% successull

Type 6: Overall success rate of short implants as per each article

Year	Survival rate (%)
2002[10]	100
2006[11]	100
2011[13]	97.4
2011[14]	97.9
2011[15]	97.7
2012[16]	97.9
2012[17]	99
2013[18]	100
2013[19]	100
2013[20]	100
2018[21]	100
2020[22]	71.4

V. Conclusion:

This structured review has identified articles with data regarding immediate implant in posterior maxilla. Immediate implants could be a preferable choice with or without sinus floor management depending on cases as the treatment becomes faster and cheaper, and these are associated preventing pneumatization of sinus. Currently, the literature notes a nonrandomized pattern of techniques related to immediate placement protocols pertaining to timing of placement as well as augmentation techniques. Therefore, immediate implant placement is defined as a technique-sensitive but predictable procedure for posterior maxilla implant restoration.

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