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Clinical and Radiographical Efficacy of Immediate Implant Placement Versus Delay Implant Placement

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Abstract:

Background: Immediate implant placement (IIP) has been increasingly popular in the recent years, particularly in the anterior region for esthetic reasons. The effect of IIP may overweight delay implant placement (DIP) in term of implant stability, success rate, clinical outcome, and radiological measures.

Methodology:

In this review, 484 randomized controlled trials and controlled clinical trials study have been reviewed for their title and abstracts. The review used PRISMA design for developing methods, and has searched both database of MEDLINE (PubMed) and The Cochrane Library. Twenty-eight papers and 1639 patients were been involved for the study analysis. Primary outcome variables were survival rate, failure rate and success rate, and secondary outcomes were clinical and radiological evaluation and aesthetic score in both IIP and DIP.

Results:

Implant success rate were slightly higher in DIP, and implant fail and complications have rated higher in IIP compared to DIP. Probing depth (PD) is mostly similar in both protocols. Numerus studies in this review have demonstrated the significant healthier soft tissue such as keratinized mucosa (KM) width, peri-implant mucosal thickness (PMT) at implantation, loss of Midfacial Mucosa Level (MML) in the IIP procedure. High significant aesthetic score was observed in IIP protocol. Pink esthetic score (PET) score in both protocols were highly varies and controversial in nine studies. Six studies concluded the significant high mean of marginal bone loss (MBL) in DIP and five studies confirmed the significant high MBL in IIP. **Conclusion**: IIP has slightly higher in implant failure and clinical outcome in term of KM width, PMT at implantation, loss of MML in the IIP procedure. IIP was associated with better aesthetic score. More studies require to conclude the radiological evaluations in both protocols.

Introduction:

Immediate implant placement (IIP) has been increasingly popular in the recent years, particularly in the anterior region for esthetic reasons. Patient conventionally may prefer the IIP while the protentional benefits and drawback of immediate implant have been well explored or studied properly[1]. However, some studies demonstrate that IIP was associated with short treatment duration and better bone volume preservation that led to provide virtuous aesthetic outcome [2] [3] A published review has imposed the higher risks of IIP in term of implant failure and complications than DIP, however aesthetic score result may be better in IIP comparing to delay DIP [4]. IIP has been defined as implants are placed in dental sockets directly after fresh tooth extraction, and conventional implant replacement according to protocol means implants are inserted after three months to allow for soft tissue healing and bone partially and completed healed [1].

Both techniques may be associated with instantaneous and potential effect on soft tissue and bone recession with time. Alveolar bone measures and soft tissue changes in both techniques are various with times by considering to particular bone graft and site of implant such as maxilla mandible, anterior, molar and premolar regions [5] [6]. IIP extend less time from tooth extraction to complete rehabilitation[7] while it may be associated with less bone loss in alveolar region. IIP has not scientifically recommended as the substitute for DIP in studies [5]. A review study refer to specific precaution about using IIP protocol [8]. In such disease conditions such as chronic periapical disease, IIP was associated with more low survival rate [7]. Despite of that, there is metanalysis that recommended IIP because of less recession in MBL and survival rate[9].

The effect of these techniques could not be only measured by implant stability and success rate [10], while the efficacy is also assessing through the gingival recession soft tissue parameter [11] and esthetics, radiographical parameter such as MBL, peri implant marginal bone loss (PIMBL) and crestal bone loss (CBL) [12]. The aim of this review was to find the clinical outcomes and radiological measures of both protocols.

Methodology:

This systematic review study has been developed to know the efficacy differences between immediate implant placement and delay implant placement. The review used PRISMA design for developing methods and conducting this review. This review examined he MEDLINE (PubMed) and The Cochrane Library databases. Randomized controlled trials, controlled clinical trials have been recruited for this review. Only English studies has been included.

Searching for paper and data collection were done through many keywords and phrases. The following keywords and phrases have been used to search paper, “immediate implant and delay

implant placement, extraction socket, fresh socket and dental implants". Initially, 484 eligible titles and abstract were screened in this review.

The review focused on implant surgery has done in diverse clinical sites such as maxilla, incisor, canine molar, sub molar area, anterior or posterior sites. Implants with or without bone augmentation procedures by using the difference grafting material and active agents such as bone morphogenetic proteins (BMPs) or platelet rich plasma (PRP) included to this review

Studies recruited patients required to more implants or severely damaged the sockets have been excluded from this review, this is because more trauma to gum and alveola bone. For instance, immediate implant placement conducted to overdenture prothesis, total edentulous and pre-existing denture have been excluded in this review. Two papers have been excluded because was conducted one pregnancy women, two papers were conducted on animal. Three papers were excluded because, the papers defined delay implant placement for less than 3 months.

Outcome variables include clinical outcome, radiological variables, survival rate, success rate and implant failure rate. Clinical outcomes compost of the condition of peri-implant soft tissue, aesthetic status and complications. Soft tissue assessment included some parameter such as Probing depth (PD), Bleeding and/or suppuration on probing (BOP/SUP), Plaque Index (PI), Keratinized mucosa (KM) width, mucosal recession (MR) of the peri-implant soft tissue, and Periotest value (PTV) [13]. Aesthetic status encompasses the aesthetic score and pink aesthetic score (PET).

All parameters regarding to clinical out come about soft tissue assessment and radiological measures about alveola and crestal bone such as Marginal bone measures (MBL) and Crestal bone level (CBL) were measure in both protocols, IIP and DIP.

Results:

In this review 484 paper has been reviewed for their title and abstracts. 28 papers have been taken to the review. Overall, 1639 patients were been involved for the study analysis.

This review has shown success rate in both protocols (IIP, DIP) are high, however success rate in in DIP mostly higher (100%) compared to IIP. Implant fail and complications have rated higher IIP compared to DIP. However only one study has statistically improved that. Implant fail ranged from (6% to 10%) in IIP and (0 %to 4.6%) in DIP. Implant stability was almost same in both protocols, (ISQ value was 66% to 79.9%) (Table 1&2).

PD is mostly similar in both protocols, while higher significant deep DP in IIP was observed one study. Few studies have measured plaque, and PI and Plaque score have not varied in both

protocols. Numerus studies in this review have demonstrated the significant healthier soft tissue such as KM width, PMT at implantation, loss of MML in the IIP procedure, while papilla level or index remain unvaried in the IIP and DIP.

This review has found a higher aesthetic score in IIP protocol almost in all included studies and two studies have improved the higher score statistically. PET score in both protocols were highly varies and controversial in nine studies, and one study support high significant score of PET in DIP, and one study found significant high improvement of PET in IIP.

Bleeding status has been measured by bleeding index or BOP in the four studies. In this review poor bleeding condition has been generally observed in the IIP protocol, however, none of the studies have shown the statistical difference. Gingival level has been less studied, one studies has improved less gingival marginal level in IIP.

Table (1)

Name of author	**Research design and procedure**	**Number of patients** **Or sample size**	**Clinical outcome (peri implant soft tissue, aesthetic) complication**	**Clinical outcome (peri implant soft tissue, aesthetic) complication**	**Type of surgery**	**Success rate** **Instability rate**
Parvini et al. (2022) [13]	**non-RCT** **IIP** Bone grafting: 15 (93.75%) Gap filling: 13 (81.25%) LRG: (12.50%) **DIP** Bone grafting: 8 (50.00%) Gap filling: 0 LRG: 9 (56.25%)	**25 patients**	**IIP** **At 6 months** PD (max): 3.22 BOP (%):5.21 PI: 0.34* KM width (buccal): 4.94 MR (buccal): 0 PTV: 0.31 **IIP** **At 12 months** PD (max) 3.25 BOP (%): 7.29 PI: 0.18 KM width (buccal) 5.25* MR (buccal) 0	**DIP** **At 6 months** PD (max): 3.38 BOP (%):2.08 PI: 0.18* KM width (buccal; mm): 4.38 MR (buccal; mm): 0 PTV: − 0.87 **DIP** **At 12 months** PD (max) 3.28 BOP(%): 8.33 PI: 0.18 KM width (buccal) 4.44* MR (buccal) 0.06	single anterior tooth (anterior maxillae)	IIP Primary stability: 42.19 PTV:0.06 **DIP** Primary stability: 41.25 PTV: − 0.88
SLAGTER ET AL (2021)	**Randomized control**	**IIP: 20** **DIP:20**	**IIP** **First month to 5 years** Marginal soft-tissue level changes	**DIP** **First month to 5 years** Marginal soft tissue level changes	maxillary anterior region	**IID** Success rate:100% Restoration

[14]	**trail**		Mesial of implant: (−0.90) * to (−1.19) Distal of implant: (−0.44) to (−1.18) Papilla index Mesial: (2.16) to (2.56) Distal: (2.37) to (2.50) GI: (0.90) to (0.00) Bleeding index: (0.60) to (0.39) PES/WES: (16.20) to (15.44)	Mesial of implant: (−0.44)* to (-0.65) Distal of implant: (−0.78) to (−1.20) Papilla index Mesial: (2.37) to (2.60) Distal: (2.00) to (2.40) GI: (0.79) to (0.0) Bleeding index: (0.47) to (0.39) PES/WES: (15.10) to (15.73)		survival: 88.9% **DIP** Success rate:100% Restoration survival: 88.2%
Santhana krishnan (2021) [15]	prospective RCT (IIP) was grafted using autogenous bone particles DIP: A combination of (DBBM) and (A-PRF)	**IIP: 25** **DIP:25**	**IIP** **Difference in 6 months** PES: 1:0	**DIP** **Difference in 6 weeks** PES: 0:7	**maxillary esthetic region**	
Santhana krishnan et al Dovepress (2021) [16]	**RCT** **IIP** xeno- graft (DBBM; Bio-Oss, Geistlich) + autologous bone particles **DIP:** xenograft (DBBM; Bio-Oss, Geistlich) + (A-PRF)	**IIP: 25** **DIP:25**	**IIP** **Difference after 6 months** PES: 1.0*	**DIP** **Difference after 6 months** PES: 0.7*	esthetic zone of maxilla	

SLAGTER et al (2021) [12]	**prospective, RCT** **IIP** ridge preservation in the esthetic region alveolus **DIP** The alveolus was augmented in the same manner as in the IIP	**IIP: 20** **DIP:20**	**IIP:** **Change in 1 month** Marginal soft tissue level change Mesial of implant: (−0.15) Distal of implant: (−0.17) Mesial and distal side: (−0.13) PI:0.00 GI: 0.05 after probing bleeding index:0.45 PES: 7.8 **Change in 60 months** Marginal soft tissue level changes Mesial of implant: (−0.30) Distal of implant: (−0.38) Mesial and distal side: (−0.27) GI:0.06 PI:0.00 bleeding index:0.50 PES: 7.55	**DIP:** **Change in 1 month** Marginal soft tissue level changes Mesial of implant: (−018) Distal of implant: (−0.23) Mesial and distal side: (−0.30) PI: 0.00 GI:0.00 after probing bleeding index:0.00 PES: 7.4 **Change in 60 months** Marginal soft tissue level changes Mesial of implant: (−0.22) Distal of implant: (−0.36) Mesial and distal side: (−0.45) GI:0.06 PI:0.06 bleeding index:0.18 PES:7.53	esthetic zone of maxilla	100% survival rate for implants and restorations in both
Tonetti et al (2016) [17]	**RCT** **IIP** bone augmentation in: 72%* **DIP** bone augmentation in: 43.9*	124 patients	**IIP** **At 1 year** FMBS: 20 FMPS :11 Inadequate PET: 42%* deeper PD: 4.1*	**DIP** **At 1 year** FMBS: 17 FMPS:12 Inadequate PET: 19%* deeper PD: 3.3 *	anterior and premolar areas	IIP 1 implant loss At 1 year Success rate 100%
W. Slagter (2016) [11]	**RCT**	**IIP: 20** **DIP:20**	**IIP:** **At 1 month** IML changes Mesial of implant: 0.15 Distal of implant: 0.17 MML changes Mid-facial of implant: 0.13 PES: 7.8 **At 1 years** IML changes Mesial of implant: 0.15 Distal of implant: 0.18 MML changes Mid-facial of implant: 0.15 PES: 7.5	**DIP:** **At 1 month** IML changes Mesial of implant: 0.18 Distal of implant: 0.23 MML changes Mid-facial of implant: 0.30 PES: 7.4 **At 1 years** IML changes Mesial of implant: 0.15 Distal of implant: 0.21 MML changes Mid-facial of implant: 0.34 PES: 7.4	in the aesthetic zone	**DIP** **At 1 year** survival rate: 100%

Koirala et a (2016) [18]	comparative clinical study	IIP: 44 DIP:44	**IIP:** **Mean loss 12-6 months** Change in: mesial PD: 0.2 distal PD: 0.2 labial PD: 0.2 lingual PD: 0.1 mean PD: 0.2	**DIP:** **Mean loss 12-6 months** Change in: mesial PD: 0.1 distal PD: 0.1 labial PD: 0.1 lingual PD: 0.1 mean PD: 0.2	anterior mandible canine region	**IIP:** PTV: 1.3 **DIP:** PTV: 1.7
POLI ET AL (2019) [19]	A Prospective Controlled Pilot Study Both groups underwent connective tissue graft (CTG)	14 patients	**IIP** **after implantation** PMT: 2.57* **6 months** Change in PMT: 0.11 **12 months** Change in PMT: -0.05	**DIP** **after implantation** PMT: 1.32* **6 months** Change in PMT: 1.32 **12 months** Change in PMT:1.08	in premolar or molar positions	Success rate: 100 in both
De Rouck et al (2009) [20]	**RCT** **IIP** **DIP** a collagen membrane (Bio-Gide, Geistlich Biomaterials,) covering the implant and the grafting material (Bio- s Oss, Geistlich Biomaterials)	**49 patients**	**IIP** **At 6 months** Plaque score (%) :(19) PD: 3.67 BOP (%):44 Loss in soft tissue dimensions Mesial papilla level: 0.41 Distal papilla level: 0.34 MML: 0.47* **At 12 months** Plaque score (%): (15) PD: 3.6 BOP: (%):40 Loss in soft tissue dimensions Mesial papilla level: 0.44 Distal papilla level: 0.31 MML: 0.41*	**DIP** **At 6 months** Plaque score (%): (17) PD: 3.36 BOP (%):39 Loss in soft tissue dimensions Mesial papilla level: 0.6 Distal papilla level: 0.63 MML: 1.16 * **At 12 months** Plaque score (%): (18) PD: 3.27 BOP: (%):36 Loss in soft tissue dimensions Mesial papilla level: 0.43 Distal papilla level: 0.53 MML: 1.16*	**Incisor, Canine, Premolar**	
Srinivasan Bhuvaneshwari (2020) [21]	A Comparative Assessment	**IIP:42** **DIP:42**	**IIP:** peri-implant esthetic score at 1 week to 6 months: 7.4- 5.8^*	**DIP:** peri-implant esthetic score at 1 week to 6 months: 6.4-4.4^*		

Schropp L (2005) [22]	Control trail	46 patients	**IIP** **After 2 years** Reduce of PD: 1.4	**DIP** Reduce of PD: 1.4	(Anteri or pre-molar) maxilla or the mandible	3 implants fail Restoration fail: 0%
Esposito M(2017) [23]	**RCT** **Both groups** the socket grafted with a bone substitute & covered with a resorbable membrane	**IIP: 70** **DIP:70**	**IIP** **At 1 years** aesthetic score: 12.52*	**DIP:** **At 1 years** aesthetic score: 11.78*	a single implant	**IIP:** Implant fail: (6%) **DIP** Implant fail: (1.6%)
Hassani A (2021) [24]	A Nonrandomized Clinical Study	**IIP: 20** **DIP20**	**IIP** **At 1 year** PES: 11.2 WES: 8	**DIP** PES: 10.2 WES: 7.65	single implants in the maxillary esthetic	**IIP:** Success rate: 100 2 minor complications **DIP:** Success rate: 100 No complications
Felice P (2015), [25]	RCT DIP: using an algae-derived (phycogenic) bone substitute, covered by a resorbable collagen barrier	**IIP:25** **DIP:25**	**IIP** **At 4 months** aesthetic score: 12.42 **At 1 year** aesthetic score: 12.78	**DIP** **At 4 months** aesthetic score: 12.28 **At 1 year** aesthetic score: 12.22	maxilla from second-to-second premolar	**IIP:** Fail rate: 8%, 3 minor complications **DIP:** Fail rate: 0%, 2 minor complications
Grandi T (2013) [26]	Clinical trail **IIP** **DIP** immediate socket grafting	**50 patients**	**IIP** **12-month** ideal gingival marginal level: 52.1%, * Rates of full closure of the Papilla: 82.6%	**DIP** **12-month** ideal gingival marginal level: 83.3%* Rates of full closure of the Papilla: 62.5%	maxillary tooth (premolar, canine, lateral or central incisor)	**IIP** **12-month** Fail rate: 8% **DIP** **12-month** Fail rate:4%

Tallarico M (2016) [27]	RCT **IIP** **DIP** Both group augmented with corticocancellous heterologous bone and porcine derma	**24 patients**	**IIP** **At one year** PES: 10.7	**DIP** **At one year** PES: 11.7	molar region of both maxilla and mandible single post-extractive	**IIP** **1 year** Mean ISQ value: 78.8 **DIP** **1 year** Mean ISQ value: 79.9 For both group **At 6 months**, No fail and complication
Esposito M (2015), [28]	RCT Both groups Anorganic bovine bone+ resorbable collagen barrier	**IIP: 54** **DIP:52**	**IIP** **At 4 months** aesthetic score: 12.8 **At 1 year** aesthetic score: 13.0	**DIP** **At 4 months** aesthetic score: 12.6 **At 1 year** aesthetic score: 12.8	maxilla from second-to-second premolar	**IIP:** implants failed: (6%) 8 minor complications* **DIP:** No fail, no complication*
Checchi V (2017) [29]	RCT wide diameter implants **IIP:** **DIP:** resorbable collagen barrier bone grafting	**IIP:** 47 **DIP** 44	**IIP** **At 4 months** PES score: 9.65* **At 1 year** PES score: 9.71*	**DIP** **At 4 months** PES score: 10.44* **At 1 year** PES score: 10.86*	molar teeth in maxilla or mandible	**IIP** Implant fail: 10.6% 10 complications **DIP** Implant fail: 4.6% 4 complications

Salimon Ribeiro (2008) [30]	**Clinical trial**	IIP: 43 DIP: 36			Maxilla incisors, canines, and premolars	**IIP** 3 years success rate: 93.5% **DIP:** success rate:100.0 %
^ significant difference of same variables with time differences * significant difference in variable between IIP and DIP						

This review has shown that bone resorption around implant in both IIP and DIP protocols was more controversial. Significant fluctuate mean of MBL was found in both IIP and DIP. Six studies concluded the significant high mean of MBL in DIP and five studies confirmed the significant high MBL in IIP. MBL also increased significantly with time period in both protocols. Studies about CBL and PIMBL have also demonstrate controversial out-comes. Bone augmentation and covered by a resorbable collagen barrier was widely used in both procedures.

Table (2)

Name of author	**Type of research or Research design**	**Number of patients** **Or sample size**	**Radiographic examination of hard tissue**	**Radiographic examination of hard tissue**	**Type of surgery**	**Success rate** **Instability rate**
Parvini et al. (2022) [13]	**non-RCT** **IIP** **Bone grafting: 15 (93.75%)** **Gap filling: 13 (81%)** **LRG: (12%)** **DIP** **Bone grafting: 8 (50%)** **Gap filling: 0** **LRG: 9 (56%)**	**25 patients**	**IIP** **After 6months** **ROI: (− 0.53) *** **Marginal ROI:(− 0.60) *** **Apical ROI: − 0.31** **After 12 months** **ROI: (− 0.37) *** **Marginal ROI: − 0.42** **Apical ROI: − 0.16**	**DIP** **After 6 months** **ROI: 0.94** **Marginal ROI: 0.83*** **Apical ROI: 0.62** **After 12 months** **ROI: 0.84** **Marginal ROI: 0.80** **Apical ROI: 0.83**	**single anterior tooth (anterior maxillae)**	**IIP** **Primary stability: 42.19** **DIP** **Primary stability: 41.25**
Shah, et al (2021)	**Clinical trial**	**9**	**IIP with Photo functionalization** **After 2-6-12 months**	**DIP** **After 2-6-12 months** **Mesial MBL:** **1.01- 1.63-1.85^**	**maxillary anterior teeth**	**Photo** **92.59%**

[31]			Mesial MBL: 1.23*- 1.68* 1.87^ Distal MBL: 0.99- 1.49- 1.68^ Mean MBL: 1.11- 1.59*- 1.78^ IIP with platelet-rich plasma After 2-6-12 months Mesial MBL: 1.00*- 1.54* -1.80^ Distal MBL: 0.91- 1.44- 1.70^ Mean MBL: 0.95- 1.49- 1.75^	Distal MBL: 0.89*- 1.44*- 1.66^ Mean MBL: 0.95- 1.53*- 1.76^		After 2-6-12 months Implant stability: 53.67*- 69.83*- 72.08*^ IIP with platelet-rich plasma Success rate: 93.01% After 2-6-12 months Implant stability: 51.25- 68.25- 71.17^ DIP Success rate: 96.42% (After 2-6-12 months) Implant stability: 48.55- 61.09- 65.09^
SLAGTER ET AL (2021) [14]	Randomized control trail	IIP: 20 DIP:20	IIP First month to 6 years MBLs change Mesial of implant: (−0.70) to (−0.71) Distal of implant: (−0.69) to (−0.71)	DIP First month to 5 years MBLs change Mesial of implant: (−0.68) to (−0.49) Distal of implant: (−0.69) to (−0.54)	maxillary anterior region	IID Success rate:100% Restoration survival: 88.9% DIP Success rate:100% Restoration survival: 88.2%
Santhanakrishnan (2021) [15]	prospective RCT (IIP) was grafted using autogenous bone particles DIP: A	IIP: 25 DIP:25	IIP Difference in 6 months labial bone thickness CBT: 0.2*^	DIP Difference in 6 weeks labial bone thickness CBT: 0:4*	maxillary esthetic region	

	combination of (DBBM) and (A-PRF)					
Santhanakrishnan et al Dovepress (2021) [16]	RCT IIP xeno- graft (DBBM; Bio-Oss, Geistlich) + autologous bone particles DIP: xenograft (DBBM; Bio-Oss, Geistlich) + (A-PRF)	IIP: 25 DIP:25	IIP Difference after 6 months CBT: 0.4*^	DIP Difference after 6 months CBT: 0.2*^	esthetic zone of maxilla	
SLAGTER et al (2021) [12]	prospective, RCT IIP ridge preservation in the esthetic region alveolus DIP The alveolus was augmented in the same manner as in the IIP	IIP: 20 DIP:20	IIP: Change in 1 month MBLs changes Mesial of implant: (−0.49) Distal of implant: (−0.71) Mesial and distal side: (−0.59) Change in 60 months MBLs changes Mesial of implant: (−0.64) Distal of implant: (−0.77) Mesial and distal side: (−0.71)	DIP: Change in 1 month MBLs changes Mesial of implant:(−0.45) Distal of implant: (−0.48) Mesial and distal side: (−0.47) Change in 60 months MBLs changes Mesial of implant: (−0.50) Distal of implant: (−0.58) Mesial and distal side: (−0.54)	esthetic zone of maxilla	100% survival rate for implants and restorations in both
LIU ET AL (2019) [32]	RCT IIP maxillary sinus floor elevation DIP maxillary sinus floor elevation	76	IIP 6 months differences Change in horizontal alveolar bone (W1) on the buccal side: 0.65 * palatal side 0.3 Change in vertical alveolar bone (H1) on the buccal: 0.60 * On palatal side: 0.24 1 years remain not significant	DIP 6 months differences Change in horizontal alveolar bone (W1) on the buccal side: 1.23 * palatal side: 0.28 Change in vertical alveolar bone (H1) on the buccal side: 1.53 * On palatal side: 0.29 1 years remain not significant	maxilla molar region	1 Year The survival rate of implants: 100%
W.	RCT	IIP: 20	IIP:	DIP:	in the aesthetic	DIP

Slagter (2016) [11]		DIP:20	At 1 month MBL changes Mesial of implant: 0.49 Distal of implant: 0.71 BBT changes Buccal of implant: 1.01 At 1 years MBL changes Mesial of implant: 0.56 Distal of implant: 0.74 BBT changes Buccal of implant: 1.00	At 1 month MBL changes Mesial of implant: 0.45 Distal of implant: 0.48 BBT changes Buccal of implant: 0.79 At 1 years MBL changes Mesial of implant: 0.51 Distal of implant: 0.54 BBT changes Buccal of implant: 0.71	zone	At 1 year survival rate: 100%
Atieh et al (2012) [10]	controlled clinical trial	24 implants	IIP After 1 year Change in MBL: 0.41 BC level: -0.17 CP-BC distance: 0.32	DIP After 1 year Change in MBL: 0.04 BC level: 0.06 CP-BC distance: 0.23	mandibular molar	IIP: Success rate: 66.7% change in ISQ values in 1 year: -3.99% DIP: Success rate: 83.3% Change in ISQ values in 1 year:7.19%
Aguirre-Zorzano (2011) [33]	Prospective clinical study IIP Connective tissue graft made	71 patients	IIP: At 6 months Mean bone loss: 0.4	DIP: At 6 months Mean bone loss: 0.1	upper premolar region	IIP: Survival rate 98.7% DIP:
Malchiodi et al (2016) [34]	RCT Both group: A mixture of autogenous bone collected during drilling and deproteinized bovine bone	IIP: 20 DIP:20	IIP: up to 12 months CBL: 0.68*	DIP: up to 12 months CBL: 0.40*	Maxilla and mandible at premolar or molar sites	IIP: up to 12 months Success rate: 100% ISQ at loading:68.15% DIP: up to 12 months Success rate: 100% ISQ at loading:66.80%
Koirala et a (2016)	comparative clinical study	IIP: 44 DIP:44	IIP: Mean loss 12-6 months	DIP: Mean loss 12-6 months	anterior mandible canine region	

[18]			Change in mesial CBL: 0.2 distal CBL: 0.2 CBL: 0.2	Change in mesial CBL: 0.2 distal CBL: 0.2 CBL: 0.2		
PRATI ET AL (2017) [6]	Clinical trail (For IIP), an atraumatic flapless root extraction was performed and after 3 months has loaded	Patients:131	IIP Preloading MBL: 0.10* ^ At 6 months MBL: 0.24*^ At 12 months MBL: 0.60*^ At 2 years MBL: 0.78*^	DIP Preloading MBL: 0.27* At 6 months MBL: 0.67* At 12 months MBL: 0.80* At 2 years: MBL: 1.02*	Maxillary and mandibular	Survival rate was 100%
De Rouck et al (2009) [20]	RCT IIP DIP a collagen membrane (Bio-Gide, Geistlich Biomaterials,) covering the implant and the grafting material (Bio- s Oss , Geistlich Biomaterials)	49 patients	IIP At 6 months MBL Mesial: 0.75 Distal: 0.71* At 12 months MBL Mesial: 0.92 Distal: 0.7	DIP At 6 months MBL Mesial: 0.89^ Distal: 0.87*^ At 12 months MBL Mesial: 0.96^ Distal: 0.97 ^	Incisor, Canine, Premolar	
Srinivasan Bhuvaneshwari (2020) [21]	A Comparative Assessment	IIP:42 DIP:42	IIP: At 6 months PICBL: 1.04	DIP: At 6 months PICBL: 1.14		
Schropp L (2005) [22]	Control trail	46 patients	IIP After 2 years MBL: 0.8^	DIP After 2 years MBL: 0.7^	pre-molar region of the maxilla or the mandible	3 implants fail Restoration fail: 0%
Esposito M(2017) [23]	RCT Both groups the socket grafted with a bone substitute & covered with a resorbable membrane	IIP: 70 DIP:70	IIP At 1 year PIMBL: -0.25*	DIP: At 1 year PIMBL: -0.31*	a single implant	IIP: Implant fail: (6%) DIP Implant fail: (1.6%)
Hassani A (2021) [24]	A Nonrandomized Clinical Study	IIP: 20 DIP20	IIP At 1 year MBLs changes (MBL): 0.47	DIP At 1 year MBLs changes (MBL): 0.54	single implants in the maxillary esthetic	IIP: Success rate: 100 2 minor complications

						DIP: Success rate: 100 No complications
Schropp L (2003) [35]	a prospective clinical study	46 patients	IIP At 3 months reductions in parallel width: 48%* perpendicular width:59%* depth of the largest defect: 48%*	DIP At 3 months reductions in parallel width: 39%* perpendicular width:77%* depth of the largest defect: 34%*	incisor, canine, or premolar region of the maxilla or the mandible	IIP survival rate: 91% DIP survival rate: 96%
Felice P (2015), [25]	RCT DIP: using an algae-derived (phycogenic) bone substitute, covered by a resorbable collagen barrier	IIP:25 DIP:25	IIP: At implant insertion MBLs: 0.01 * At 1 year MBL: 0.13	DIP: at implant insertion MBLs: 0.06* At 1 year MBL: 0.19	maxilla from second-to-second premolar	IIP: Fail rate: 8%, 3 minor complications DIP: Fail rate: 0%, 2 minor complications
Grandi T (2013) [26]	Clinical trail IIP DIP immediate socket grafting	50 patients	IIP 12-month PIMBL: 0.71	DIP 12-month PIMBL: 0.60	maxillary (premolar, canine, lateral or central incisor)	IIP 12-month Fail rate: 8% DIP 12-month Fail rate:4%
Tallarico M (2016) [27]	RCT IIP DIP Both group augmented with corticocancellous heterologous bone and porcine derma	24 patients	IIP At 6 months horizontal alveolar bone reduction level A: 1.78 * Level B: 0.98 * Level C: 0.55 * At one year PIMBL: 0.43 *	DIP At 6 months horizontal alveolar bone reduction level A: 0.45 * Level B: 0.14* Level C: 0.24* At one year PIMBL: 0.10*	molar region of both maxilla and mandible single post-extractive	IIP 1 year Mean ISQ value: 78.8 DIP 1 year Mean ISQ value: 79.9 For both group At 6 months, No fail and complication
Esposito M (2015), [28]	RCT Both groups Anorganic bovine bone+ resorbable collagen barrier	IIP: 54 DIP:52	IIP At implant MBLs after graft: 0.10* At 1 year MBLs: 0.23*	DIP At implant MBLs after graft:0.02 * At 1 year MBLs: 0.29*	maxilla from second-to-second premolar	IIP: implants failed: (6%) 8 minor complications* DIP: No fail, no complication*

Checchi V (2017) [29]	RCT wide diameter implants IIP: DIP: resorbable collagen barrier bone grafting	IIP: 47 DIP 44	IIP At implant MBLs: 0.04* At one years MBL: 1.06*	DIP At implant MBLs: 0.11* At one years MBL: 0.63*	one or two molar teeth in maxilla or mandible	IIP Implant fail: 10.6% 10 complications DIP Implant fail: 4.6% 4 complications
Tallarico M (2017) [36]	RCT Both groups grafted with cortico-cancellous heterologous bone and porcine derma	12 patients	IIP At one year MBL loss: 0.63 *	DIP At one year MBL loss: 0.23*	molar region of both maxilla and mandible	No fail No complications IIP: At Six months mean ISQ value:78.8 DIP: At Six months mean ISQ value: 79.9
^ significant difference of same variables with time differences * significant difference in variable between IIP and DIP						

Discussion:

Aim of this systematic review was to know the clinical and radiological efficacy in IIP and DIP protocols. Implant success rate, implant fail, complication and instability were also assessed in the IIP and DIP protocols. Review has been conducted for 484 eligible papers and 28 comparative clinical papers, and 1639 patients were recruited and used to analysis in this review.

Implant success and survival rate was considered to be satisfactory in both protocols (IIP, DIP) in this review, however higher success rate in DIP (was nearly to 100%) was mostly observed among the reviewed studies compared to IIP. This finding was contradicted with another review study which has provided evidence for higher success rate of IIP over DIP [37]. Survival rate may relate to other factors such as preservation and loading time. For instance survival rate in other study was ranged from (87% -100%) for IIP and (83%–100%) for DIP, these ranges were various depending on when restoration and loading have been done for the implants[38] [39]. Several studies demonstrated that survival rate and success rate do not significantly differences in both procedures, immediate implants survival rate was 98.3% and delayed implants was 96.9% [40] [38] [41] [42]. However many metanalysis study found a significant higher survival rate in DIP [43] [8]. Variation in implant survival rate in both protocols may also relate to augmentation and bone graft such as autogenous onlay grafts, iliac crest grafts and intra-oral grafts [40].

The review found that higher implant fails rate and more complications were more observed in the IIP comparing to DIP, however only one study could significantly confirm this outcome. The implant fails rate among the recruited studies were ranged from (6% to 10%) in IIP and (0 % to 4.6%) in DIP. This finding was also observed in other review studies [43] [1]. Implant failure mostly related to implant diameter and socket conditions; since significant high failure rate was more observed in wider implant diameter and socket with chronic periapical disease rather than normal socket and less implant diameter [44] [45].

In this review, implant stability rates were almost same in both protocols, ISQ value was generally rated from (66% to 79.9%). This findings was also supported by several review studies which found that primary stability and ISQ do not differ in IIP and DIP [8] [37]. While another study showed the high primary stability of dental implants in DIP [46]. Implant stability may relate to early potential osteointegration which has affected by bone augmentation materials.

In this review, clinical outcomes and soft tissue complications were varied in IIP and DIP protocols. Other review confirmed on that soft tissue recession and soft tissue preservation could be same in both protocols [37]. Another study also confirmed no significant difference of soft tissue change in both protocols, however, less recession of midbuccal soft tissue margins and interproximal tissue height were observed in the IIP [47]. There is a study that found no significant difference in the soft tissue papillary levels, midfacial gingival level in both protocal [48].

Although there are not significant differences in PD between the IIP and DIP in this review, one study found higher significant deep PD in IIP. This finding could not be concluded in this review and other study [49]. Some metanalysis found similar result which confirmed that PD would not be significantly change in IIP and DIP [43] [8]. Meanwhile there is some studies that support the significant reduction in PD in DIP [50] [42]. Type of procedures and surgery, oral hygiene, and patient's age and chronic diseases may contribute in PD.

The analysis indicated that soft tissue level, such as KM width, PMT at implantation, and loss of MML remain significantly healthier in IIP procedures, while papilla level or index was shown to be indifferent in IIP and DIP procedures.

This review demonstrated that the significant high aesthetic score was more frequently observed in the IIP protocol. This result has been supported by other study and review[1] [42], meanwhile there are several studies that showed aesthetic result in both protocols was not varies [39][50]. PET score in IIP and DIP protocols were highly varying and controversial in the nine recruited studies, two of the studies in this review have confirmed the high significance PET scores in the

DIP protocol, while one study discovered a significant PET score in the IIP protocol. PET did not differ in both protocols in some other studies [39] [43].

Gingival level has been less studied, in this review one study has improved less gingival marginal level in IIP. Gingival aesthetic score is better in IIP [42]. Another study also supports significant high gingival level in DIP [51]. Poor bleeding conditions in term of bleeding index or BOP have frequently been noted in the IIP procedure in this review, although no study has demonstrated a statistically significant difference. Same finding has found by other study[49]. Plaque has only been measured in a small number of trials, and both PI and Plaque score have remained constant. However, one study shows that IIP significantly has a higher PI.

A review study has also provided evidence about no difference in interproximal bone level and crestal bone level in both IIP and DIP [37]. While bone recession around the implant is more controversial in this review. MBL was measured more frequently in the studies, and its mean was more inconsistent. In this review five studies showed the significant high MBL in IIP, while six studies show the significant high mean of MBL in DIP. This findings was consistent with a metanalysis study which mentioned that MBL was conflicting and highly biased in IIP and DIP [43], and other recent metanalysis has shown the insignificant differences of MBL in IIP and DIP [2] [52]. While significant reduction of marginal bone in DIP is also supported by other study [50]. Varies MBL may related to sites of implants, and bone augmentation and the use of PRF. This is because MBL in maxilla and mandibular was statistically varies in another study [41]. MBL also increased significantly with time period in both protocols, this findings has improved in other study [48] .

The studies about CBL and PIMBL have also revealed on contentious results in this review. However, there is more evidence about less bone reduction in IIP. There is a study that showed less bone resorption in IIP in 1 and 2 years of follow up [39]. Another study also found the significant more buccolingual bone width in IIP compared DIP after 6 months of implantation [53]. While, some other studies indicated no significant difference or similar response of crestal bone in IIP and DIP regarding the hard tissue changes [51] [54]. Greater reductions of ridge width after 6 months was observed in IIP while it was not statistically proved [47].

Variation techniques, procedures, protocols and site of the implants in IIP and DIP were considered as main limitation of this reviews. Each protocol, IIP and DIP, has distinct types depend on restoration and loading. For instance, IIP could be immediately, early or delay loaded after implantation. In addition, each protocol has been performed with differences procedures, some studies have used various bone grafting materials and resorbable collagen barrier membrane. Lastly, implantations have done for maxilla, mandible, molar, premolar, canine and other sites. In this review despite of that implant procedure and site of implant for each have

been determined, but these two variables could not be able use to analysis. Some study have shown that marginal bone resorption and implant failure rate were varied between maxilla mandible [49]. In this review, alveolar bone augmentation and covered by a resorbable collagen membrane were broadly used in both procedures. MBL and PD were significantly varies in socket augmented by autogenous bone graft or synthetic bone graft [55].

Conclusions:

Twenty-eight papers and 1639 patients have been recruited to this systematic review. Success rate and survival rate and implant stability were almost same in both protocols. Implant fail and complication were observed high in IIP comparatively. PD and PI were not varied in both protocols. PET score in both protocols were associated with controversial outcome among published literatures. This review provide evidence about high aesthetic score and improved soft tissue in term of KM width, PMT at implantation, loss of MML in the IIP procedure. Few studies support less gingival marginal level in IIP. Poor bleeding condition in term of bleeding index or BOP were observed in IIP procedure while studies could not significantly improve. Bone reduction around implant in both was controversial among studied. MBL, CBL and PIMBL were not being concluded in regarding to IIP and DIP.

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