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OUTCOME OF ALVEOLAR BONE GRAFTING IN PATIENTS WITH UNILATERAL CLEFT LIP AND PALATE OPERATED BY ONE-STAGE METHOD

OCENA WGOJENIA PRZESZCZEPU KOŚCI DO WYROSTKA ZĘBODOŁOWEGO SZCZĘKI U PACJENTÓW Z JEDNOSTRONNYM ROZSZCZEPEM WARGI I PODNIEBIENIA OPEROWANYCH METODĄ JEDNOETAPOWĄ

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Abstract

The aim *of the study was the assessment of outcome of alveolar bone grafting in patients with unilateral cleft lip and palate operated on by the one-stage surgical procedure.*

Material and methods: *The study concerned 108 patients (69 boys, 39 girls) with unilateral cleft of lip and palate operated by one stage method in the Surgical Department of Children and Adolescents IMC between 1994 and 2003. The reconstruction of alveolar process in these patients was carried out by autogenic bone graft at the age ranged from 1.5 to 16 years. The surgical procedure was the same regardless of age. The patients were divided into 3 groups according to age during this procedure: I – below 6 years, II – between 6 and 10 years, III – above 10 years. Evaluation of outcome of bone grafting was assessed on the base of Oslo classification and Chelsea scale. The relation between the patient's age at the time of bone grafting and the bone healing result was analyzed by the Spearman's rank correlation coefficient for the studied group as a whole, the age subgroups and the gender groups.*

Results: *Good results of treatment (I and II type) was obtained in 93 (86%) of patients, bad (III and IV type) in 15 patients according to Olso classification. According to Chelsea scale ultimate or satisfactory results (A, B, C) were obtained in 93 patients (86%) , unsatisfactory results (D, E, F) were obtained in 15 patients. Negative correlation between bone graft outcome and age of patients at the time of the procedure above 6 years was confirmed. No statistical significance in relation to sex of patients was found.*

Conclusions: *According to two classifications (Oslo, Chelsea) good results of bone graft were obtained in 86% of patients. There was a relationship in outcome of bone grafting and the age of patients. The inter-gender correlation did not gain the statistical relevance.*

Key words: bone grafting, unilateral cleft lip and palate, one-stage operation

Streszczenie

Cel: *Ocena wyników przeszczepu kości autogennej do wyrostka zębodołowego szczęki u pacjentów z jednostronnym całkowitym rozszczepem wargi i podniebienia operowanych metodą jednoetapową.*

Materiał i metody: *Badaniami objęto 108 pacjentów (69 chłopców, 39 dziewczynek) z jednostronnym rozszczepem wargi i podniebienia operowanych metodą jednoetapową w Klinice Chirurgii Dzieci i Młodzieży w latach 1994 – 2003. Autogenny przeszczep kości do wyrostka zębodołowego szczęki wykonywano między 18 miesiącem a 16. rokiem życia. Przeszczep wykonywano w ten sam sposób niezależnie od wieku. Pacjentów podzielono na 3 grupy w zależności od wieku w chwili wykonania przeszczepu: I – poniżej 6 lat, II – miedzy 6. a 10. rokiem życia, III – powyżej 10. roku życia. Ocenę wgojenia przeszczepu wykonano na podstawie klasyfikacji Oslo oraz skali Chelsea. Przeanalizowano zależność między wiekiem pacjenta oraz płcią a wynikami wgojenia przeszczepu.*

Wyniki: *Dobry wynik leczenia stwierdzono u 86% (typ I i II według skali Oslo), natomiast zły u 14 % (typ III i IV według skali Oslo). Stosując skalę Chelsea uzyskano wynik dobry lub satysfakcjonujący (A, B, C) u 93 (86%) pacjentów, wynik zły(D, E, F) potwierdzono u 15 pacjentów. Potwierdzono negatywną korelację wyniku wgojenia kości od wieku pacjenta podczas zabiegu przeszczepu kości od 6 roku życia. Takiej korelacji u dzieci poniżej 6 lat nie wykazano. Nie stwierdzono również znamiennej statystycznie zależności wyniku przeszczepu kości od płci pacjenta.*

Wnioski: *W oparciu o dwie klasyfikacje oceny (Oslo, Chelsea) dobry wynik przeszczepu kości uzyskano u 86% pacjentów. Wykazano związek miedzy wynikami wgojenia przeszczepu a wiekiem pacjenta w chwili operacji. Nie wykazano zależności statystycznej między płcią pacjentów a wynikami leczenia.*

Słowa kluczowe: przeszczep kości, jednostronny rozszczep wargi i podniebienia, operacja jednoetapowa

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INTRODUCTION

The first report about the alveolar bone grafting in aim to obtain the continuity of the alveolar process was published by *von Eiselsberg* in 1901 (1), and *Lexter* in 1908 (2), who used free bone grafting or pedicled flap of bone and soft tissues of the fifth digit. In 1914 *Drachter* described aveoloplasty with autogenous cancellous bone and periostium harvested from tibia (3).

The alveolar bone grafting gained its popularity to became in the 60's of XX century the integral part of the surgical protocol of cleft lip and palate treatment of majority of the cleft centres all over the world. The procedure was performed employing a variety of techniques, usually before the end of the second year of age. This was the so called primary bone grafting – the procedure performed before or during the palatal closure (tab. I). Therefore it required dissection of the special muco-periosteal flaps to cover the transplanted bone surface.

Gradually it became evident that the procedure has a negative impact on maxillary development (5, 6, 7). In longitudinal observations many authors described the maxillary growth restriction – retruded maxilla, concave face profile and often cross bite (7, 8). As a consequence this way of treatment was finally abandoned for secondary bone grafting proposed by *Boyne* i *Sands* (9). The term of bone grafting was delayed until the 9-12th year of age under assumption that at this age the anterior part of maxilla to certain extend is already finished (10) so the trauma of the procedure cannot have a significant impact on its later proper shape and length. Additionally the surgical technique became more simple and less traumatic than before because bone grafting was done after the closure of hard palate and alveolar area.

At the beginning the bone grafting was performed at the Institute of Mother and Child (IMC) in Warsaw routinely at the age of 9 to 12 years. However the implementation of

Table I. Terms of alveolar bone grafting in surgical protocols of the cleft lip and palate treatment according to *Tatum* et al. (5).

Tabela I. Terminy zabiegów przeszczepu kości do wyrostka zębodołowego szczęki w protokołach leczenia rozszczepu wargi i podniebienia wg Tatum i wsp. (5).

Primary alveolar bone grafting ***Pierwotny przeszczep kości***	**Secondary alveolar bone grafting (after palate repair)** ***Wtórny przeszczep kości do wyrostka zębodołowego szczęki (po operacji podniebienia)***
A. Before lip repair *Przed operacją rozszczepu wargi*	A. Early – before transitional dentition stage *Wczesny – przed uformowaniem uzębienia mlecznego*
B. At the time of lip repair *W czasie operacji rozszczepu wargi*	B. Intermidiate – during transitional dentition stage *Przejściowy – w okresie uzębienia mlecznego*
C. After lip repair, before palate repair *Po operacji rozszczepu wargi, ale przed operacją rozszczepu podniebienia*	C. Late – after transitional dentition stage *Późny – po wymianie uzębienia mlecznego*
D. At the time of palate repair *W czasie operacji rozszczepu podniebienia*	

one-stage operation at the age of 6 to 12 months enabled the term of bone grafting to occur earlier. So the term of bone grafting initially started to be performed before the age of 10 years than gradually even sooner – before the age of 6 years. Finally, since 1997 the procedures of bone grafting have been performed around the 3rd year of age. The surgical technique of bone grafting has always been the same – the secondary bone grafting – regardless late or early.

The aim of the study was to evaluate the outcome of the secondary alveolar bone grafting in patients with unilateral cleft lip and palate operated by the one-stage method.

MATERIAL AND METHODS

The study group consisted of 108 patients (69 boys and 39 girls) with UCLP. The patients were operated during the first year of their life (5-12 month of life) by one-stage method between March of 1994 and November 2003 in the Surgical Department of Children and Adolescents, Institute of Mother and Child. The structure of the group concerning gender and location of the cleft side is presented in table II.

The second stage of treatment consisted of the alveoloplasty performed with autogenic bone grafting. The age of the patients at this moment of surgical protocol ranged from 1.5 (18 months) to 16 years. That enabled to establish three subgroups depending on the patient's age at a time of bone grafting: I – below 6 years (71), II – 6-10 years (22), III – above 10 years (15). The surgical technique of the procedure was always the same regardless the age of the patient and described hereby as follows. Dissection of the oral mucosa was performed in aim to detach it from the nasal mucosa in the region of the alveolar cleft fissure. The cancellous bone fragment was put there and fixed between divided alveolar segments. In case of oro-nasal fistula in the area of the alveolar process the operation was an occasion to close it during the same surgical session.

The anterior part of the iliac crest was always a donor site. Although the surgical technique of harvesting bone was open it was done with avoidance of the epiphyseal chondral tissue. Both the primary cleft operations and bone grafting procedures have been performed by 4 surgeons, members of the cleft team of the Surgical Department of Children and Adolescents of IMC. However, not always the same surgeon performed all the operations of a certain patient. The bone harvesting procedure as a rule was done simultaneously by the surgeon other than the one performing bone grafting in the second operating field. The orthodontic treatment was implemented in accordance with the Institute of Mother and Child standards. This aspect has not been analysed in this paper since the orthodontic specialist, a member of the cleft team has described it in her paper (11). The source of information about the operated patients were at first the Theatre Register which recorded the essential detail of all procedures done in the Operating Theater and the Patient Movement Record of IMC. The obtained data were verified by each single patient's medical history. The collected data were inserted into the Microsoft Exel 2010 programme and initially processed. The part of medical records were dental radiographs as well. The evaluation of the bone levels in the grafted areas was carried out using intraoral radiographs – a standardized upper anterior occlusal taken through the cleft line and a periapical part of the cleft region. Only the clear radiographs taken at least one year after bone grafting were considered for the assessment.

The assessment was performed according to the Oslo grading system (12), also known as Bergland's scale. With this scale the obtained bone level of interdental septum is compared with the normal side and is reported as: type I, septal height approximately normal; type II, septal height at least ¾ of normal; type III, septal height less than ¾ of normal; or type IV, absence of a continuous bony bridge.

Additionally the Chelsea scale was used (13) which rates bone graft take by six categories (A to F) depending on the volume and the position of the bony bridge spanning the cleft related to the cleft teeth (fig. 1). The categories A, B, C are considered to be acceptable and D, E, F as less than satisfactory.

Table II. Gender and location of the cleft side in the studied group of 108 patients.

Tabela II. Płeć i lokalizacja jednostronnego rozszczepu wargi i podniebienia w grupie 108 pacjentów.

	Males ***Płeć męska*** **N**	**Females** ***Płeć żeńska*** **N**	**Overall** ***Razem*** **N (%)**
Right side of cleft *Wada rozszczepowa po stronie prawej*	22	8	30 (27.8)
Left side of cleft *Wada rozszczepowa po stronie lewej*	47	31	78 (72.2)
Overall *Razem N (%)*	69 (63.9)	39 (36.1)	108 (100)

N – sample size, % – percentage.

N – liczebność, % – udział procentowy.

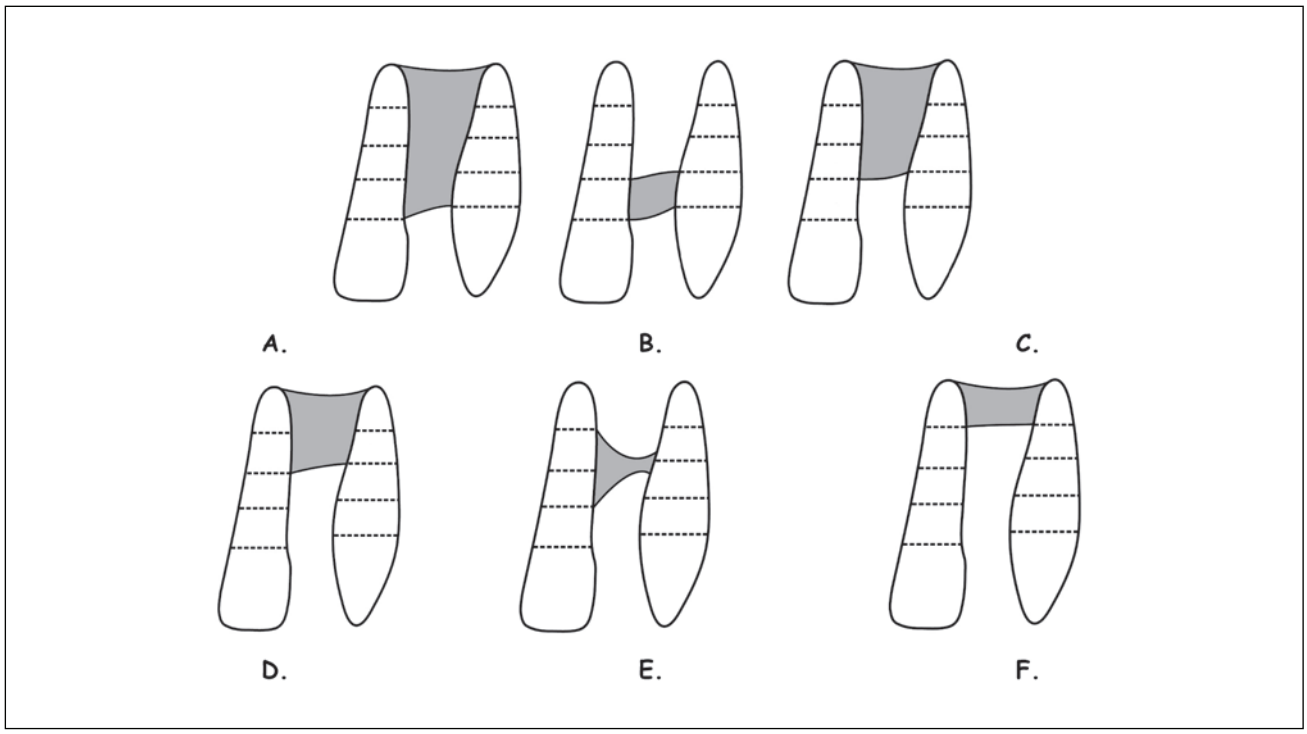

Fig. 1. Sketches of six categories of the Chelsea scale (12). A – at least 75% of both roots must be covered with bone; B – bone must be present at the amelocemental junction and at least 25% of both roots, C – bone must be present across at 75% of the cleft roots from an apical direction; D – bone must be present across at 50% of both roots from an apical direction; E – any bony bridge but without bone apically and coronally; F – bone of 25% or less across both roots from an apical direction.

Ryc. 1. Sześciostopniowa klasyfikacja Chelsea (12). A – przynajmniej 75% powierzchni obu zębów pokryta tkanką kostną; B – 25% powierzchni obu korzeni przykryta kością, kość obecna w okolicy połączenia szkliwno-cementowego, C – przynajmniej 75% powierzchni obu zębów od strony wierzchołków pokrytej tkanką kostną; D – przynajmniej 50% powierzchni obu korzeni zębów pokryte kością mierząc od okolicy wierzchołkowej; E – każdy most kostny w szczelinie rozszczepu, ale brak kości w okolicy wierzchołków i szyjek obu zębów; F – do 25% powierzchni obu korzeni zębów pokrytej kością mierząc od okolicy wierzchołkowej.

In search for relation of bone healing and patient's gender the mean value of the grade of healing according to Oslo scale was established in gender groups than statistically compared with the Mann-Whitney U-test.

The relation between the patient's age at a time of bone grafting and the bone healing result was analyzed by the Spearman's rank correlation coefficient for the studied group as a whole, the age subgroups and the gender groups.

RESULTS

The evaluation of medical record enabled to assess the groups as homogenous in respect of type of a cleft and surgical methods of treatment.

On the Oslo scale, there were 78 (72.2%) patients rated type I (septal height approximately normal); 15 (13.9%) type II; 9 (8,3%) type III and 6 (5.6%) type IV. The results in relations to patient's gender are presented in table III whereas percent distribution of the patients in figure 2.

The calculation of the mean values of the grade of healing according to Oslo scale for male (1.590) and female (1.449) patients and compering them with the Mann-Whitney U-test did not confirm the statistical relevance (p=0.518).

The results of bone grafting according to the Oslo scale in the age subgroups (<6 years, 6-10 years and >10 years) are presented in figure 3.

The analyses of the relation between the patient's age at a time of bone grafting and the bone healing result found the statistical relevance (p<0.050) only in relation to children operated when older than 6 years (the subgroups of 6-10 years and >10 years combined) with the Spearman's rank correlation coefficient r=0,397 with p=0,010. The stronger correlation was noticed in boys r=0,485 with p=0,022. That kind of correlation was not confirmed in relation to the whole group of 108 patients together r=-0,054 with p=0,578.

The results of bone grafting according to the Chelsea scale are presented in table IV and figure 4. The ultimate outcome – category A was obtained in 78 patients (72.2%) whereas the less favorable but still satisfactory outcome – category C was observed in 15 patients. The unsatisfactory outcome – categories D, E, F were registered in 3, 3, and 9 patients respectively.

DISCUSSION

The assessment of bone grafting in patients of IMC suffering from UCLP operated previously by one-stage

Table III. Gender and types of healing according to the Oslo scale.
Tabela III. Struktura badanej grupy według płci i typu wgojenia kości wg skali Oslo.

Bone healing *Wgojenie kości*	**Males** *Płeć męska* **(N=69)**	**Females** *Płeć żeńska* **(N=39)**	**Overall** *Razem* **(N=108)**
Type I	52	26	78
Type II	9	6	15
Type III	5	4	9
Type IV	3	3	6

Table IV. The results of bone healing among 108 patients according to the Chelsea scale.
Tabela IV. Wyniki wgojenia kości u 108 pacjentów wg skali Chelsea.

Category of bone healing *Kategoria wgojenia kości*	**Males** *Płeć męska* **N (%)**	**Females** *Płeć żeńska* **N (%)**	**Overall** *Razem* **N (%)**
A	52	26	78 (72.2)
B	0	0	0
C	9	6	15 (13.9)
D	1	2	3 (2.8)
E	2	1	3 (2.8)
F	5	4	9 (8.3)
Overall *Razem N (%)*	69 (63.9)	39 (36.1)	108 (100)

N – sample size, % – percentage.
N – liczebność, % – udział procentowy.

operation revealed acceptable results (type I and II) in 86% of patients and unsatisfactory results (type II and IV) in 14 % of patients according to the Oslo scale. The chosen comparable publications are presented in table V.

Unfortunately the material of majority of the publications concerning that kind of assessment usually is not homogenous and includes both the unilateral and bilateral cases. That is why it can be used as a rough estimation only.

Usually the outcome of bone grafting in UCLP is more favorable than BCLP (16, 22). Although some authors did not register such a difference (23, 24).

On the Chelsea scale, in this study the acceptable results were obtained in 86.1% (category A 72.2%, B 0, C 13.9%), and unacceptable in 13.9% (category D 2.8%, E 2.8%, F 8.3%). By comparison the results published by *Withrow* et al. (12) were respectively 85% (A 58%; B 20%; C 7%) and 15% (D 3%; E 3%; F 9%); whereas results published by *Marzec* et al. (24) were 69.3% (A 13.3%; B 17.3%; C 38.7%) and 30,7% (D 6.7%; E 16%; F 8%). Though the material of the mentioned articles were heterogeneous and included different kind of cleft cases so any comparisons can only be approximated.

The obtained results suggested a better outcome of bone grafting in male patients. However it did not gain the statistical relevance (p = 0,518). Neither did the studies of other authors (14, 24, 25, 26).

The correlation between the age of a patient during the procedure of bone grafting and its final outcome was noticed. However the statistic relevance was confirmed only with respect to the group of patient aged 6-16-years-old and not confirmed in the group of patients younger than 6 years at a time of bone grafting. The acceptable results in the age subgroups: <6 y.; 6-10 y. and >10 y. were obtained in 84.5%; 95.5% and 80% of patients respectively. Similarly *Opitz* et al. (27) obtained the best results among 6- to 9-years-olds while the results obtained

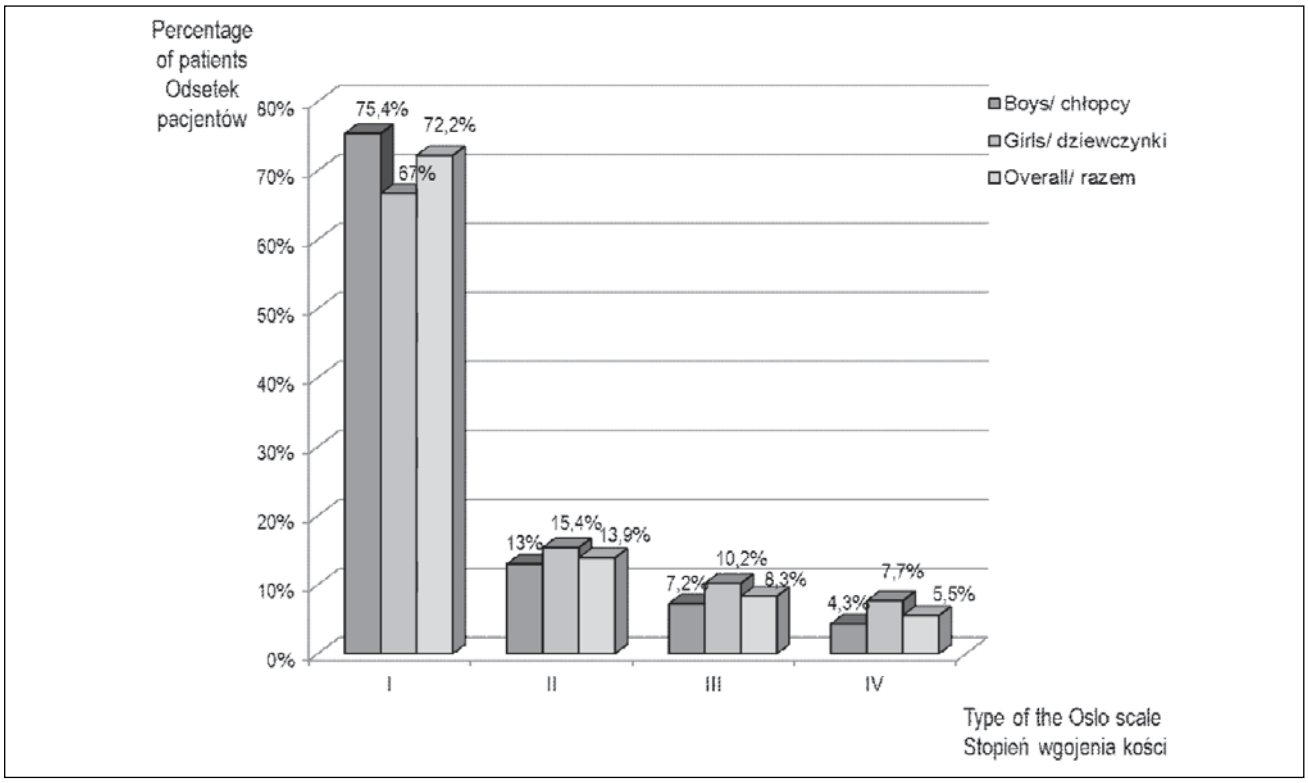

Fig. 2. The prevalence of male (69) and female (39) and all patients together (108) in the respective types of bone healing according to the Oslo scale.

Ryc. 2. Procentowy udział pacjentów płci męskiej (69) i żeńskiej (39) oraz łącznie (108) w poszczególnych typach wgojenia przeszczepu kości zgodnie ze skalą Oslo.

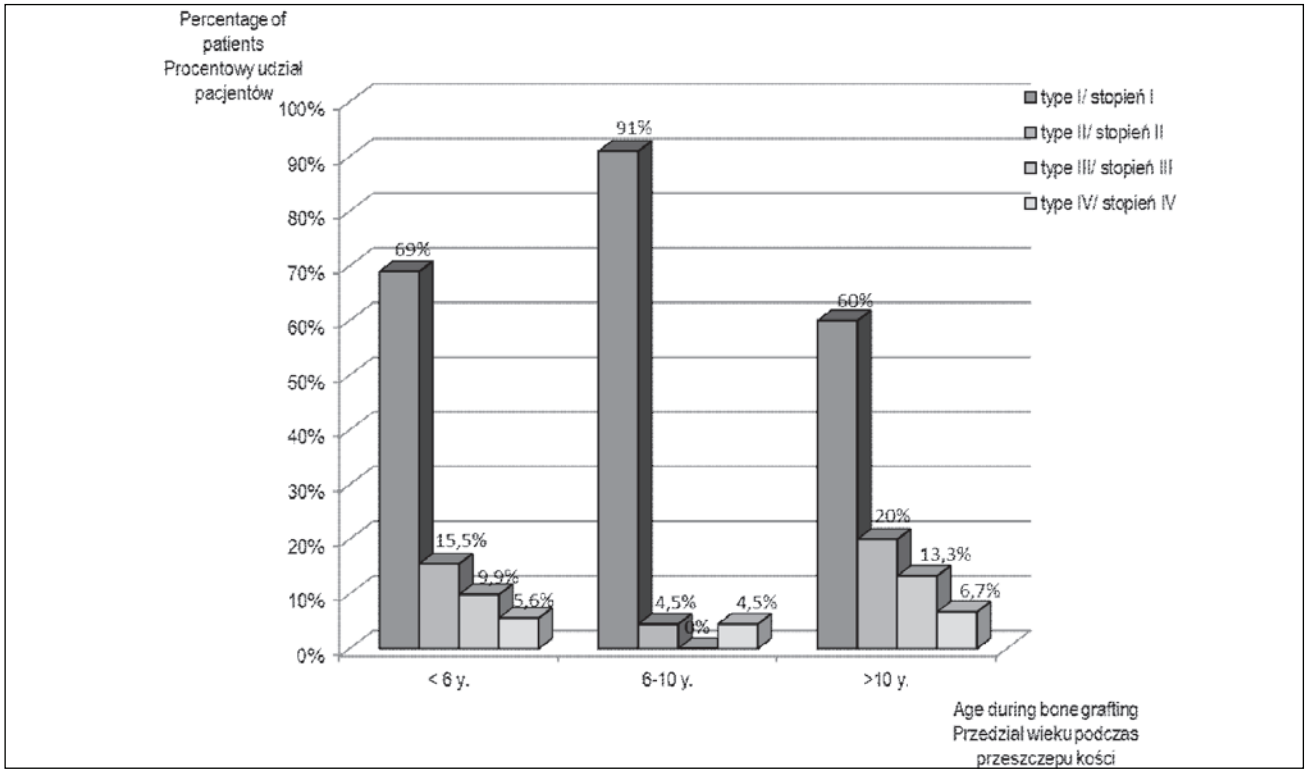

Fig. 3. The prevalence of types of bone healing according to the Oslo scale in three age subgroups: <6 years; 6-10 years; >10 years.

Ryc. 3. Procentowy udział stopni wgojenia przeszczepu kości wg skali Oslo (I-IV) w trzech podgrupach wiekowych: <6 rż.; 6-10 rż.; >10 rż.

Table V. The chosen data from literature review about the results of bone grafting according to the Oslo scale in chronological order.

Tabela V. Zestawienie wybranych informacji z piśmiennictwa na temat wyników wgojenia kości po przeszczepie do wyrostka zębodołowego wg klasyfikacji Oslo w porządku chronologicznym.

Author and year *Autor, data*	**Country of origin** *Kraj pochodzenia*	**N**	**The patient's prevalence in types of the Oslo scale (%)** *Udział pacjentów w typach skali Oslo (%)*						**Type of cleft** *Rodzaj wady*
			I	**II**	**III**	**IV**	**Acceptable result (I+II)** *Dobry wynik*	**Unsatisfactory result (III+IV)** *Zły wynik*	
Bergland et al., 1986 (14)	Norway Norwegia	378	50	40	7	3	90	10	BCLP, UCLP
Tan et al., 1996 (15)	Australia Australia	72	88.9	5.6	4.1	1.4	94.5	5.5	UCLP
Collins et al., 1998 (16)	Great Britain Wielka Brytania	115	45.99	40.88	10.95	2.18	86.87	13.13	BCLP, UCLP
Withrow et al., (2002) (13)	Great Britain Wielka Brytania	66	62.9	21.4	4.3	5.7	84.3	10	BCLP, UCLP
Hynes i Earley, 2003 (17)	Ireland Irlandia	58	60.5	32	6	1.5	92.5	7.5	BCLP, UCLP
Schultze-Mosgau et al., 2003 (18)	Germany Niemcy	68	69	19	10	1	88	11	BCLP, UCLP
Nightingale et al., 2003 (19)	Great Britain Wielka Brytania	48	67	13	12	8	80	20	BCLP, UCLP
Trindade et al., 2005 (20)	Brazylia	65	71	15	NS	NS	86	NS	UCLP
Jia et al., 2006 (21)	China Chiny	102	NS	NS	NS	NS	95* / 83**	5* / 17**	UCLP
Presented study Prezentowana praca	Poland Polska	108	72.22	13.9	8.33	5.55	86.12	13.88	UCLP

*before canines eruption, **after canines eruption, N – sample size, NS – not stated, ULCP – unilateral cleft lip and palate, BCLP – bilateral cleft lip and palate.

**przed wyrżnięciem kłów, **po wyrżnięciu kłów, N – liczebność, NS – brak danych, UCLP – jednostronny rozszczep wargi i podniebienia, BCLP – obustronny rozszczep wargi i podniebienia.*

for the over 14-year-olds were least satisfactory. *Marzec* et al. (25) reported higher percentage of the acceptable results in the patient who had bone grafting up to the 12th year of age. The similar correlation was registered also by other authors (16, 22, 28, 29). The same authors mention the higher success rate of bone grafting when performed before the upper canines eruption (20, 30, 31, 32). Other authors studying the grafted bone resorption by CT did not register any difference in success rate among the patients who are older or younger than the 12th year of age (33) and older or younger than the 9th year of age (24).

The studies about the relative bone density of bone grafts performed by *Mikołajczak* et al. (34) by the means of digital intraoral radiographs with tomosynthesis option revealed that the younger age of a patient at a time of bone grafting means the better grafted bone mineralization. However the youngest age subgroup in the cited publication was 10.3 years old so we can only speculate about that tendency in the patients bone grafted at younger age.

The provision of acceptable level of grafted bone that unites the maxillary alveolar segments previously divided by cleft is clinically important though it is only the part of problems connected with bone grafting. Other subjects such as normal maxillary development, undisturbed teeth eruption in the cleft region, obtaining satisfactory occlusion, possibilities of providing dental prosthetic restorations, the optimal donor site, surgical technique and its complications and many others.

CONCLUSIONS

According to Olso classification and Chelsea score good results of bone graft were obtained in 86% of patients.

There was a relationship in outcome of bone grafting and the age of patient, at the time of the procedure. The inter--gender correlation did not gain statistical relevance.

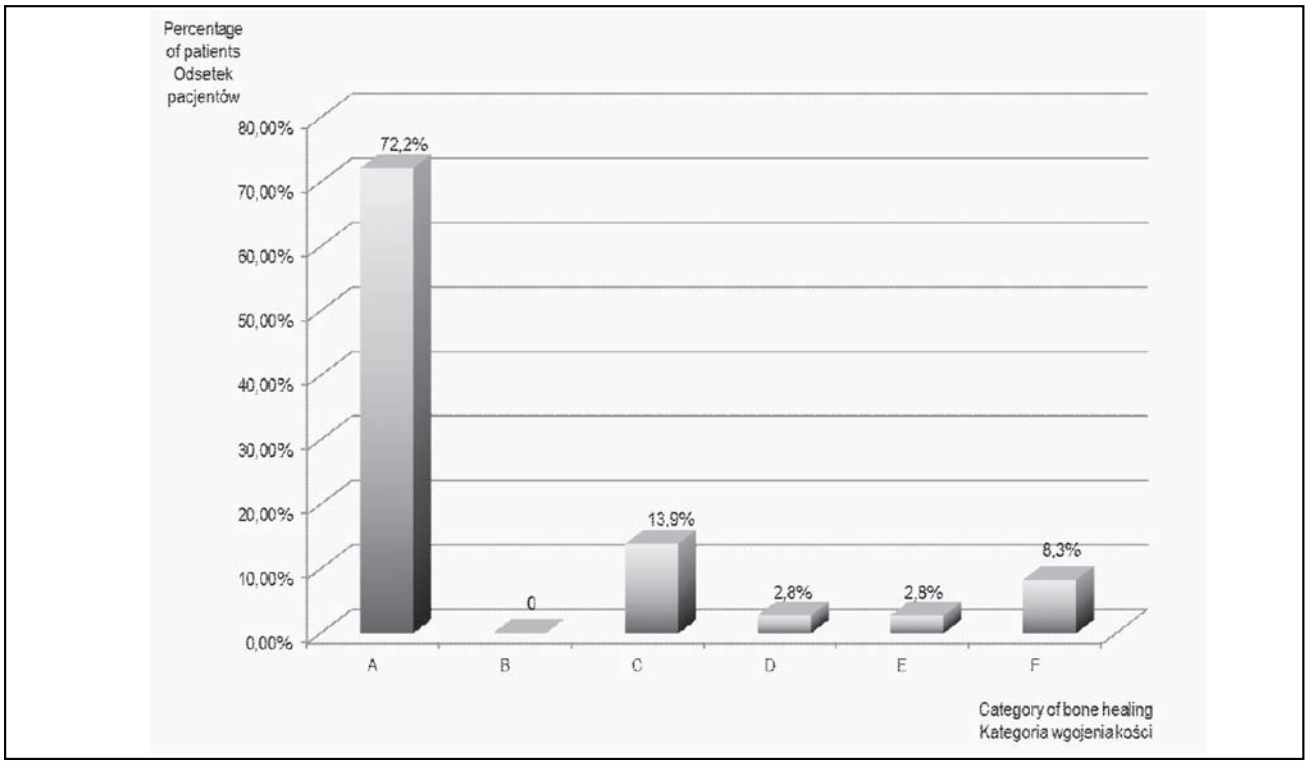

Fig. 4. Percentage of patients in respective categories according to the Chelsea scale.

Ryc. 4. Rozkład procentowy pacjentów badanej grupy w poszczególnych kategoriach wgojenia przeszczepu kości wg skali Chelsea.

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