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Secondary alveolar bone grafting in cleft lip and palate: A comparative analysis of donor site morbidity in different age groups

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ABSTRACT

Introduction: There is no consensus regarding the optimal timing for secondary alveolar bone grafting for clefts defects. We aimed to investigate the potential correlation between the age of patients during surgery, donor site symptoms, surgical time and hospitalization following this procedure.
Material and methods: The outcome of 195 consecutive alveolar bone grafting procedures among different age groups (mean: 7.1 years; range 1.8–40.5) was retrospectively assessed based on a chart review and purpose-prepared report forms. The association between age, gender and hospitalization following bone harvesting was tested by Spearman rank correlation, while relationships (i.e. between age and pain) were evaluated by logistic regression.
Results: The most frequent donor site complaints included: pain equal to or exceeding that of the recipient site (93%) and gait disturbances (92.5%) immediately after the procedure. Chronic complaints included: iliac contour alteration (40.1%), unsightly scar (23%) and recurring discomfort (2.1%). Statistical analysis showed no correlation between donor site symptoms, their duration or hospitalization time following surgery at different ages, except a higher incidence of significant pain immediately after bone harvesting in older females ($r = 0.268$; $p = 0.030$).
Conclusion: Alveolar bone grafting at an earlier age does not increase donor site symptoms, surgical duration or hospitalization following surgery.

1. Introduction

In clinical practice, autogenous bone tissue, despite its potential alternatives, still remains the best material for the replacement of bone defects (Kneser et al., 2006; Gazdag et al., 1995; Oppenheimer et al., 2008), while the anterior iliac crest is considered to be the preferred donor site for alveolar bone grafting in most cleft centers (Burstein et al., 2000; Eppley and Sadove, 2000; Murthy and Lehman, 2005). Secondary alveolar bone grafting is considered one of the principal elements of the surgical protocol for every cleft defect encompassing the alveolus. The procedure of autogenous bone grafting, introduced for the first time in the early 1900s (Fujishiro et al., 2008), has been commonly used in multiple clinical situations since then. Despite its long history, the donor site for bone harvesting has been the subject of many recent articles, most often comparing different donor sites and bone harvesting techniques. Nevertheless, a current tendency to perform the secondary alveolar bone grafting at an earlier age in the surgical protocol of cleft treatment (Precious, 2009; Brudnicki et al., 2014; Dissaux et al., 2016) raises the question about the potentially higher risk of donor site-related complaints or surgical duration in younger patients, and sometimes, as a result of that, longer hospitalization. To our knowledge the literature is devoid of this aspect of cleft surgery, especially concerning cleft patients much younger than 6 years old.

The aim of the study was to determine the potential correlation between the age of cleft patients at bone harvesting and their symptoms associated with the donor site, surgical duration and hospitalization following this procedure.

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2. Material and methods

2.1. Patients

This retrospective study evaluated data of patients born with cleft defects who had undergone secondary alveolar bone grafting over one calendar year (2012) at our center. The collected data included 195 consecutive patients whose bone tissue was harvested from the anterior iliac crest. Patients who had bone harvested from other donor sites or for purposes other than bone grafting to the alveolar cleft defects did not meet the inclusion criteria.

2.2. Methodology

All research on enrolled participants has been conducted according to the principles expressed in the Declaration of Helsinki. Informed consent was obtained from all patients or their legal guardians.

The source of information about consecutive procedures performed in our center was the Operating Theatre Register. The obtained data was verified, completed and duly extended in accordance with the medical records of the shortlisted patients. The following variables were recorded: patient age, gender, cleft type, location of alveolar defect being repaired, donor site location, procedure duration, additional procedures performed together with bone grafting, identity of operating surgeons, days of hospitalization following bone grafting, any early complications that appeared and any complaints reported at follow-up appointments. In addition, postoperative symptoms associated with the donor site were evaluated with the help of a simple purpose-prepared report form which had always been filled in by a doctor on the basis of the patient's/legal guardian's answers. The forms included questions about the incidence and lasting effect of the following symptoms: pain (pain equal to or exceeding that at the recipient site), gait disturbances or reluctance to walk, wound healing problems (infection, irritation, and hypertrophic scar), iliac crest notch and any other complaints if not mentioned earlier.

2.3. Surgical technique

The procedures were performed under general and local anesthesia. The surgical technique in each case was principally analogous regardless of the patient's age or which member of the surgical team was operating. The bone harvesting consisted of an open approach to the anterior iliac crest with the medially based trap door technique.

The surgical technique at the recipient site was carried out principally in accordance with that described by Boyne and Sands (1972) and remained the same in all cases. Any possible differences were attributed to the severity of a particular case or the need for coexisting alveolar oronasal fistula closure. Bone grafting was always carried out by firmly fixing a cancellous bone block between the bony edges of the cleft fissure and covering with a gingival mucoperiosteal flap.

2.4. Statistical analysis

The statistical calculations were performed by Statistica 10 (StatSoft) software.

Spearman rank correlation was used to test the association of age and gender and evaluated variables, including hospitalization after bone harvesting. Logistic regression was used to evaluate significant relationships (i.e. between age and pain). The significance level for all analyses was set at $p < 0.05$.

3. Results

Over a 12 month period (from 02 January 2012 till 18 December 2012), there were 195 bone harvesting procedures carried out from the anterior iliac crest – 126 (64.6%) in male and 69 (35.4%) in female patients, aiming to repair the alveolar cleft defects. The study cohort included patients suffering from various cleft malformations including: unilateral cleft lip and palate (105 cases), bilateral cleft lip and palate (72 cases), unilateral cleft lip and alveolus (13 cases), bilateral cleft lip and alveolus (4 cases), bilateral cleft lip and unilateral cleft alveolus and soft palate (1 case). The general characteristics of the collected material are presented in Table 1.

Pre-operative antibiotics were given intravenously to all patients and continued for 6 days postoperatively; clindamycin was routinely administered.

As a rule, the bone grafting procedure was performed by one surgeon operating at the recipient site and a second surgeon operating simultaneously at the donor site, thus allowing for an optimized overall surgical duration. The bone harvesting procedure alone took 30–40 min and never exceeded recipient site preparation time. The surgical duration of alveolar bone grafting in the collected material was 83 min on average (SD 21.7; range 45–150) and varied considerably because it often included additional procedures such as closure of alveolar oronasal fistulas, correction of the upper lip, nasal tip correction, correction of the nasal ala position, upper lip scar dermabrasion and tooth extractions. The evaluation using the Spearman rank test showed a positive correlation between the patient's age and surgical duration in male patients ($r = 0.360$; $p < 0.001$) and the total group ($r = 0.280$; $p < 0.001$).

The mean length of hospitalization postoperatively was 2.9 days and varied from 1 to 8 days (Table 2). The majority of patients was discharged on the second (66 cases) or third day (102 cases) following the procedure. The evaluation with the Spearman rank correlation did not reveal any statistical significance between the patient's age and hospitalization length following bone harvesting ($r = 0.099$; $p = 0.169$).

The survey based on the report forms covered 95% of patients shortlisted for evaluation. The results of the report form evaluation are presented in Table 3. The most frequent reported complaints associated with the donor site were: pain equal to or exceeding that at the recipient site – 93% (n = 174), and gait disturbances/reluctance to walk – 92.5% (n = 173) of evaluated patients, respectively. Fortunately, the character of these complaints was temporary and lasted merely 3–5 days on average (Table 4). The chronic donor site complaints reported at the evaluation were: any kind of iliac

Table 1
Material characteristics at the time of bone grafting.

	n (%)	Mean age in years (range)	SD	Median	Location of the alveolar defect	
					Right	Left side
Males	126 (64.6)	7.2 (1.8–40.5)	6.40	12.98	58	68
Females	69 (35.4)	6.7 (2.2–27.5)	5.98	9.27	26	43
Total	195 (100)	7.1 (1.8–40.5)	6.25	9.27	84	111

Table 2
The length of hospitalization following bone grafting in days.

	N	Mean	SD	Range	Median
Males	126	2.9	1.03	1–8	3.0
Females	69	2.8	1.08	1–7	3.0
Total	195	2.9	1.05	1–8	3.0

Table 3
Report form evaluations results about donor site-related complaints.

	Experienced pain n (%)	Gait disturbances/reluctance to walk n (%)	Delayed wound healing n (%)	Unsatisfactory scar n (%)	Iliac contour alteration n (%)	Recurring discomfort n (%)
Males (n = 121)	112 (92.6)	112 (92.6)	5 (4.1)	25 (20.7)	45 (37.2)	3 (2.5)
Females (n = 66)	62 (93.9)	61 (92.4)	6 (9.0)	18 (27.3)	34 (51.5)	1 (1.5)
Total (n = 187)	174 (93.0)	173 (92.5)	11 (5.9)	43 (23.0)	79 (40.1)	4 (2.1)

contour alteration – 40.1% (n = 79), unsatisfactory scar – 23% (n = 43) and recurring discomfort in the area adjacent to the donor site, often described as weather dependent aches – 2.1% (n = 4) (Table 3). A breakdown of the analyzed variables by age subgroups is presented in Table 5.

The evaluation with the Spearman rank correlation did not reveal any statistical significance between indicated donor site complaints and age or gender (r near zero), with the exception of a small positive correlation of pain at the donor site being stronger than that at the recipient site immediately after bone harvesting in female patients with increasing age ($r = 0.268$; $p = 0.030$). The results of the correlation analysis are presented in Table 6.

4. Discussion

This study intended to evaluate the potentially very subtle relationship between the patients' age and donor site-related symptoms, including any potential complications, which may in turn be associated with the surgical duration of the procedure or hospitalization length following bone grafting. Hence, all efforts were made to obtain as homogenous data as possible, with the exception of the patients' age at the time of alveolar bone grafting. The age ranged significantly from 1.8 to 40.5 years. The study was based on the medical records of a large number of cases operated consecutively using the same surgical technique of bone harvesting limited to the anterior part of the iliac crest and for the same purpose of secondary alveolar bone grafting, which granted relatively similar and small amounts of harvested bone.

Table 4
Duration of temporary complaints evaluated by the report form in days.

	Mean	SD	Range	Median
Experienced pain	3.4	2.2	1–14	3.5
Temporary gait disturbance/reluctance to walk	4.6	4.7	1–30	3
Delayed wound healing	5.1	3.4	3–12	3

The study results seem to exclude the higher risk of incidence and lasting effects of donor site-related symptoms or hospitalization in younger patients. In contrast, the evaluation revealed a positive correlation between pain at the donor site being stronger than that at the recipient site immediately after operation and the age among female patients. This suggests that donor site morbidity at a younger age cannot be considered as an argument against performing early secondary bone grafting before the 6th year of life.

The incidence and duration of donor site-related symptoms in the study, apart from some differences are generally consistent with the reports in the literature. The most frequent complaint in our study was pain at the donor site, which 93% of our patients indicated as more painful than that at the oral wound. The percentages reported in the literature range from 26 to 70% (Canady et al., 1993; Kalk et al., 1996; Eufinger and Leppanen, 2000; Rawashdeh and Telfah, 2008). Temporary postoperative donor site pain interferes with early mobilization, which presumably is an explanation for the similar level of gait disturbance/reluctance to walk indicated by 92.5% of our patients. The postoperative pain at the iliac crest limits walking and may in turn result in prolonged hospitalization and recovery. Rawashdeh & Telfah (2008), who evaluated anterior iliac crest morbidity, reported a mean value (in days) regarding duration of pain experienced – 10.5, problems with walking – 6.7 and hospital stay – 3.6; in comparison our results were 3.4, 4.6 and 2.9, respectively. According to reports in the literature, the average hospitalization length after bone grafting varies in different centers from 1 to 6 days (Hughes and Revington, 2002; Perry et al., 2005; Swan and Goodacre, 2006). These variations, however, may be influenced not only by the special care needs of the recipient site but also by geographic determinants, surgeon's preferences and different insurance restrictions as well (Rawashdeh and Telfah, 2008).

The surgical duration of alveolar bone grafting in the collected material was 83 min on average, and varied from 45 to 150 min. Since bone harvesting was carried out simultaneously with the recipient site preparation and never lengthened the surgical duration, an inverse correlation between the patient age and surgical duration registered in the study was most probably due to the

Table 5
Breakdown of analyzed variables by age subgroups.

Analyzed variables	Age at bone grafting in years				
	≤3 n = 93	4–6 n = 32	7–9 n = 12	10–12 n = 15	≥13 n = 35
Experienced pain n (%)	85 (91.4)	29 (90.6)	12 (100)	14 (93.3)	34 (97.1)
Duration of pain in days	3.4	2.7	4.7	3.4	3.5
Temporary gait disturbance/reluctance to walk n (%)	87 (93.5)	28 (87.5)	12 (100)	14 (93.3)	32 (91.4)
Days of gait disturbance/reluctance to walk	4.9	2.9	5.3	3.6	5.7
Delayed wound healing n (%)	8 (8.6)	1 (3.1)	1 (8.3)	1 (6.7)	0
Unsatisfactory scar n (%)	20 (21.5)	6 (18.7)	4 (33.3)	5 (33.3)	8 (22.9)
Iliac contour alteration n (%)	38 (40.9)	15 (46.9)	6 (50)	7 (46.7)	13 (37.1)
Recurring discomfort n (%)	1 (1.1)	0	0	1 (6.7)	2 (5.7)
	n = 97	**n = 33**	**n = 12**	**n = 15**	**n = 37**
Surgical duration in minutes	78	82	86	88	96
Hospitalization length following operation in days	2.7	3.1	2.8	3.2	2.8

Table 6
Correlation analysis results *a* – binomial variable. Statistically significant results shown in bold font (the significance level is set at $p < 0.05$).

Analyzed variables	*R* for age-related correlations					
	Female (n = 66)	p-value	Male (n = 121)	p-value	Total (n = 187)	p-value
Experienced pain[a]	**0.268**	0.030	0.024	0.794	0.094	0.201
Duration of pain	0.148	0.236	−0.026	0.777	0.034	0.644
Temporary gait disturbance/reluctance to walk[a]	0.149	0.232	−0.110	0.230	−0.019	0.796
Duration of gait disturbance/reluctance to walk	0.037	0.768	−0.159	0.082	−0.081	0.270
Delayed wound healing	−0.121	0.333	−0.034	0.711	−0.071	0.334
Unsatisfactory scar[a]	0.024	0.848	0.132	0.149	0.082	0.265
Iliac contour alteration[a]	−0.194	0.119	0.078	0.395	−0.025	0.734
Recurring discomfort	0.195	0.117	0.059	0.520	0.103	0.161
	Female (n = 69)		Male (n = 126)		Total (n = 195)	
Surgical duration	0.161	0.185	**0.360**	<0.001	**0.280**	<0.001
Hospitalization length following operation	0.064	0.601	0.117	0.192	0.099	0.169

[a] Binomial variable.

additional procedures performed together with alveolar bone grafting, and had nothing to do with the donor site preparation.

Some severe complications reported in the literature, such as permanent sensory disturbances in the distribution area of the lateral femoral cutaneous nerve (Kalk et al., 1996; Schaaf et al., 2010), arterial injury (superior gluteal, fourth lumbar, ilio-lumbar and deep iliac circumflex), ureteral injury (Fowler et al., 1995), retroperitoneal haemorrhages, jejunal perforation, hernias (Velchuru et al., 2006) and pelvic fractures (Nocini et al., 2003), in the cases of harvesting for the purpose of alveolar cleft bone grafting should be probably regarded as exceptionally rare. None of these complications were noted in our study group, nor were they reported by the oldest members of our team regarding past years.

Surprisingly, the high level of reported iliac contour alteration (40%) and unsatisfactory scar (23%) in this study indicated the necessity to change or at least revise the current surgical technique of bone harvesting by some surgeons of our team. The prepared iliac crest lid should always be wider than the bone block taken, thus allowing its firm fixation to its previous position afterward. Another possible solution would certainly be the closed technique with a trephine; however, this method completely excludes the possibility to harvest a bone block which is currently preferred by our surgeons as it enables mechanical fixation between bone edges at the recipient site.

This study had to be limited to a general assessment of pain experience and duration, since its intensity level evaluated by the VAS would not have been feasible to be performed in very young patients. The question probing whether pain experienced as equal to or worse than the pain at the recipient site additionally eliminates any bias coming from the use of postoperative painkillers.

The limitation of the study focused on the evaluation of the anterior iliac crest only, and did not necessarily imply that evaluation of other donor sites would yield similar results.

5. Conclusions

The study did not reveal any correlation between the patient age at the time of bone harvesting and donor site symptoms revealed in the study, with the exception of a higher risk of incidence of significant pain immediately after operation in older female patients. There was an inverse correlation registered between the patient age and surgical duration of alveolar bone grafting, and no correlation connected to the hospitalization following bone harvesting. The results of the study imply that performing secondary alveolar bone grafting at an earlier age does not increase donor site-related symptoms.

Ethical approval

The study was approved by the Bioethics Committee of the Institute of Mother and Child in Warsaw (number 31/2017).

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The study was performed as part of a major statutory project of the Department of Pediatric Surgery, Institute of Mother and Child in Warsaw, Poland regarding the treatment of children suffering from oro-facial clefts.

Conflicts of interest

The authors declare no conflicts of interest.

Patient consent

The informed consent of patients or their legal guardians was obtained. All research on enrolled participants has been conducted according to the principles expressed in the Declaration of Helsinki.

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All authors have viewed and agreed to the submission of this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcms.2018.11.006.

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