Revision Rates of Alveolar Bone Grafting in Unilateral Cleft Lip and Palate Patients with and without Orthodontic Preparation

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The main purpose of the present study was to compare the revision rates of alveolar bone grafting in cleft lip and palate (CLP) patients with and without orthodontic preparation. The dental record of 101 patients with unilateral cleft lip and palate were examined. Details were recorded of general characteristic, the need for revision, intraoral condition prior to surgery, surgical procedure and the cause of revision. The revision rates were 11.9% and 20.6% in orthodontic preparation and non-orthodontic preparation groups, respectively. The Fisher's exact test showed that there was no difference in the revision rate between both groups. Intraoral conditions prior to grafting and different surgical procedures did not affect the success of alveolar bone grafting.

Keywords: *Cleft lip and palate, Alveolar bone graft, Revision*

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Cleft lip and palate (CLP) is one of the most common birth defects;its incidence in Thailand is between 1.26 and 1.62 per 1,000 live births[1]. The treatment of CLP patients requires prolonged multidisciplinary rehabilitative effeort.

Among patients with complete cleft of primary and secondary palates, collapse of dento-alveolar arch segments due to lack of bony support at the cleft site(s) is common[2]. In order to create sufficient bony support, secondary alveolar bone grafting was introduced[3,4]. For the best result, this procedure be performed at a stage of transitional dentition when the canine root has not fully formed age of 9-11[5].

The objectives of secondary alveolar bone grafting have been well documented[3,5]. Successful grafting is important, particularly for following orthodontic treatment. From the orthodontic, the alveolar bone grafting procedure allows successful tooth movement at the cleft site. Obtain the maximum successful grafting result, the surgeon and orthodontist have usually been involved, especially in the presurgical orthodontics. For some patients, orthodontic preparation is helpful and sometimes necessary before bone graft placement. These procedures often involve arch expansion, aligning rotated teeth and correcting cross bites[6]. Especially expanding the arch before bone grafting facilitates surgery by creating more space at the cleft defect for placement of the graft[7]. However, arch expansion will also open any existing anterior oronasal fistula residual to the primary cleft closure in infancy. Thus, alveolar bone grafting is a recommended procedure for both fistula closure and bone-fill at the cleft site[8].

In some cases, placing a cancellous bone graft prior to orthodontic treatment to avoid greatly increasing the size of an already open fistula reduces the amount soft tissue cover. This dilemma of whether or not to do orthodontic preparation for bone grafting must be made on the merits of each case[7]. Many studies have suggested that the consideration whether to perform orthodontic treatment prior to or after grafting is based on collaborative treatment planning between the maxillofacial surgeon, orthodontist and other team members[2,6,7,9].

Failures of alveolar bone grafting do occur,

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and determination of the possible factors that affect the quality of grafting can help the orthodontist and maxillofacial surgeon to maximize favorable outcomes. To the authors knowledge, there have not been any studies reporting a comparison of the success of alveolar bone grafting between patients who received orthodontics prior to vs. after grafting. Based on these considerations, the purposes of the present study were (a) to compare the revision rates of grafting procedure between orthodontic preparation and non-orthodontic preparation in CLP patients and (b) to identify the cause that patient required a repeat surgery.

It was hypothesized that the condition prior to surgery-non-orthodontic preparation or orthodontic preparation-makes a difference in the revision rate of bone grafting in CLP patient.

Material and Method

Subjects

101 unilateral CLP patients, comprising 46 males and 55 females, between the ages of 6 and 34 years, were included in this study. All of the subjects received alveolar bone grafting with or without prior orthodontics at the University Cleft Center,Faculty of Dentistry, of Khon Kaen University (KKU). They received alveolar bone grafting at least 3 months prior to bone graft assessment[10], and had future treatment planning at the cleft site after the grafting procedure.

Study procedure

All of the subjects were classified into two main groups:

Orthodontic preparation group

Patients in this group received orthodontic treatment prior to alveolar bone grafting. The preoperative orthodontics consisted of maxillary arch expansion, and derotation of teeth adjacent to the cleft or aligning maxillary teeth with a removable or fixed orthodontic appliance.

Non-orthodontic preparation group

In this group, patients received cancellous bone grafting before any orthodontic treatment.

Data collection

Data recorded for each patient included general characteristics, condition before grafting procedure, effect of orthodontic treatment, surgical procedure, and the need for and cause of revision (Fig. 1). Determinations of the need for revision of grafts were made by experienced orthodontists who were in charge of the individual cases;based onclinical examination, periapical and occlusal dental radiographs and intraoral photographs. The need for repeat bone graft surgery was based on findings such as insufficient bone stock, or fistula recurrence, *i.e.*, that did not allow continued orthodontic management.

Statistical analysis

The age, sex, side of cleft, and pre- and post-grafting conditions of each patient was recorded. The

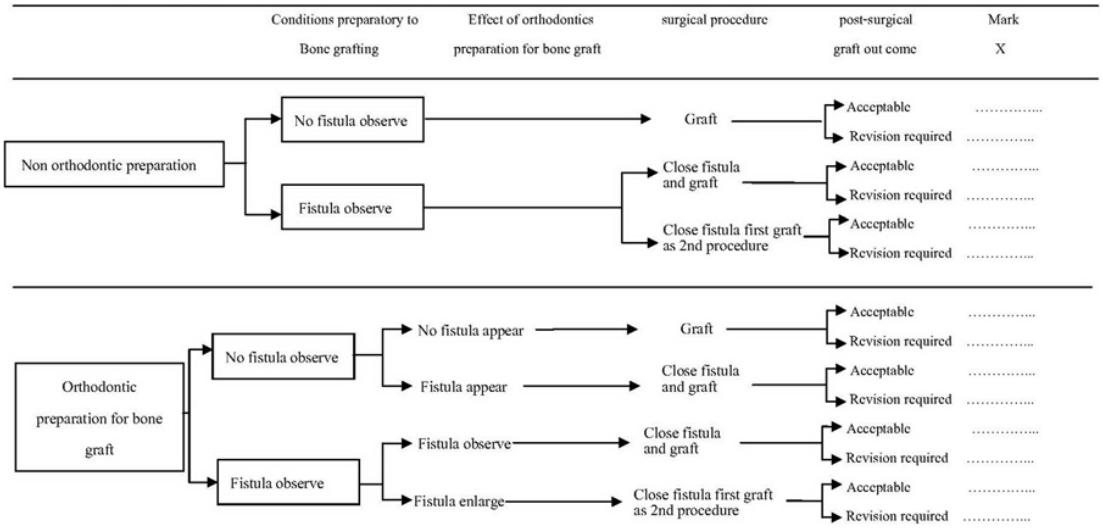

Fig. 1 Flow chart for data collection

data were presented as the number and percentage of cases. The Fisher's exact test was used to analyze the revision rates in each group. A p-value < 0.05 was considered significant. SPSS (version 10) was used to analyze for statistical differences.

Results

General characteristicsof the subjects are presented in Table 1.

Overall, 14.8 % (n=15) of patients required repeat surgery (Table 2). The patients in the non-orthodontic preparation group had a revision rate of 20.6% (n = 7) and patients in the orthodontic preparation group had a revision rate of 11.9% (n = 8). The statistical evaluation revealed no significant difference in revision rates between both groups (Table 2).The causes of the revision were identified as either postoperative infection (2.9%, n = 3) or inadequate bone support in grafted site (11.9%, n = 12).

In comparing the revision rates associated with the three different fistula states prior to alveolar bone grafting, there was no statistically significant difference in graft outcomes (Table 3).

Comparisons of revision rates, with and without the need to close an existing fistula and including one patient having soft tissue closure of a wide fistula followed by repeat bone grafting are presented in Table 4.

Discussion

The percentage of repeat surgery for patients on whom orthodontic preparation had been performed was similar to those who had had no prior orthodontics. Generally, maxillary arch expansion[11] prior to bone graft aimes to provide a better access for soft tissue closure at the nasal floor which forms the base of the pocket into which the bone is placed[12]. The present study showed that the success of grafting is not related to the orthodontic preparation. One interesting study by Long et al[13] provides an explanation of this finding as

Table 1. General characteristic of the subjects

	Non-orthodontic preparation (n = 34)	Orthodontic preparation (n = 67)
Age		
Mean (SD)	17.0 (5.5)	17.3 (5.9)
Age at graft		
Mean (SD)	11.6 (5.3)	12.8 (4.8)
Sex		
Male	17 (50.0%)	29 (43.3%)
Female	17 (50.0%)	38 (56.7%)
Follow-up		
Mean (SD)	5.4 (3.7)	4.4 (3.4)
Side of cleft		
Rt	16 (47.1%)	36 (53.7%)
Lt	18 (52.9%)	31 (46.3%)
Treatment plan at cleft site		
Orthodontic space closure	28 (82.4%)	58 (86.6%)
Prosthesis	6 (17.6%)	9 (13.4%)
Implant	0 (0.0%)	0 (0.0%)

Table 2. Comparison of the revision rates between the non-orthodontic and orthodonticpreparation groups

	Single procedure (n)	Revision (n)	Revision rate (%)	p-value
Non-orthodontic preparation (n = 34)	27	7	20.6%	0.25
Orthodontic preparation (n = 67)	59	8	11.9%	
Overall (n = 101)	86	15	14.8%	

Table 3. Comparison of the revision rates for different intraoral condition prior to bone graft

	Single procedure (n)	Revision (n)	Revision rate (%)	p-value
Fistula absent (n = 49)	45	4	8.2%	0.068
Fistula present (n = 47)	38	9	19.1%	
Fistula enlarged (n = 5)	3	2	40.0%	

Table 4. Comparison of the revision rates for different surgical procedures (including "Close fistula and graft as 2nd procedure" with "Close fistula and graft" group)

	Single procedure (n)	Revision (n)	Revision rate (%)	p-value
Graft	46	4	8.0%	0.055
Close fistula and graft or Close fistula and graft as 2nd procedure	40	11	21.6%	

they found a low correlation between cleft width and bond graft adequacy. They therefore concluded that orthodontic treatment prior to bone graft appears to have little or no impact on the success of the graft. This concurs with the present study by Aurouze et al[14], who found that the size of presurgical cleft defects appears to have no correlation with the success of the secondary alveolar bone graft.

The results of the comparison of surgical revision rates among different intraoral conditions (fistula present, absent or enlarged) showed that orthodontic preparation had no impact on the success of the graft (Table 2).This lack of any significant finding relating the conditions prior to surgery (including any fistula problem)to the success of alveolar bone grafting seems to indicate that presurgical orthodontics, including arch expansion, can be carried out without creating a preoperative situation that would diminish the likelihood of success of the subsequent bone graft. This observation is especially important because the most common concern presurgical orthodontic is enlargement of the oro-nasal fistulae; which would otherwise make the surgical procedure more difficult and complex. The current study, however, shows that if a fistula appears, or is enlarged during, the pre-bone grafting stage of orthodontic treatment, the surgeon is mostly able to simultaneously manage both fistula closure and grafting[13]. If orthodontic alignment or expansion is performed after the bone grafting and a fistula appears, an additional surgical procedure will be required.

From the surgical point of view, absolute failure of grafting (such as no continuous bone bridge across the cleft) is rare. , inadequacy of a bony bridge is also important as attested to by routine post-grafting evaluation by orthodontists. In the present study, the causes of graft failure were recorded, as also noted in other studies[15-17]. Collins et al[18] noted that other complications although likely to be of low incidence included: cervical root resorption, internal resorption, non-eruption of the canine, bony dehiscence and proliferative granulation tissue. Any lack of periodontal health before, during, or subsequent to, alveolar bone grafting is also a significant reason for graft failure[13]. Additionally, failure may be due to poor surgical technique or infection[19].

Important surgical considerations include good exposure the cleft site, proper flap design, and use of cancellous bone. Epker and Fish[20] suggested that for success of osseous reconstruction in cleft patients, it is essential to achieve good soft tissue closure of the nasal floor, palate and labial alveolus. Boyne and Sands[3] claimed that a dehiscence of the palatal incision with loss of some fragments of the bone graft in this area may be caused by the relative difficulty in moving the thick palatal flaps as opposed to the ease of closure with the posteriorly base buccal and the labial flap. Thus it seems that when the width of the cleft is markedly increased, it is more difficult to create appropriate muco-periosteal flaps to surround the graft and so to obtain an optimal result. Nevertheless, more experienced surgeons facing this problem can be

expected to handle the situation effectively[21].

Tables 5-7 summarize some comparisons with other studies. Table 5 shows the geographical spread of international institutions being compared. The revision rate found in the present study is comparable with most other studies (Table 6).The marked reduction in failure/revision rates reported from two studies in the United Kingdom between 2001[22] and 2010[23] (42% to 6%) could be attributed at least in part to improvements in surgical care for cleft lip and palate instituted by the British Ministry of Health following its Clinical Standards Advisory Group Report in 2001[22]. Variations among the studies are intriguing in that there was a wide variety of clinicians employed among the different studies, although the joint approach involving an orthodontist and a surgeon seems to be favoured (Table 7). Reasons for the variations in the findings among the studies can only be suggested, whether resulting from varying surgical skill, or in part, from bias among the respective evaluator's background, or on the nature of evaluative criteria that were used to assess bone graft quality. From the above considerations, it is evident that close cooperation between surgeon and orthodontist is required[13].

Although the revision rate can present the success of alveolar bone grafting of the KKU Cleft Center, graft success from additional perspectives should be evaluated in future studies, including inter-center comparisons of outcomes. Consideration of factors such as psychological effects, cost-effectiveness of various procedures, and variations in surgical technique, may suggest further improvement

Table 5. Reports included in comparison study

Study	Sample population details			Population
	Unilateral cleft	Bilateral cleft	Total cleft site	
Long et al[13]	29	14	56	USA
Opitzet al[15]	73	28	129	Germany
Goudy et al[17]	61	42	145	USA
Collins et al[18]	87	28	143	UK
Williams et al[22]	157	-	157	UK
Newlands[16]	32	16	48	Ireland
Bayerlein et al[24]	37	9	55	Germany
Felstead et al[23]	46	7	60	UK
Present study	101	-	101	Thai

Table 6. Summary comparisons of the revision rates in different studies

Study	Overall revision rate	Study detail
Long et al[13]	14%	86 % rated as clinically successful
Opitz et al[15]	10.1%	13.9% were assigned as Bergland scale Types III /IV but 10.1% needed repeat osteoplasty.
Goudy et al[17]	-	18% revision of unilateral cleft 32% revision of bilateral cleft
Collins et al[18]	14%	86% success
Williams et al[22]	42%	58% rated as clinically success
Newlands[16]	-	11% of preoperative orthodontic group were assigned as Bergland scale Types III /IV. 5% of non-preoperative expansion group were assigned as Bergland scale Types III /IV.
Bayerlein et al[24]	24%	76% were assigned as graft success (Bergland scale Types I/II).
Felstead et al[23]	6%	94% successful
Present study	-	20.6% revision of non-orthodontic preparation group 11.9% revision of orthodontic preparation group

Table 7. Summary of team membership in making decision for repeat alveolar bone grafting and the criteria for the determination

Study	Study's team members	Criteria in determination of revision
Long et al[13]	3 Orthodontists	Not reported in the study
Opitz et al[15]	1 Orthodontist 1 Facial surgeon	Not reported in the study
Goudy et al[17]	3 Otolaryngologists 1 Orthodontist 1 Oral and maxillofacial surgeon	Insufficient bone stock for tooth movement and retention
Collins et al[18]	1 Orthodontist	Bergland radiographic scale
Williams et al[22]	2 Orthodontists	Bergland radiographic scale
Newlands[16]	1 Oral and maxillofacial surgeon	Not reported in the study
Bayerlein et al[24]	1 Orthodontist 1 Oral and maxillofacial surgeon 1 Diagnostic radiologist	Not reported in the study
Felstead et al[23]	1 Orthodontist 2 Surgeons	Bergland radiographic scale
Present study	3 Orthodontists individually assessing their respective patients	Inadequate bone level for further orthodontic treatment at cleft site or post-operative infection. (based on determination of each orthodontist)

in the management, selection, appropriate timing and technique for grafts in cleft palate patients.

Conclusion

The findings of the present study indicate the following.

1. There was no difference in the revision rate of alveolar bone grafting between the non-orthodontic preparation group and the orthodontic preparation group.

2. Presence or absence of an oro-nasal fistula prior to grafting was not associated with any differences in possible effects on the revision rates of alveolar bone grafting. Although some surgeons suggest that increasing cleft width may diminish the amount of soft tissue for covering the cleft site to adversely affect outcomes, this relationship was not found in the present study.

3. At the Khon Kaen University Cleft Center, 20.6 % of unilateral cleft lip and palate patients in the non-orthodontic preparation group and 11.9% in the orthodontic preparation group required repeat alveolar bone grafting. The main causes for the need of revision were insufficient bone support and post-operative infection.

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Potential conflicts of interest

None.

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อัตราการปลูกถ่ายกระดูกซ้ำในผู้ป่วยปากแหว่งเพดานโหว่ข้างเดียวที่ได้รับและไม่ได้รับการจัดฟันก่อนปลูกถ่ายกระดูก

มนเทียร มโนสุดประสิทธิ์, ทัศนีย์ วังศรีมงคล, คีท ก็อดฟรีย์, สุจิตรา ไชยสังข์, บวรศิลป์ เชาวน์ชื่น

วัตถุประสงค์หลักของการศึกษาเพื่อเปรียบเทียบการปลูกถ่ายกระดูกซ้ำในผู้ป่วยปากแหว่งเพดานโหว่ ที่ได้รับการจัดฟันก่อนผ่าตัดและไม่ได้รับการจัดฟันก่อนผ่าตัด บันทึกการรักษาทางทันตกรรม ในกลุ่มตัวอย่างปากแหว่งเพดานโหว่ด้านเดียวจำนวน 101 คน ถูกนำมาวิเคราะห์ ข้อมูลทั่วไป การปลูกกระดูกซ้ำ สภาพช่องปากก่อนทำการปลูกถ่ายกระดูก และขั้นตอนการทำศัลยกรรมปลูกถ่ายกระดูก พบว่าอัตราการปลูกถ่ายกระดูกซ้ำเป็นร้อยละ 11.9 และ 20.6 ในกลุ่มที่ได้รับการจัดฟันก่อนผ่าตัดและไม่ได้รับการจัดฟันก่อนผ่าตัดตามลำดับ จากการทดสอบของฟิชเชอร์ พบว่าไม่มีความต่างกันของการปลูกถ่ายกระดูกซ้ำระหว่างกลุ่มตัวอย่างทั้งสองส่วน สภาวะในช่องปากก่อนการผ่าตัดปลูกถ่ายกระดูก และขั้นตอนการผ่าตัดที่ต่างกันก็ไม่มีผลต่อความสำเร็จของการปลูกถ่ายกระดูกเช่นกัน