

Comparison of peri-implant modifications between immediate implantation and delayed implantation

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Abstract

Introduction: We speak of immediate implantation (II) when it is performed before the total healing of the alveolus in order to take advantage of the hemodynamic and scarring modifications generated by the avulsion to promote osseointegration. Unlike delayed implantation (De), which is performed when the bone tissues are fully consolidated.

Objective: The objective of our study is to compare two implant techniques: extraction immediate implantation and delayed implantation with respect to soft and hard tissue modifications.

In the maxillary and mandibular sector including all sextants with the exclusion of wisdom teeth.

Materials and method: It's a study prospective and comparative, it was performed on 102 implant sites, from December 2016 to March 2021, divided into two groups, 54 cases of delayed implantation and 48 cases immediate implantation in both jaws and including all sextants.

The oral cavity can be divided into six frames; we therefore speak of a sextant. The sextants are respectively: the upper right premolar-molar group, the maxillary incisor-canine, the upper left premolar-molar, the lower left premolar-molar, the mandibular incisor-canine and finally the premolar lower right molar.

Patients were followed for 6 months, during which time tissue changes and osseointegration were assessed using a NABERS periodontal probe and Radio Visio Graphy (RVG).

Results: We did not obtain any rejection in the 2 techniques.

For immediate implantation: osseointegration (OI) was obtained especially at 4 months for most of the implants.

The loss of keratinized fibro mucosa (KFM) was localized to the mandible, it concerned sextant 4, much more for bone type 3 and 1, on the other hand the gain was observed at the level of sextant 1 and 6, especially for type 2 bone.

The gain in the mesial bony crest (MBC) and distal bone (DBC) were higher in the male gender in the II compared to the female gender.

The mesial fibro mucosa (MFM) was superior compared to the distal fibro mucosa (DFM) at 1 month and at 6 months.

For delayed implantation: Osseointegration (OI) was mainly at 5 months for most of the implants.

The loss of the keratinized fibro mucosa was localized at the level of the two maxillae.

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The gain in the mesial bony crest and distal bone were higher in the female gender in the (De) compared to the male gender

Conclusion :It is difficult to find a consensus within the current literature as to the superior interest of the technique compared to the other but at the end of this work, we can conclude after the analysis of our results that the II is preferable to IR because it makes it possible to reduce manipulations on the soft tissues, limit the resorption of hard tissues and the filling of the papillae more quickly after loading of the implant more than in the delayed technique, this of course if the preservation of the papillae was performed during the dental extraction, hence an atraumatic or so-called periodontal extraction.

Keywords: Immediate or delayed implantation; Keratinized fibro mucosa; Crete bone; Osseointegration

1. Introduction

For about twenty years, oral implantology has experienced considerable growth. So today, dental implants represent a reliable treatment option in the oral rehabilitation of partially or totally edentulous patients.

This technique has thus become a standard procedure for replacing lost teeth in a way that combines efficiency and elegance (1).

Today, while the fundamental functional needs of patients represented mainly by food and communication are satisfied, surgical techniques must also meet increasingly demanding requirements such as the reduction of treatment time, the reduction of cost and discomfort, preserving periodontal tissues for the most esthetic result possible.

The development of minimally invasive surgery in the various medical specialties and the increasing demands of patients have led us to use these two techniques, without flap elevation. This will avoid us any bias related to the consequences of the elevation of the latter.

Many studies conducted on humans and even on animals have addressed these two techniques and their relationship with the peri-implant tissues, or osseointegration, with a filling or graft (2). However, no study has compared the ratio of the implantation technique with these different parameters, at the same time. This work, by this novelty, finds its originality.

2. Material and methods

2.1. Study type and population

This is a prospective and comparative study, since our main objective is to compare two groups of patients for two different techniques.

The patients entering this study were recruited at the consultation of pathology and oral surgery of the CHU

Béni Messous, in the number of 52 patients.

The statistical unit was the implant, so we had 54 cases of delayed implantation and 54 cases of immediate implantation.

Recruitment concerned any patient aged over 18 and who requires dental replacement by an implant, after having explained to him all the possibilities of prosthetic restoration.

For each patient, a clinical form is carefully filled out, as well as an impression and request for an X-ray.

2.2. Selection criteria

Take into account the following parameters:

2.2.1. The patient

- The age of the patient which must be over 18 years old, for both sexes.

- The patient must be motivated to maintain proper oral hygiene. He must not have any disease or parafunction likely to influence the result.

2.2.2. *The tooth*

These are all cases of:

- Trauma: dental fractures, dental expulsions
- Root resorptions
- Failures of endodontic treatments
- Slow-growing periodontitis.
- Tooth replacements in certain agenesis
- Replacement of a fractured implant

2.2.3. *The implantation site*

- The alveolar walls must be sufficient (minimum 2 mm) particularly the vestibular wall.
- Have enough bone beyond the apex (3-5mm) to engage the implant to achieve the required primary stability.
- The bone morphology of the alveolus must allow the insertion of the implant, without resorting to a procedure of bone augmentation or tissue grafting

2.3. **Non-inclusion criteria**

- Inability to provide free and informed consent
- Inability to follow post-operative instructions
- Systemic condition contraindicating implant placement
- Tooth with acute or chronic infection, untreated periodontal disease.
- Smoking subject if he refuses to quit smoking
- Fracture of one or more walls during extraction
- Peri-implant bone defect: gaps resulting from the difference in the anatomical shapes between the walls of the uninhabited socket and the implant.

2.4. **The practical organization of the study**

Our protocol is based on 3 steps:

- 1st step : Pre-implant
- 2nd step: Implant surgery
- 3rd step: Control and follow-up spread over 6 months from implantation

2.4.1. *Pre-implant stage*

- Collect information about the tooth to be implanted and the elements that are related to the implantation.
- Cast
- Photography
- Life-size panoramic X-ray which allowed us to:

Eliminate from the study any implantation that could interfere with an anatomical structure, whether maxillary or mandibular.

Assess the position and orientation of the implant.

2.4.2. *Surgical technique*

- For the 1st group (immediate implantation)

We practiced an immediate extraction and implantation technique (II) which consists of placing our implant in a single surgical step.

This involves extraction and implant placement at the same session.

Once the indication of the dental extraction posed, this one must be done under satisfactory safety conditions, The patient is installed on the armchair, on the back, the head in hypertensive position if the intervention takes place in the maxilla .

In normal position if it is the extraction of a mandibular tooth.

The act is carried out under traditional local anesthesia, induced by infiltration, the operating field is disinfected beforehand.

All removable prostheses are removed, the face is isolated from the perilabial region. The oral cavity is disinfected with chlorhexidine.

Alveolectomy should never be resorted to because bone decay is a contraindication to immediate implantation.

The tooth is dislocated and then carefully extracted with forceps (trying to preserve the bone in the socket): (so-called periodontal extraction).

The extraction in this case is a more difficult step than the act itself because we must imperatively preserve the vestibular bone table.

The access flap was not performed for reasons that will be explained later.

A meticulous curettage of the alveolus is carried out before drilling.

Sanitation of the socket with an antiseptic solution.

Assess the implant site:

- The integrity of the bone tables is checked using a probe.
- Take post-extraction physiological resorption into account.
- The insertion of the implant is ensured by drilling

The 1st drilling is carried out with a 2.0 mm drill with a point of penetration slightly more palatal than the anatomical apex parallel to the palatal wall of the alveolus because the implant positioned at a distance from the vestibular bone table is a guarantee of success.

The speed used is 250 rpm for the cortex and 70 rpm for the spongy bone. Drilling length = Length of the implant + gingival thickness (under radiological control).

Then we use the 2.3 mm drill then drills of increasing diameter if the bone is type 1 or 2 or condensers if the bone is type 3 while respecting the roots of the adjacent teeth.

- Control of the vestibular wall with a CCO probe. Insertion of the implant as close as possible to the alveolar walls. Verification of the gap at the level of the alveolar wall. We let the blood fill the alveolus.
- Control of the insertion axis in relation to the alveolar walls and adjacent tooth(s) if present.
- We also ensure the primary stability of the implant.
- Control X-ray using a Radio Visio graphy (RVG): The device uses a conventional dental tube. The X-ray film is replaced by a digital device placed in the mouth (solid sensor, an optical fiber plate and a miniaturized CCD camera or a radio-luminescent screen with memory or phosphor plate. The only difference with the classic method is the use instead of the film of a small sensor containing a scintillator, an optical fiber plate and a miniaturized camera.

The stored image appears immediately on the screen of the PC to which the sensor is connected.

The RVG will allow us to evaluate the positioning of the implant in the alveolus in relation to the alveolar walls and possibly the adjacent teeth; it also allows the measurement of the mesial and distal bone crests (MBC) (DBC) in the state initial which will be controlled during the 6 months of follow-up.

This is the time for mucosal and bone tissue healing.

- Vestibular keratinized fibro mucosa (KFM) of each implant was measured in mm (fig.1), using a graduated Nabers periodontal probe. Each measurement was taken from the gingival margin to the mucogingival junction. The mucogingival junction was identified by the rolling technique, in which the mucosa was rolled until the non-moving part of the keratinized tissue was identified (fig.1, A)
- The measurements that are repeated every month for 6 months.
- The mesial and distal fibro mucosas (MFM) (DFM) are also measured (fig.2).

A measure that is repeated every month for 6 months.

All measurements were performed by myself, with the same probe to avoid discrepancies that may be encountered due to differences in interpretation between one person and another.

Given that we carry out experimental measurements in difficult conditions (difficulty in assessing the positioning of the instrument, poor visibility, fogging, lack of rigor, Parallax error) and that these are small measurements, difficult to appreciate correctly, we opted for an appreciation of half a millimeter.

Treatment is initiated based on beta-lactam type, Amoxicillin if no allergy

As well as an analgesic, it is explained to the patient and recommended to be taken regularly during the days following the installation of the implant, in order to compensate for any possibility of infection.

Do not exert stress on the implant.

Adapt the diet, for 6 to 8 weeks.

Rigorous hygiene

Complement to brushing as a mouthwash.

- The patient is seen again at 2 days, then after one week.
- This clinical radio control is repeated after 1 month then regularly every month until the 6th month.
- Radiographic evaluation covers the following parameters:

Measurement of the mesial and distal peri-implant marginal bone level.

The RVG were obtained on the day of implantation called: initial state, then the evaluation was carried out during the reference visits (monthly) until the 6th month.

RVG's CCD (charge coupled device) was held in precise orientation with a bisector angle technique.

If the x-ray was not legible, new x-rays were taken. The data was recorded on the PC and using a millimeter grid overlay the measurements were taken mesially and distally to the implant.

- Peri-implant marginal bone levels were measured using for each image distances following the linear reference points which are the neck of the implant and the most coronal point of the bone-implant interface.

The apparent dimensions of the implants were measured on the radiographs and divided by the actual size of the implant. The corresponding bone level in millimeters detected radiologically was divided by the magnification factor to obtain the actual measurement.

Implants covered with bone up to the coronal edge of the implant were given a value of 0 (fig.3).

- For the 2nd group (delayed implantation)

The 2nd group is made up of 54 cases of implantation chosen according to the inclusion criteria mentioned above.

We practiced a technique of delayed implantation (De) which consists in placing our implant after bone healing (same protocol).

The vestibular keratinized fibro mucosa is measured in mm from the mucogingival line to the edge of the ridge, in the middle of the vestibular part of the implant, using a graduated Nabers periodontal probe. A measure that is repeated every month for 6 months.

- Control X-ray to assess the positioning of the implant and measure the mesial and distal bone crests in the initial state and which will be controlled during the 6 months of follow-up.

Prescription of Amoxicillin-type Antibiotic and Analgesic

Do not exert stress on the implant.

For 6 to 8 weeks: adapt the diet.

Rigorous hygiene

Complement to brushing as a mouthwash.

- The patient is seen again at 2 days, then after one week.
- This clinical radio control is repeated after 1 month then regularly every month until the 6th month.



Figure 1 KFM measurement technique / (A and B) papilla measurement technique



Figure 2 DFM measurement technique

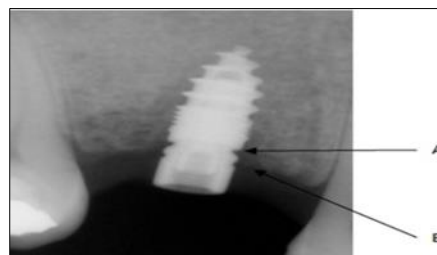


Figure 3 Illustrating the measurement from the bone crest mesial to the implant

Point A corresponds to the neck of the implant, B corresponds to the most coronal point of the bone-implant interface [the distance between A and B constitutes the assessed bone level]

2.5. Data control, entry and analysis

An input mask and an analysis plan have been established.

The survey sheets were checked one by one for errors, or a lack of consistency between variables

- After validating the collection sheets, the data was entered using the program (data entry) of the Epi Data entry version 3.2 software.
- Data cleaning was carried out to identify typos and input errors. These errors have been corrected by referring to the validated sheets.
- The exploitation and the analysis of the data were made with the programs Epi Data analysis and Epi Info 6 [version 6.04 CDC, Atlanta, GA].
- The control and analysis of the data were carried out using Epi Info 6 version 6.04 and Epi Data analysis V 2.2.2.175 software to describe the sample and perform the statistical tests.
- The analysis concerned:

Data on the epidemiological and clinical characteristics of the patients included.

Quantitative variables: mean, median, standard deviation, extreme values.

The qualitative variables will be expressed in number and percentage corresponding to the different methods.

The characters of the dispersions of the values will be given by: minimum, maximum, median.

A univariate and bivariate analysis.

2.6. Study analysis plan

2.6.1. Measurement that characterizes mucosa and bone tissue values:

These are the measures relative frequencies for qualitative variables.

Study of central tendency and dispersion parameters for quantitative variables (mean, median, mode, standard deviation).

2.7. Statistical Association:

A univariate analysis was performed, each factor taken separately from the others to look for the gain and loss of keratinized mucosa and bone resorption as well as osseointegration.

Appropriate statistical tests were used; these include in particular:

Person χ^2 test, Yates χ^2 test, Fischer exact test with a significance level of 5%.

3. Results

With a sample of 52 patients presenting 108 cases of implantation (54 cases for each technique) planned at the start of the study, we were able to obtain 46 patients with 102 cases of implantation, 54 De and 48 II.

06 cases in technique II, were excluded because the patients were not seen again for 4 months.

3.1. Descriptive study (univariate)

3.1.1. Patient age and gender

The average age of the patients was a 41.79+/-12.78 year with extremes ranging from 19 years to 69 years (fig.4).

We observed a female predominance in the population studied: 63.1% (29 women), 36.9% (17 men) with a sex ratio (F/M) of 0.5 women for one man (fig.5).

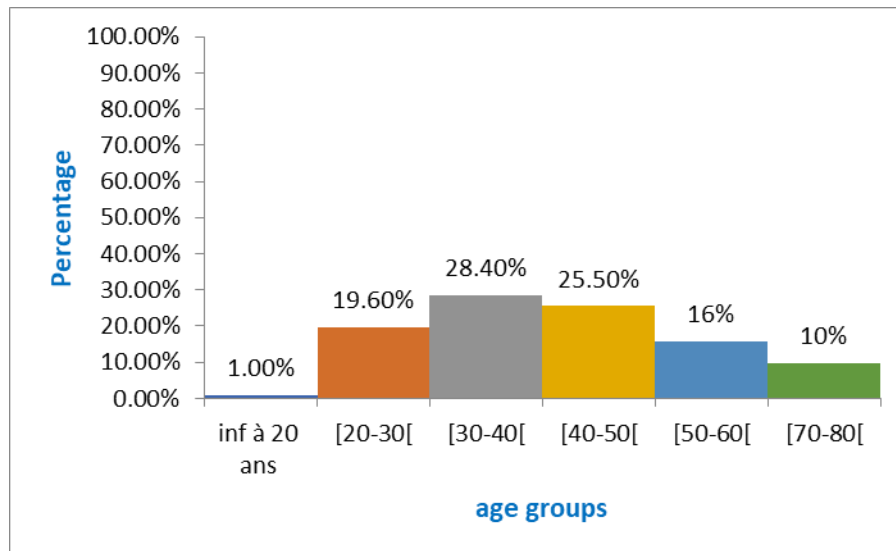


Figure 4: Distribution of patients studied according to age groups

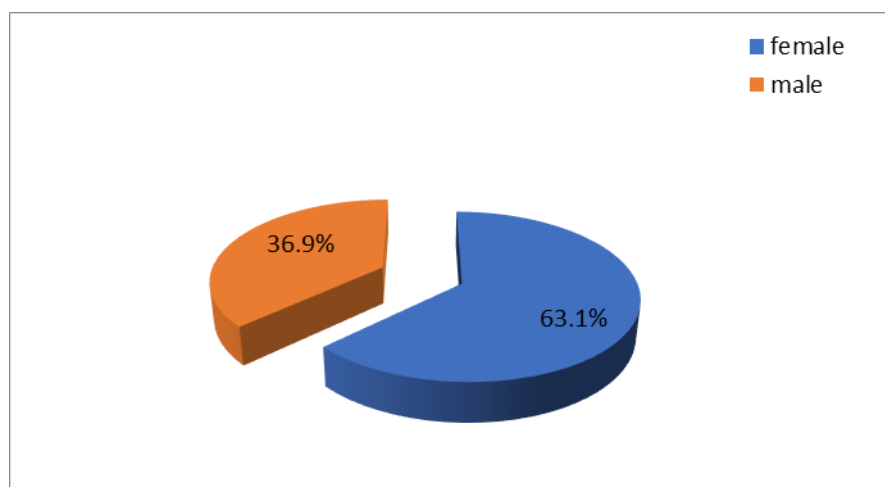


Figure 5 Distribution of patients by gender

3.1.2. Periodontal biotype

66.7% of patients had a thick periodontal biotype; 18.6% had a thin periodontite and 14.7 had a moderate periodontite.

3.1.3. Sextants

73.5% of implants are in the maxillary region and 26.5% in the mandibular region

72.2% IR in the maxilla for 27.8% in the mandible

75.0% II in the maxilla for 25.0% IR in the mandible.

3.1.4. Osseointegration in the delayed and immediate surgical technique (fig.6)

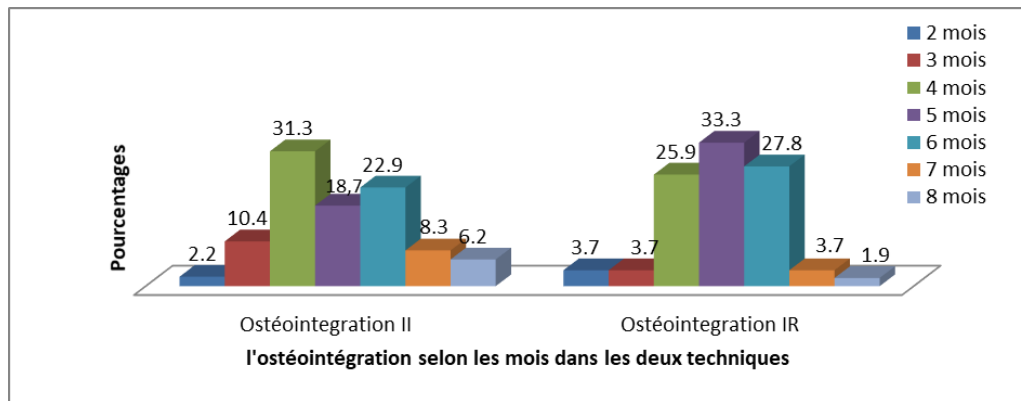


Figure 6 Osseointegration in the delayed and immediate surgical technique

Osseointegration was obtained on average at 4.96 ± 1.16 ranging from 2 to 8 months in the De.

Osseointegration was obtained on average at 4.94 ± 1.39 ranging from 2 to 8 months in II.

3.2. Descriptive study (bivariate)

3.2.1. Periodontal biotype by gender

86.1% of the male gender has a thick periodontite.

For the female gender:

56.1% of the female gender has a thick periodontite.

3.2.2. Study of keratinized fibro mucosa (KFM)

The average loss of FMK in the delayed surgical technique at day 180 is 0.556 ± 1.36 .

The average loss of KFM in the immediate surgical technique at day 180 is 0.0208 ± 1.28 .

- Comparison of the values of the evolution of the KFM between the maxilla and the mandible in the technique of delayed and immediate implantation

The average FMK loss in the delayed implantation technique is

0.641 ± 1.29 mm at J180 in the maxilla and 0.333 ± 1.54 mm in the mandible.

- Comparison of FMK values in delayed and immediate surgical technique/gender

The average loss of FMK in the delayed implantation technique in men is 0.864 mm and 0.344 mm in women at D 180, this loss does not differ according to sex ($p = 0.46$).

The average loss of FMK in the immediate surgical technique is 0.864 ± 1.08 in men, and 0.344 ± 1.49 in women (p value = 0.168).

- Comparison of FMK values in delayed and immediate surgical technique / periodontal biotype

The KFM in the delayed surgical technique is an average of 0.0 ± 1.34 for the thin periodontite.

A gain of an average of 0.618 ± 1.35 for the thick periodontite and a loss of an average of 1.0 ± 1.32 for the moderate periodontite.

The FMK in the immediate surgical technique is an average of 0.147 ± 1.37 mm for the thick periodontite, 0.500 ± 0.756 mm for the thin periodontite, and 0.333 ± 1.21 for the moderate periodontite.

(P value=0.240) for De and (P value=0.364) for II.

3.2.3. Study of the mesial and distal fibro mucosa in the immediate implantation technique

The average mesial fibro mucosa is 3.66 ± 0.915 , ranging from 1 to 6 mm at baseline, and 3.38 ± 0.990 at D (day) 30; 3.21 ± 1.02 at D 60; 3.30 ± 0.976 at D 90, 3.36 ± 1.01 at D 120; 3.51 ± 1.21 at D150; 3.53 ± 1.27 at D 180.

The average of the distal fibro mucosa is 3.57 ± 0.927 , ranging from 1 to 6 mm at the initial state, and from 3.40 ± 0.90 at D 30; 3.43 ± 0.827 at D 60; 3.19 ± 0.825 at D 90, 3.31 ± 0.970 at D 120; 3.21 ± 1.16 at D 150; 3.26 ± 1.22 at D 180.

- Comparison of mesial and distal fibro mucosa values in immediate surgical technique/gender

The average mesial fibro mucosa loss in the immediate surgical technique in men is 0.286 ± 1.38 for an average loss of 0.0606 ± 1.20 in women.

An average loss of the distal fibro mucosa in the male gender is 0.429 ± 1.34 for an average loss of 0.273 ± 1.18 in the female gender.

- Study of the mesial and distal fibro mucosa in the immediate/periodontal implantation technique

The mean MFM in the immediate surgical technique is 0.0 ± 1.0 for the moderate periodontite.

A loss of an average of 0.250 ± 1.98 for the thin periodontite.

A loss of an average of 0.118 ± 1.09 for the thick periodontite.

An average gain of FMD in the immediate surgical technique of 0.200 ± 0.837 for the moderate periodontite and a loss of an average of 0.235 ± 1.18 , 1.0 ± 1.41 for the thick and thin periodontite respectively ($p = 0.169$).

3.2.4. Results of bone crest level measurements mesial and distal to the implant in the immediate surgical technique and delayed /sex

- In the immediate surgical technique

A gain of the mesial bone crest of an average of 0.356 ± 0.818 in men, and 0.0156 ± 0.848 in women.

A gain of the distal bone crest of an average of 0.261 ± 0.925 in men, and 0.0794 ± 0.953 in women.

- In the delayed surgical technique

The mean of the mesial bone crest 0.0950 ± 0.789 in men, for a value of 0.291 ± 0.702 in women.

The level of the distal bone crest in man is an average of

0.0409 ± 0.611 , and 0.101 ± 0.611 in women.

- Comparison of mesial bone crest level values and distal in the immediate and delayed surgical technique / periodontal biotype

A gain of an average of 0.179 ± 0.823 of the MBC in the immediate surgical technique for the thick periodontite and of 0.299 ± 0.795 for the thin periodontite.

A loss of 0.495 ± 0.910 for the moderate periodontite

A gain of an average of 0.110 ± 0.986 in the DBC in the immediate surgical technique for the thick periodontite, 0.173 ± 0.947 for the thin periodontite and 0.202 ± 0.771 for the moderate periodontite.

A gain of an average of 0.200 ± 0.837 of the MBC in the delayed surgical technique for the moderate periodontal, a loss of an average of 1.0 ± 1.41 for the late periodontite and of 0.235 ± 1.18 for the thick periodontite ($p = 0.169$).

The evolution of DBC in the delayed surgical technique presents:

A loss of an average of 0.0048+/-0.564 for the thick periodonte.

A gain of an average of 0.301+/-0.658 for the thin periodonte.

A gain of an average of 0.0989+/-0.689 for the moderate periodonte (p=0.354).

3.2.5. Osseointegration in technique II and according to gender

The mean osseointegration in technique II is 4.77+/-1.30 in men compared to 5.06+/-1.43 in women.

(P value=0.529).

The average of osseointegration in the De technique in humans is 4.87+/-0.869 for

4.97+/-1.35 in women (P value=0.762).

4. Discussion

4.1. Strength of the study

To meet the requirements of the study, the clinical files, the surgery and the measurement of the parameters studied were carried out by myself.

The technical means devoted to the development of this study, namely:

Implantation equipment, radiology, measuring probe, computer; are the same.

4.2. Limit of the study

- A bias concerns the covid period in which we lost sight of 6 patients.
- Also the technique of implantation is expensive and which is not permitted for all class levels of society, therefore the recruitment of them is difficult.

The goal of our study was to compare two implant surgical techniques: immediate implantation (II) and delayed implantation (De), in relation to the modifications and behaviors of the soft and hard tissues, in the vicinity of the implant.

We were led to exclude from the study sample non-exploitable cases, such as those who had lost sight of permanently, i.e. patients who never presented themselves for post-operative check-ups, numbering 06 cases of immediate implantation.

Therefore, the statistical study included 46 patients for 102 cases of implants: 54 cases for IR and 48 cases for II.

Our study is similar, in terms of the number of patients, to those conducted by C.E.Nemcovsky and al (2002). They had done two complementary studies. The first involved 24 patients with 31 implants placed immediately after extraction, while the second included 19 patients with 23 implants placed late (3).

4.3. Descriptive study (univariate)

4.3.1. Age and gender of patients

In our study population, there is a female predominance 63.1% and 36.9% for males with a sex ratio (F/M) of 0.5. This tendency has already been pointed out by other authors including J. Rustemeyer and A. Bremerich. (2007) (4), EA.De.Lima and al (2012) (5).

These publications also report a percentage of around 68% in the female sex and 41% for men. They attribute these results to the particular interest of women in oral aesthetics.

Our patients have an average age of 41.79+/-12.78 which is consistent with the average age of the de N.N. Douaouda’s study. (2020) (6) who reported an average age of 32.25 +/- 10.57 years with a median at 30 years old, the youngest subject is 19 years old.

4.3.2. *The periodontal biotype*

This is the consistency of the epithelium located in the immediate vicinity of the neck of a tooth. Its assessment is done by testing the probe, according to the technique taken up by

JYK.Kan .and al. (2010) (7), it consists of introducing a periodontal probe at the level of the sulcus and assessing the degree of visibility of the instrument, through the crevicular epithelium.

We noted the predominance of the thick biotype 66.70% in both sexes. This rate is however, higher among men 86.1% compared to women 56.1%.

The predominance of the thick biotype in men is consistent with that of the Asian study of

B.Vinaya. S.Sonali. (2013) (8).

It will be necessary to take into consideration the morpho-ethnic aspect differing from the North African (Algerians) from the Asian.

Table 1 Distribution of the thick biotype in men according to the literature

Study	Thick periodonte	
	Female	Male
B .Vinaya, Sonali Shetty 2013 (Asian) (12)	41%	63%
Our study (2023)(North Africa)	56.1%	86.1%

4.3.3. *Sextants*

The majority ofwork focuses on the anterior maxillary region, in relation to immediate loading:

Comparative studies on the two implant techniques relate to only one segment of the maxilla: UC. Belzer. and al. (2009) (9). R.Noharet, S.Viennot. (2014) (10).

Table 2 Distribution of implantation by maxilla in our study according to the literature

Authors	Distribution of implantation by maxilla	
	maxillary	mandible
CPU. Belzer. and al. (2009) (9)	100%	0%
R.Noharet, S.Viennot. (2014) (10)	100%	0%
Our study	73.5%	26.5%

Table 3 Distribution of the two techniques by maxilla in our study

	Immediate implantation	Location. delayed	Distribution. implants
Maxilla	75.0%	72.2%	73.5%
Mandible	25.0%	27.8%	26.5%
Total	100%	100%	100%

This preponderance of the maxilla explained by the high rate of success, due to the nature of the bone it self. The areolar histological structure of this bone, coupled with significant vascularization, allows for high success rates.

- The results obtained show that the bone typology is very flexible and varies from one sextant to another of the same maxilla. In addition, variable bone morphology allows the use of different implant sizes from region to region. The (Table 4) shows the distribution of bone type in the jaws.

Table 4 Distribution of bone type according to the sextants in our study

Sextants	% Bone type 1	% Bone type 2	% Bone type 3
1	12.4	43.8	43.8
2	42.1	36.8	21.1
3	04.2	37.5	58.3
4	00	21.4	78.6
5	50	50	00
6	11.1	77.8	11.1

This variability in bone density and volume implies an adaptation of the surgical technique.

4.3.4. Osseointegration

Many authors PA.Fugazzotto. (2008) (11); A.Acocella. and al. (2010) (12) looked at studies exclusively focused on extraction and immediate implantation in the posterior sector. They show success rates of 97.8% at 3 years for the 1st author, 99.5% at 6 years for the 2nd author and 95% at 3 years for the last, ie a prognosis completely comparable to conventional implantology.

In our study, the comparative results show significantly earlier osseointegration in immediate implantation compared to IR. These results agree with those of I. Aires, J.Berger. (2002) (13) who placed 29 immediate implants and 33 delayed implants in 7 patients. They obtained over a period of 4 months, 96.6% success for immediate implants and 96.5% success for delayed implants.

CE Nemcovsky. and al. (2002) (3) conducted two separate studies. They obtained after extraction implantation, 97.2% success, after a period of 6-8 months, for late insertion a success rate of 90.2%, over the same period.

During our study, we noticed that osseointegration is finalized between 2 and 8 months.

For RJ Lazzara. (1989) (14) placement of implants in immediate extraction sockets, with or without concomitant placement of regenerative materials, results in high levels of osseointegration.

Table 5 Comparison of the osseointegration of our study with the literature

Study	Effective	Middle age	Insert torque	tracking time	Survival rate	Success rate	success criteria
De Rouck and al (2009) (15)	49 (15-25)	NR	> 35Ncm	12 months	97%	97%	Smith and Zarb
Den Hartog and al. (2011) (16)	31 (15-25)	38.4 +/- 14.0	> 45Ncm	18 months	96.77%	NR	NR
Grandi and al (2013) (17)	50 (15-25)	NR	NR	12 months	94%	NR	NR
N.N.Douaouda (2020) (6)	44 (12-22)	32.25 +/- 10.57	> 35Ncm	36 months	92.68%	92.68%	Albrektsson and al
Our study (2023)	102 (54-48)	41.79+/- 12.78	30.72+/- 8.26	6 months	No rejection		Albrektsson and al

NR: Not Reported

4.4. Bivariate descriptive study

4.4.1. Peri-implant soft tissues

This is the height of the keratinized mucosa and that of the mesial and distal papillae bordering the implant. The quality of this bordering mucosa is essential for the long-term success of the implant.

- The peri-implant mucosa

In comparison with other work, our results, on the fibro mucosa, point in the same direction, insofar as the quasi-majority of the studies speak of a gingival recession, after a prosthetic restoration. This recession is observed both in immediate and delayed load, particularly at the previous level.

The work of NN Douaouda. (2020) highlight this tendency to recession, in the anterior region, with immediate temporization (6).

For NP Lang. et al. (2012) (18), vestibular gingival recession of more than one mm occurs in 20% of cases after 3 years. It would be, essentially, related to the positioning of the implant and the gingival biotype. They recommend an immediate provisional restoration which, according to them, could limit this phenomenon.

These data confirm the results of CDJ.Evans. and ST. Chen. (2008) (19), for which, the recession is three times greater for implants positioned vestibularly (1.8 mm), against (0.6 mm) for placements positioned palatal).

The comparison having focused on 46% of thin gums and 33% of thick gums.

We found in the literature, the study by PK .S-Kumar.and al. (2013) (20). who reported in the immediate groups, a mean FMK thickness at inclusion of 2.07 ± 0.41 mm, increasing to 2.42 ± 0.81 mm after 9 months and at 2.50 ± 0.86 mm at the 18th month. In the delayed group at baseline, it was 1.92 ± 0.55 mm which increased to 2.35 ± 0.37 mm at 9 months and 2.42 ± 0.5 mm at 18 months. In comparison between the delayed and immediate groups, it was not statistically significant ($P > 0.05$) Compared to the percentages, in the immediate group it increased to 24.15% and in the delayed group it increased to 25.9% at the 18th month.

These results are different from ours, because our average at the initial state is different.

The average FMK loss is 0.0208 ± 1.28 mm in the immediate implantation technique for an average loss of 0.556 ± 1.36 mm in the delayed implantation technique the difference is significant ($p = 0.04$).

The average FMK in the immediate implantation technique at D 180 in the maxilla is 0.0833 ± 1.34 mm for a loss of an average of 0.333 ± 1.07 mm in the mandible.

We obtained a loss in the mandible and a gain in the maxilla, with no statistically significant difference ($p = 0.334$).

4.4.2. The papillae bordering the implant

A .A-El-Salam (2003) (21) defined the papilla according to its position in relation to the teeth and the implants

Thus, the interdental papilla corresponds to the gingival volume occupying the space between the proximal surfaces of two contiguous natural teeth. The peri-implant papilla, on the other hand, is located between an implant and a natural tooth. Finally, the inter-implant papilla represents a papilla located between two implants.

The height of the papillae between the implants is determined by the underlying inter-implant bone crest (T.Fortin, 2010) (22). If, for the immediate avulsion-implantation of a tooth, a distance of at least 1.5 mm is respected between the tooth and the implant, the papilla at the end of the treatment will be the one existing at the time of the avulsion

The location of the papilla between a natural tooth and an implant is dependent on the level of attachment of the connective tissue to the natural tooth. Between an implant and a tooth, an average of 4.5 mm in papilla height has been reported (H.Salama and al. 1998) (23)

Since there are no papillae in the delayed implantation, we could only follow the papillary changes in the immediate implantation technique. The purpose of this evaluation was to find out whether immediate implantation could delay the papillae obliteration after extraction.

The papilla was measured on D 0 (at the time of implantation), with a graduated Nabers probe, then monthly until the 6th month, ie at tissue maturity, of the fibro mucosa after extraction.

A series of studies in periodontal surgery has clearly demonstrated that the incision and the papillary detachment are systematically accompanied by a retraction of 1 mm of the papilla at 3 months and, even in the case of a healthy periodontite P. Velvart. (2002) (24); J. Kleinheinz. and al. (2005) (25).

This convergence of views justifies the requirement for a reduction in disturbances of the vascularization of the periosteum in order to allow the preservation of the interdental papilla and the maintenance of the volume of the soft tissues.

This is in agreement with several authors: T. Jemt. (1997) (26), M. Quirynen., D.van Steenberghe. (1993) (27) who show through their studies that in the majority of cases, the papillae end up reforming in a predictable way around single implants, when these are present at the base. It is therefore absolutely necessary to do everything possible during the various implant and prosthetic stages to preserve them as much as possible.

For L. Schroppet. para. (2005) (28), the risk of having an unsightly papilla from the start of treatment is 7 times higher for delayed implantation than for immediate implantation; similarly, soft tissue appearance at baseline and at 10 years would be better for early placement. However, at 10 years, the results converge with an improvement in the size of the papilla (complete papilla in more than 1/3 of cases) and no change in the height of the clinical crown.

In the end, for these authors, the early placement of single implants in the anterior maxilla would have comparable or even better results in terms of soft tissue esthetics. Early or delayed implants show high survival rates and few bone resorptions or biological complications, similar to late conventional placement.

It should be remembered once again that the study of the papilla has always been related to the loading of the implant, whether temporary or permanent,

However, our work revolves above all around the question of whether immediate implantation delays the obliteration of the papillae, which will accelerate filling, after loading. The results allowed us to draw the following conclusions:

During our observation of the patients after loading of the implants we noticed that almost all the patients in II, had the index of 3 of T.Jemt. (1997) (26), a papilla occupying the entire interdental space with respect to the IR.

Finally, we made sure to study the proximal fibro mucosa according to the regions; the results are as follows:

- Mesial fibro mucosa

A gain of an average of 0.5 ± 0.548 , for the anterior maxillary region.

A loss of an average of 0.02 ± 0.714 , for the posterior maxillary region.

A loss of an average of 0.10 ± 0.845 , for the posterior mandibular region.

- Distal fibro mucosa

A loss with an average of 0.500 ± 0.837 , for the anterior maxillary region.

A loss with an average of 0.464 ± 1.26 , for the posterior maxillary region.

A gain of an average of 0.182 ± 1.17 , for the posterior mandibular region.

At the end of our work on the FMM and the FMD, we found only studies which speak of the mesial and distal papilla after loading of the implant using the PE parameters (Pink Esthetic Scores).

N.N.Douaouda (2020) (6) found that the appearance of the taste buds improves. They become longer and better fill the interdental space after placement of the standard ceramic restoration, which improves this biological integration and filling, by the soft tissues, of the prosthetic embrasures.

- Peri-implant hard tissues

BU.Zachrisson. (2006) (29) lists the main complications that any practitioner may face when placing an implant in the anterior sectors, due to aesthetic priority. Gingival dyschromia and progressive bone lysis may appear vestibular.

Clinical infraclusion or gingival recession, with exposure of the prosthetic edges, is also possible. A decrease in ridge volume, 2/3 of which occurs during the first three months, is the rule. This bone resorption is significantly greater in the vestibulo-lingual direction than in the vertical direction.

The crest is frequently offset lingually or palatally, because although the bone resorption is of the same magnitude, vestibularly and lingually, the vestibular bone wall is narrower and the vertical bone loss is therefore greater there. In the study they conducted, JYK.Kan. et al. (2003) observed an average bone loss, at 1 year, not exceeding 0.66 mm. Their measurements taken mesially and distally on retro-alveolar radiographs show that the bone has not undergone more resorption than with a conventional protocol (30).

Mr Paolantonio. and al. (2001) (31) studied the average bone loss. They conclude that it varies between 0.75 and 0.5 mm, in 2 years and that it is the same for the two methods.

Sasi's study. Kumar .and al. (2013) (20) which carried out a prospective clinical study was to compare the peri-implant and prosthetic conditions for single implants, placed according to the immediate (Im) and delayed (De) placement protocols during a control examination at 18 months.

T.Linkicius. and al. (2009) (32) conducted a study in which test implants were placed approximately 2 mm supracrestal, while control implants were positioned at bone level. The results revealed that there were significant differences in terms of bone loss between the thin and thick biotype groups on both the mesial and distal sides.

G.Ueli. and al. (1999) (33) who evaluated immediate and delayed implant placement after 12 months of loading and found that bone loss was approximately 0.8 mm interproximal. These results are also consistent with the study conducted by MS. Block. et al. (2009) (200)

RV.Sunita .and al. (2008) (34) showed that flap elevation can lead to increased crestal bone loss during the healing period.

According to JJ Ndjoh. and al. (2023) (35), the interactions between implant adjacent tissues and the implant depend on the type of biomaterials, the characteristics of the individual and the environment.

In a study conducted on melano-African and European leucoderma patients, these authors deduce that bone resorption around dental implants is less important around zirconia implants than titanium implants.

Our study roughly corroborates the studies summarized in (Table 6)

And this is probably due to the duration of patient follow-up ranging from 9 to 36 months for the authors cited.

Table 6 Comparison of the level of bone resorption of our study with the literature

Study	Average loss/gain (mesial)/ II	Average loss/gain (distal) /II	Average loss/gain (mesial)/ IR	Average loss/gain (distal)/IR	X-ray type
NN-Douaouda.(2020) (6)	-0.636 mm		+0.133 mm		CBCT
De Rouck and al 2009 (15)	-0.92	-0.72	NR	NR	Long cone
Sasi. Kumar .and al. (2013) (20)	-1.12 +/- 0.34		-1.18 +/- 0.84		RVG
Our study (2023)	+0.188+/-0.578	0.010+/-+1.07	0.421+/-+0.782	0.295+/-+0.772	

At the end of this comparative study of two implant surgical techniques: immediate implantation and delayed implantation. We deduce the advantages and disadvantages of each of the two techniques.

Due to favorable histological circumstances and functional and aesthetic advantages. II technique reduces soft tissue manipulation.

It avoids the untimely resorption of hard tissues, the vast majority of which occurs during the first three months following the extractions. According to Rj.Lazzara. (1989) (14)

Moreover, dental extraction leads to a significant vascular supply related to the periodontal and the opening of the medullary spaces at the level of the site, which would optimize healing.

The immediate extraction implantation associated or not with an immediate loading of the implant sets as objectives the following points:

- Preservation of the initial bone volume,
- Preservation of adjacent soft tissue:
- Preservation of keratinized tissues
- Preservation of taste buds.
- Exploitation of the regeneration potential of extraction sites.

Its disadvantage according to Mj.Araujo and al. (2006) (36). it does not allow the precise location of the drilling site nor a limitation of bone resorption.

Currently, whether delayed, deferred or post-extraction, implant treatment is recognized as reliable. Longitudinal studies (37) in the medium and long term prove that implantology today is a scientific achievement, even if there are still points that deserve to be refined.

The method of extraction is one of the most important factors in preventing the reduction of alveolar bone loss.

The extraction is performed very delicately to preserve the vestibular bone wall as much as possible. In order to avoid any reactive bone resorption of 0.2 to 0.8 mm (38) following any surgical bone exposure, no full-thickness flap should be lifted.

The periosteum is indeed responsible for 80% of the bone vascularization, compared to the internal vascularization (centromedullary) which is only 20%, M.Chanavaz. (1995) (39).

It is easy to understand the results of an ischemia that sets in and the consequences of impaired remodeling and secondary resorption. This resorption, even minimal, can have unfortunate consequences in terms of aesthetics, even if stability and function are maintained. Any bone loss will result in surface soft tissue remodeling

The vascularization of the papillae is preserved by the absence of incision and detachment.

In the review of I .Sanz. and al. (2012) (40) including 8 articles, the early and delayed protocols are compared, with results in favor of the “early group”. Indeed, this protocol offers advantages in terms of preservation of soft and hard tissues around the implants: the meta-analyses highlight a difference between the 2 groups of

13.11% in the vertical resorption, and 19.85% in the horizontal resorption, in favor of the “early group”.

Although the aesthetic results seem to be better with immediate and early implants, there would be a higher risk of complications with these protocols compared to a deferred classic protocol where the socket is left to heal completely before implanting.

In terms of implant survival rate, systematic reviews are in agreement and show a survival rate of at least 95% whatever the protocol (41, 42, 43).

The works of D. Buser and those of L. Schropp are the articles that we consider to be a reference, due to their significant clinical experience, their number and their type.

Several prospective studies by D. Buser. and al. (2011;2013, 2008) (44, 45,46) show excellent aesthetic results in the medium and long term for this type of treatment associated with guided bone regeneration, with a low or even non-existent risk of mucosal recession at 5- 9 years, and stable bone levels over time.

5. Conclusion

Any implant placement is, by definition, post-extraction; only the lapse of time between the extraction and the installation of the implant makes it possible to establish a classification.

Implant surgical protocols vary widely. The same parameters compared in a post-extraction technique without having defined it as (immediate, early, delayed, deferred) are at the origin of the heterogeneity of the conclusions. To be comparable, the results must be obtained under the same surgical conditions, carried out by a single operator, on the same type of implant and oriented towards the same objective.

The major elements to consider before indicating an immediate avulsion-implantation protocol are:

- The possibility of respecting the positioning of the implant in the three dimensions of space.
- The possibility of obtaining primary stability of the implant,
- Assurance that the vestibular bone table was intact

It is difficult to find a consensus, within the current literature, as to the superior interest of one technique over another. However, it is accepted that an extraction-implantation immediately after dental extraction, carried out according to the rules of the art, offers several advantages.

- It reduces manipulations on soft tissues
- Limits hard tissue resorption
- Activates the filling of spaces, especially after early loading of the implant.

These advantages are, of course, dependent on an atraumatic, so-called periodontal extraction, preserving above all the papillae and the vestibular bone table.

Immediate implantation after dental extraction benefits from the significant vascular supply, linked to the periodonte and the opening of the medullary spaces, at the level of the site, which optimizes healing. The analysis of the parameters allows us to favor immediate implantation after tooth extraction compared to delayed implantation.

Our results clearly show that bone density is inhomogeneous both within the same sextant and within the same site; thus, it differs at the beginning and at the end of the same borehole.

The osseointegration obtained, generally between 2 and 8 months for the 2 techniques, shows differences according to the sextant and the bone type. Thus, it is earlier in the immediate implantation.

According to sex, osseointegration is earlier in the male gender, in both techniques.

The loss of keratinized tissue is less for immediate implantation than for delayed implantation with a statistically significant difference.

The retraction of the fibro mucosa, consecutive to the delayed implantation, seems related to the moderate gingival biotype, whereas a gain is observed with the thick gingival biotype. On the other hand, in the immediate implantation, we note a gain for the thick periodontal and a loss for the thin and moderate periodontal.

For bone, we observed a gain with type 2 bone, in immediate implantation. This gain observed in the posterior maxillary region.

For delayed implantation, we found generalized loss in both maxillae.

For sex, we observed a loss for both sexes, increased in men compared to women.

We noticed that the mesial fibro mucosa was stable for the moderate periodontal, with a gain for the underlying type 1 and 2 bone. For the distal fibro mucosa, on the other hand, a gain is observed with the moderate periodontal and does not concern than type 2 bones.

Loss of mesial and distal fibro mucosa is seen in both sexes, but is increased in men.

For the mesial and distal bone crests surrounding the implant, in the immediate implantation, they present a gain in the male sex. On the other hand, in delayed implantation, the gain is observed to be less significant in humans for the two peaks.

The type of implantation, immediate, delayed, is a choice made by the clinician in response to a clinical situation. Each of these treatments has its indications and contraindications.

The extraction-implantation technique is now very well codified. Studies with a longer follow-up would, however, confirm its choice.

However, it requires an experienced surgeon.

Compliance with ethical standards

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Disclosure of Conflicts of Interest

The authors declare no conflict of interest

Statement of ethical approval

The jury of Medical University, Algiers, Algeria approved the present study (142/Dir/ 2023 of 13.03.2023).

Patients were enrolled after informed consent was obtained, and the protocol conformed to the ethical guidelines.

Statement of informed consent

Informed consent was obtained from all subjects involved in the study.

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