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Dental implants and skeleton maturation as factors influenced implant insertion by adolescent patients with missing permanent teeth: 5- year prospective study

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Abstract: *The aim of this study was to evaluate the treatment of adolescent/young adults patients after multidisciplinary therapy including implants insertion and effect of diameter of dental implants on osseointegration. A prospective study of 73 implants (Osseo Speed™ ASTRA TECH Implant System™, Ltd, UK) was prepared. The patients at implants surgery ranged from 16 to 23 years of age (13 men and 20 women; average age 20.4 years). The patients were followed up for a 6 - year period. The aesthetic appearance was checked mainly from the point of view of vertical position of the framework. The effect of microthread on the maintenance of marginal bone level was evaluated. The influence of fixture diameter on marginal bone level was ranged from +0.34 (SD 0.40) (3mm fixture diameter) to + 0.40 (SD 0.33) (4.5 mm fixture diameter). The amount of peri-implant bone was significantly lower with the 5 mm diameter fixture -0.10 (SD 0.25). This result was statistically significant and depended on the bone quality before the treatment following anodontia or trauma. Marginal bone-level increase for different heights of microthreads from 0.18 (SD 0.43)-microthread 0.14 mm, 0.34 (SD 0.37) microthread 0.16 mm; 0.04 (SD 0.35) microthread 0.22 mm. The use of dental implants in young patients is not limited, but multidisciplinary treatment planning is directly connected with skeletal maturation. Our research shows that individual skeletal maturity and jaw development control helps to receive long-term clinical treatment success. Our long-term study confirms that young age and also implant shape and size guarantees not only stable osseointegration but also bone level increase.*

Keywords: *adolescent patient, skeleton maturation, anthropological age, dental implants treatment, osseointegration.*

I. Introduction

Dental care of adolescent patients without own teeth is not easy. Anthropological age determination for implant insertion is important and prosthodontic methods can be often applied only after multidisciplinary therapy by the surgeon, orthodontist and prosthodontist. Mainly we try to find the age of adolescent patient in which we can start with the implantation of dental implants. As we know the implantation is possible only if the growth and skeleton maturation is finished.

The neurocranial growth process is mostly completed after the fourth year of age. However, the viscerocranial growth process can continue also after 20 years of age. If implant insertion is planned in a growing child, we must accept the fact that osseointegration forms ankylosis and implants do not follow the spontaneous and continuous eruption of the natural dentition. Similar to ankylosed teeth [1] the implants remain stationary in the bone and do not follow the changes of the alveolar process with continuous eruption of the natural dentition [2, 3]. This inability to move with adjacent teeth causes deficiencies in the alveolar bone and surrounding gingival tissues and leads to a discrepancy in the sagital and transversal dimension, described as infraocclusion or infraposition of the implant [4].

Such implants may also disturb the normal development of jawbones. In order not to interfere with the growth of the jawbones, the installation of an implant should generally be postponed on average until after puberty or after the so – called growth spurt of the child [5]. For ease of understanding, growth of the jaws is commonly discussed according to its direction of manifestation: transverse, anteroposterior (sagital), and vertical. Growth of the mandible and the maxilla follows a distinct chronology, being completed first in the transversal plane, then in the sagital plane, and only at a later stage in the vertical plane. It is important to realize that, in relation to implant displacement of the entire bony complex (via sutural growth) will be followed by oral implants, and as such does not create a major risk unless the prosthetic rehabilitation crosses the suture [5].

Since changes in the dentoalveolar complex are of particular importance for the functional/aesthetic outcome of implants, a study by Iseri and Solow [6] showed that between the ages of 15 and 25 years the vertical tooth movement can amount to 5 mm - a distance difficult to span with implants. The follow-up study of

dental implants in the upper adolescent region inserted in adolescent patients, has shown that continuous eruption of the adjacent teeth, even after completed dental and skeletal development, may end up in an infraoccluded implant-supported crown [7]. For that reason implant insertion in the anterior tooth area should be postponed until after the completion of the 15th year of age in girls and the 17th year of age in boys, and, therefore, it is first then necessary to evaluate the upper and lower jaw development. It is known, that the biological indicators of skeletal maturity refer mainly to somatic changes in puberty, thus emphasizing the strict interactions between the development of the craniofacial region and the modifications in other body regions [8]. Individual skeletal maturity can be also assessed by means of several biological indicators: increase in body height; skeletal maturation of the hand and wrist (Fig. 1); dental development and eruption; menarche or voice changes; and cervical vertebral maturation (Fig. 2) [7]. For that reason the identification of the pubertal growth spurt has great value in dentistry, mainly in implant insertion area. The effectiveness of a biological indicator of skeletal maturity is directly related to factors such as the ability to detect and predict the growth spurt peak without the need for additional radiation exposure and the high level of agreement between examiners for the definition of the stages [9].

Fig. 1: Schematic representation of growth. Hand – wrist radiograph indicators can be used to place a patient in the general area of the growth. The sesamoid bone (S) of the thumb usually begins to calcify during the accelerating phase of the pubertal growth spurt. Since a substantial amount of growth still remains, this is an inappropriate time to place an implant. Capping of the middle phalanges of the third finger (MP3cap) usually occurs after the maximum growth velocity has passed and indicates a deceleration of the pubertal growth spurt. This correlates with the approximate onset of menstruation in girls and deepening of the voice in boys. Since most pubertal growth has been completed, consideration of implant placement can begin. When the epiphysis of the radius fuses and forms a bony union with the diaphysis (Ru), adult levels of skeletal growth have been attained and no further increase in statural height can be expected (end of growth, E).

a) Wrist of child. PP2 = growth his in early stage. Skeletal growth isn´t still finish and this is an inappropriate time to place an implant.

b) Wrist of child 2 years after. Mpcap indicates that maximum growth velocity has passed. Skeletal growth is finished. Implant placement can begin.

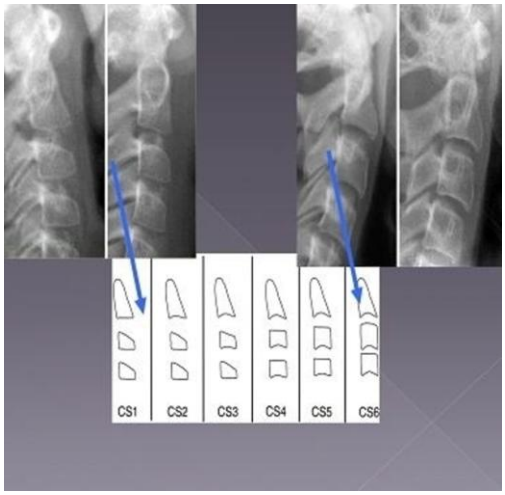


Fig. 2: Schematic representation of the stages of cervical vertebrae according to the newly modified method according Baccetti T et all. [7].

The biological fixation between the dental implant surfaces and jaw bones should be considered a prerequisite for the long – term success of implant – supported prostheses [10]. Osseointegration is seen as the close contact between bone and implant [11] and the interest on diameter engineering has to be understood as an important and natural trend. Nowadays, a large number of implant types with a great variety of diameter properties and other features are commercially available and have to be treated with caution.
The aim of this study is to evaluate the long-term treatment of adolescent/young adult patients after multidisciplinary therapy including implants insertion and effect of diameter of dental implants on osseointegration.

II. Materials and methods

A prospective study of 73 implants (Osseo Speed™ ASTRA TECH Implant System™) (Table 1) was prepared. The patients at implants surgery ranged from 16 to 23 years of age (13 men and 20 women; average age 20.4 years). Multidisciplinary therapy by the surgeon, orthodontist, as well as prosthodontist before implant insertion was monitored. The patients were followed up for a 6 - year period. The aesthetic appearance was checked mainly from the point of view of vertical position of the supra-construction, loss of bone marginal support, patient satisfaction, and quality of life after patient rehabilitation. Also, the effect of microthread on the maintenance of marginal bone level was evaluated.

Jaw	**Placed Site**													
Tooth	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Maxilla	1	4	2	2	2	4	3	5	7	3	5	8	6	1
Mandible	2	3	3	1	0	2	1	0	2	1	0	3	2	0
Total	3	7	5	3	2	6	4	5	9	4	5	11	8	1

Table 1: Distribution of the installed implants according to jaw and fixture.

2.1. Patient selection

Subjects for the study were selected from patients referred to the Department of Stomatology. The study was approved by the Ethics Committee of the Faculty Hospital Motol. Informed consent was obtained from all subjects and they were consecutively enrolled in the study according to the predefined inclusion criteria: absence of any local or systemic disease; sufficient bone height for placing implants with a minimum length and width of 11 mm with or without additional bone augmentation and bone grafting of a membrane; 1–3 missing unit.

At the time of selection, patients included in this study showed good general health. After receiving initial therapy including oral hygiene instruction, implantation was performed only after patients had shown good self-performed plaque control. The coronal portion of Astra Tech Single Tooth Implant was tapered with the Microthread™. The fixture diameters were 3.0 – 5.0 mm and the length of implants varied from 11 to 13 mm.

2.2. Treatment procedure

Following the manufacturer´s directions, the fixtures were installed in a randomized order at the edentulous area of each patient, see Table 1. Individual skeletal maturity was checked using skeletal maturation of the hand and wrist. After a healing period of 3 months in the mandible and 6 months in the maxilla, second surgery was performed followed after three weeks by prosthesis delivery. The CAD – CAM technique Zircon Zahn (Prettau® Zirconia) and BioCam (Lasak) were used to establish a supra-construction. The patients were recalled every 6 months for thorough professional plaque control and repeated oral hygiene training. In total, 73 Astra Tech Dental Implants were installed (53 in the maxilla and 20 in the mandible).

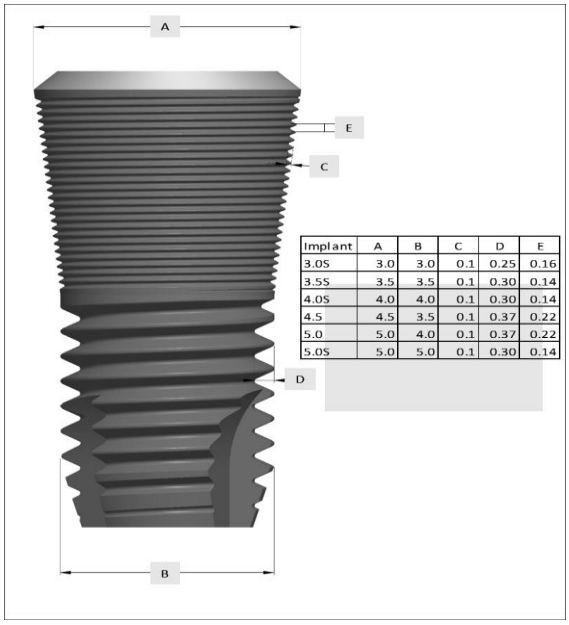
2.3. Follow-up parameters

Clinical examination was conducted every 6 months. The appropriate number of intra-oral radiographs for each subject was taken from 1 to 6-year follow-ups. The following clinical variables were recorded: pain from implant regions; implant stability; gingival inflammation; suprastructure complications; photo and radiographic examination. A periapical digital radiograph (Gendex EXPERT® DC with VistaScan Mini image plate scanner) was taken using the parallel cone technique.

2.4. Marginal bone-level changes

Marginal bone-level measurements were made from the reference point to the lowest observed point of contact of the marginal bone with the fixture. The reference point of the fixture was the border between the titanium oxide-blasted surface and the machined surface of the fixture (Fig. 3). Calibration was performed with

the known fixture length. The marginal bone increase for each type of implant was calculated using microthread – bone level changes. Every implant had 25 microthreads, but the height was different. The measurements are illustrated in (Fig. 3, 4a, 4b).



Implant	A	B	C	D	E
3.0S	3.0	3.0	0.1	0.25	0.16
3.5S	3.5	3.5	0.1	0.30	0.14
4.0S	4.0	4.0	0.1	0.30	0.14
4.5	4.5	3.5	0.1	0.37	0.22
5.0	5.0	4.0	0.1	0.37	0.22
5.0S	5.0	5.0	0.1	0.30	0.14

Fig. 3: Microthread size and shape calibration – conical shape
http://www.dentsplyimplants.com/~/media/M3%20Media/DENTSPL%20IMPLANTS/Product/1207012%20Product%20catalog.ashx?file=type=.pdf.

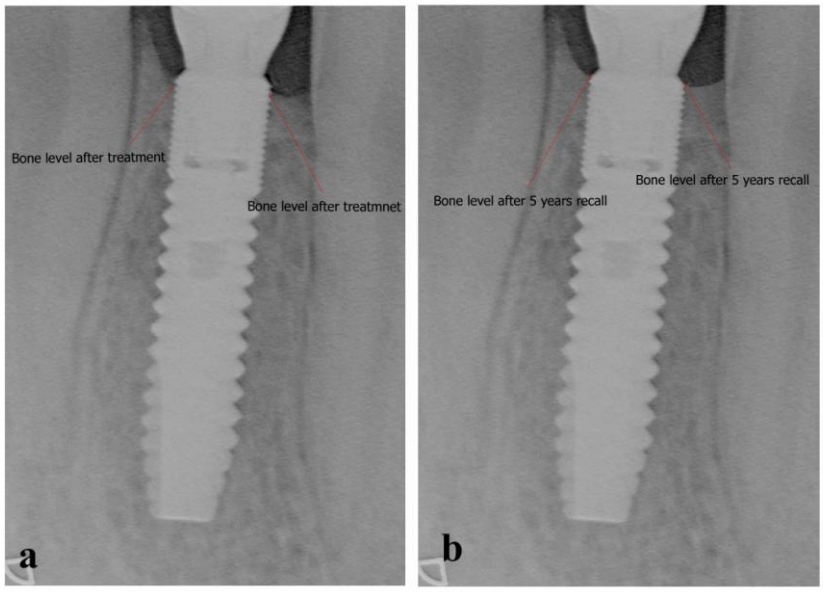


Fig. 4a, 4b: The marginal bone increase: a – after therapy; b - 5 year recall. (As we can see marginal bone increase of 2 microthreads on the both side of implant surfaces which means by implant 40S 2 x 0,14mm = 0,28mm bone increase).

III. Results

3.1. Clinical examination

No remarkable complications were found during the observation period, no patient suffered from pain, no mobility on implants was detected, and also there were no prosthetic complications. Aesthetic optimum was obtained mainly after trauma. Shape and size compromise was necessary in 18 % (13 implants). Atypical shape had no influence on optimal implant papilla formation. Two patients (6%, one man and one woman) had lateral incisors in infraocclusion.

3.2. Marginal bone-level changes

The marginal bone increase for each type of implant except for the 5 mm diameter was illustrated in Table 2. The influence of fixture diameter on marginal bone level was ranged from +0.34 (SD 0.40) (3mm fixture diameter) to + 0.40 (SD 0.33) (4.5 mm fixture diameter). The amount of peri-implant bone was significantly lower with the 5 mm diameter fixture -0.10 (SD 0.25). This result was statistically significant and depended on the bone quality before the treatment following anodontia or trauma. The minimal amount of hard tissues protecting the implant neck was two millimeters of bone surrounding fixture microthreads.

Fig. 5 shows marginal bone-level increase for different heights of microthreads (see Fig. 3) from 0.18 (SD 0.43)-microthread 0.14 mm, 0.34 (SD 0.37) microthread 0.16 mm; 0.04 (SD 0.35) microthread 0.22 mm.

Fixture diameter (mm)	Average of Bone Level (mm)	Standard Deviation of Bone Level
3.0	+ 0.34	0.40
3.5	+ 0.29	0.47
4.0	+ 0.09	0.33
4.5	+ 0.40	0.33
5.0	- 0.10	0.25
Total	+ 0.17	0.39

Table 2: Influence of fixture diameter on marginal bone level - increase (+ mm) or loss (- mm).

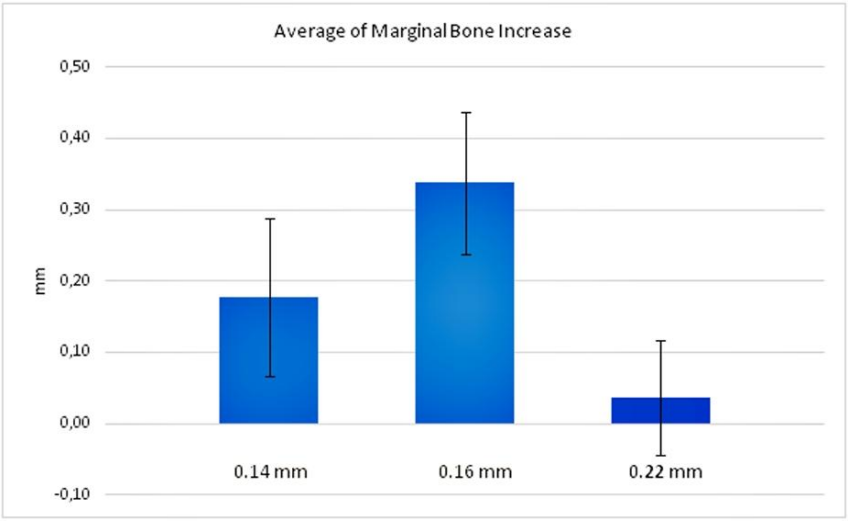


Fig. 5: Effect of microthread height on maintenance marginal bone level.

IV. Discussion

Congenital partial anodontia and traumatic tooth loss are frequently encountered in pediatric patients. Oral rehabilitation is safe and successful after skeletal and dental maturation. Removable partial denture is a treatment of choice, but it has certain complications like increased caries rate, periodontal complications, and increased residual alveolar resorption [12]. Successful replacement of lost natural teeth by osseointegrated implants is a major advance in clinical dental treatment. The basis of these successful long-term results of endosseous implants depend mainly on the preservation of bone support. From our study it was evident that limited bone support had directly influenced the marginal bone level. The thinner implants surrounded with 2-3 mm bone showed a statistically significant bone level increase. The radiographic image was the most important source of information for determining the amount of cervical alveolar bone loss or increase around dental implants [13]. The success criteria of Albrektsson et al. [14] proposed that marginal bone-level changes for the assessment of implant survival and success in the first year should be <1–1.5 mm and for ongoing annual bone loss <0.2 mm. A 15-year study of osseointegrated implants using the Branemark System reported a bone loss of 1.2 mm for the first year. Also, relations were evaluated between marginal bone loss around implants and the level of the first thread with other systems after 12 months [15]. The implants concluding multidisciplinary therapy after anodontia or dental injury showed marginal bone increase based on microthreads presence [16]. A Finite Element Analysis [17] confirms our clinical results that thinner implants (less than 4 mm) reduce stress at the crestal bone level.

Implants are an alternative to orthodontic space closure, autotransplantation, and conventional prosthetic replacement [18]. Implant-supported CAD CAM crowns achieved the best possible long-term result

from an aesthetic point of view, and with the least possible distress and suffering for the patient [19]. Our contribution confirmed the fact that a fixed chronological age is no guidance for implant placement. Only a dental stage indicating fully erupted permanent teeth and skeletal maturation protects dental rehabilitation against infraocclusion of the implant-supported crown. As technological advances in multidisciplinary therapy have progressed, dentists have widened their diagnostic criteria and treatment. Orthodontic screening at the age seven years allows good planning for ideal correction of a malocclusion [20]. Correction of many orthodontic problems in the developing or adolescent dentition is preferable to waiting until the adult dentition. Treatment during this younger period increases the chance of achieving excellent results and better post-treatment stability [21].

V. Conclusion

The use of dental implants in young patients is not limited, but multidisciplinary treatment planning is directly connected with skeletal maturation. It is evident that jaw growth is important for dental implants insertion. It is known that more and more implants are placed in adolescents, especially after trauma or anodontia. From literature it is known that implant ankylosis can have negative effect not only for jaw development but also in 3D position of implant suprastructure in the dental arch. Our study shows that individual skeletal maturity and jaw development control helps to receive long-term clinical treatment success. Our long-term study confirmed that young age and also implant shape and size guarantees not only stable osseointegration but also bone level increase.

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References

[1]. Kawanami M, Andreasen JO, Borum MK, Schou S, Hjorting – Hansen E, Kato H. Infraposition of ankylosed permanent maxillary incisors after replantation related to age and sex. Endod Dent Traumatol 1999; 15: 50-56.
[2]. *Cr*onin RJ Jr, Oesterle LJ, Ranly DM. Mandibular implants and the growing patient. Int J Oral Maxillofac Implants 1994;9:55 – 62.
[3]. Oesterle LJ, Cronin RJ Jr, Ranly DM. Maxillary implants and the growing patient. Int J Oral Maxillofac Implants 1993; 8 :377 – 8.
[4]. Thilander B, Odman J, Grondahl K, Friberg B. Osseointegrated implants in adolescents. An alternative in replacing missing teeth. Eur J Orthod 1994;16:84-95.
[5]. Op Heij DG, Opdebeeck H, van Steenberghe D, Quirynen M. Age as compromising factor for implant insertion. Periodontology, 2000; 33, 2003, 172 – 184.
[6]. Iseri H, Solow B. Continued eruption of maxillary incisors and first molars in girls from 9 to 25 years, studies by the implant method. Eur J Orthodont *1996*; 18*:* 246–256.
[7]. Thilander B, Odman J, Jemt T. Single implants in the upper incisor region and their relationship to the adjacent teeth. An 8-year follow-up study. Clin Oral Implants Res 1999; 10: 346-55.
[8]. Baccetti T, Franchi L, McNamara J A. The Cervical Vertebral Maturation (CVM) Method for the Assessment of Optimal Treatment Timing in Dentofacial Orthopedics. Elsevier Inc., Semin Orthod 2005;11:119–129.
[9]. Franchi L, Baccetti T. The use of maturational indices for the identification of optimal treatment timing in dentofacial orthopedics. In: McNamara JA Jr, Kelly KA, eds. Treatment timing: orthodontics in four dimensions. Craniofacial growth series. Vol. 39. Ann Arbor, MI: Center for Human Growth and Development, University of Michigan; 2002: 151 – 70.
[10]. Hagg U, Pancherz H. Dentofacial orthopaedics in relation to chronological age, growth period and skeletal development. An analysis of 72 male patients with class II division 1 malocclusion with the Herbst appliance. Eur J Orthod 1988; 10 : 169 – 76.
[11]. Novaes AB Jr., de Souza SLS, de Barros RRM, Pereira KKY, Iezzi G, Piattelli A. Influence of Implant Surfaces on Osseointegration. Braz Dent J 2010; 21: 471 – 481.
[12]. Albretksson T, Wennerberg A. Oral implant surfaces. Part – 1 – review focusing on topographic and chemical properties of different surfaces and in vivo responses to them. Int J Prosthodont 2004; 17: 536 – 543)
[13]. Mishra SK, Chowdhary N, Chowdhary R. Dental implants in growing children. J Indian Soc Pedod Prev Dent 2013; 31: 3-9.
[14]. Verhoeven JW, Cune MS, de Putter C. Reliability of some clinical parameters of evaluation in implant dentistry. J Oral Rehabil 2000; 27:211–216.
[15]. Albrektsson T, Zarb G, Worthington P, Eriksson RA. The longterm efficacy of currently used dental implants. A review and proposed criteria for success. Int J Oral Maxillofac Implants 1986;1:11–25.
[16]. Adell R, Lekholm U, Rocker B, Branemark P I. A 15- year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981; 10: 387–416.
[17]. Lee D W, Choi Y S, Park K H, Kim CS, Moon I S. Effect of microthread on the maintenance of marginal bone level: a 3-year prospective study. Clin. Oral Impl. Res 2007; 18: 465-470.
[18]. Schrotenboer J, Tsao Y, Kinariwala V, Wang H. Effect of Microthreads and Platform Switching on CrestalBone Stress Levels: A Finite Element Analysis. Journal of Periodontology 2008; 79: 2166-217.
[19]. Behr M, Driemel O, Mertins V, et al. Concepts for the treatment of adolescent patients with missing permanent teeth. Oral Maxillofac Surg 2008; 12:49-60.
[20]. Fuster-Torres MA, Albalat-Estela S, Alcañiz-Raya M, Peñarrocha-Diago M. CAD / CAM dental systems in implant dentistry: update. Review. Med Oral Patol Oral Cir Bucal 2009; 14: E141-5.
[21]. Kamínek M. Ortodoncie. 1st edition, Galen, Prague 2014*;* 246.