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Original Article

EFFECT OF THE TIMING OF ORTHODONTIC TREATMENT ON THE SUCCESS OF SECONDARY ALVEOLAR BONE GRAFTING IN PATIENTS WITH CLEFT LIP AND PALATE

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Abstract

Objective: The aim of this study was to find a correlation between the timing of secondary alveolar bone grafting and orthodontics regarding the success of the graft. **Design:** A systematic review of English articles using 5 search engines was done using the appropriate keywords. The articles were screened, reviewed and assessed by 2 independent authors.
Inclusion criteria: Randomized controlled trials, case control trials, and retrospective studies describing the relation between alveolar bone grafting and orthodontic treatment were included. **Outcome:** Success of alveolar bone grafting. **Results: -** 3 CCTs ,2 retrospective studies and one RCT were included from a total of 2600 studies screened. Two researches focused on pre-grafting orthodontics while 2 focused on post-grafting orthodontics and the retrospective studies compared both pre- and post-grafting expansion. **Conclusions:** Qualitative analysis of the results suggests that multiple areas of research could be opened up by the conclusions of the 6 researches. The evidence they provide, although significant in the sense of opening doors for future research, remains insufficient to draw a consensus for the effect of timing of alveolar bone grafting and orthodontic treatment.

Keywords: Secondary alveolar bone grafting, alveolar clefts

I. INTRODUCTION

Cleft lip and palate (CLP) is the most common craniofacial anomaly.[1] An integral part of rehabilitation in CLP is alveolar cleft management.[2] For the most part, it is universally accepted that alveolar cleft management is a joint effort between orthodontists and surgeons.[3] However, there still remains controversy on the exact parameters of this collaboration.[4] Two main protocols exist governing the collaboration; pre-grafting palatal expansion as preparation for the graft, and post-grafting palatal expansion.[5]

The advocates of each of the two protocols present valid arguments, but the mere fact that two protocols still exist and are implemented regularly throughout different cleft care centers indicates the need for further study of the subject.

Many studies state that pre-grafting orthodontics provide a higher success rate for SABG.[6–8] The argument being that orthodontic preparation provides the surgeon with wider access to the cleft site and easier surgical maneuvers, as well as alignment of the teeth adjacent to the cleft site and alignment of the cleft segments. However, pre-grafting expansion also produces a wider defect with higher graft demand and therefore longer time for graft consolidation.[9–12]

Despite pre-grafting orthodontics somewhat dominating in the sense of popularity worldwide, the advocates of post-grafting orthodontics present a

solid argument for their case.[13–15] The central concept of the protocol is related to the findings of Feichtinger et al. Feichtinger's group studied graft resorption over a three-year period post-operative in secondary alveolar bone graft cases. The researchers found evidence of a much higher rate (up to 95.2%) of graft loss when performed in the permanent dentition, i.e. when there was no tooth to erupt within the grafted bone. Their findings pointed to the significance of physiological stimulation of the graft which, in mixed dentition, is provided by the eruption of teeth into the grafted bone. Advocates of post-grafting orthodontics claim that the orthodontic forces induce dynamic load on the graft during the healing period thus improving the healing by providing physiologic stimulation of the graft.16 Grafting first would also provide a narrower cleft site requiring a smaller amount of graft and, theoretically, a shorter time for graft replacement.

If such "physiological stimulation" and graft maintenance is achievable by orthodontic treatment, the dynamic of the collaborative orthodontic/surgical effort to gain maxillary arch continuity and alveolar graft volume would lead to a clearer "optimal personalized grafting age". Therefore, in light of what is known today, would pre-grafting orthodontics better prepare the site for the graft? Or would post-grafting orthodontics aid in consolidation and maintenance of the graft? A lack of consensus was viewed as an opportunity for research regarding the proper timing of secondary alveolar bone grafting in relation to the orthodontic treatment.

II. METHODS

Eligibility Criteria

Studies were selected according to the criteria elaborated below.

A. Inclusion Criteria:

a) Study designs: Randomized clinical trials, case-control studies, and retrospective studies studying the success of secondary alveolar grafts before and/or after orthodontic treatment were included.

b) Participants: Studies examining cleft lip and palate patients with alveolar clefts at age of secondary alveolar bone grafting were included.

c) Intervention: Secondary alveolar bone grafting procedures with orthodontic preparation.

d) Comparator: Secondary alveolar bone grafting with subsequent orthodontic treatment.

e) Type of outcome measured: Success of alveolar graft.

Information Sources

Search was applied to PubMed, Wiley, Scopus, Cochrane and ScienceDirect. The search was limited to English journals and human subjects. To ensure literature saturation, the reference lists of included studies or relevant reviews identified through the search were scanned. A hand search was also performed in most relevant journals to topic.

Search Strategy

Both qualitative and quantitative studies were sought. No study design, date or language limits were imposed on the search. PubMed, Wiley, Scopus, Cochrane and ScienceDirect were searched. The specific search strategies were created by a reviewer with expertise in systematic review searching. PROSPERO was searched for ongoing or recently completed systematic reviews. As relevant studies were identified, reviewers checked for additional relevant cited and citing articles. The search was updated toward the end of the review, after being validated to ensure that the PubMed strategy retrieves a high proportion of eligible studies found through any means but indexed in PubMed. Table (1) shows details of search terms used.

Study Selection

The review authors independently screened the titles and abstracts yielded by the search against the inclusion criteria. Review authors screened the full text reports and decided whether these meet the inclusion criteria. Disagreements were resolved through discussion. The reasons for excluding trials were recorded. Table (2) and Table (3) show details of excluded studies and included studies with reasons for exclusion.

Data Collection Process

A data extraction sheet customized to the data of the included studies was developed. A reviewer extracted data from the included studies and the second author the extracted data for mistakes. Disagreements were discussed between the two authors and, when no resolution was possible, a third author was given the decision.

Data Items

Data was extracted from each included study on; (1) Demographic data (including age, gender, number of participants) (2) Materials and methods (including type of graft, orthodontics performed, records taken) (3) results and conclusions (including baseline characteristics, statistical tests, type of measurements, and conclusion).

Risk of Bias in Individual Studies

Judgements on risk of bias were made independently by two review authors based on the criteria for judging the risk of bias (Table 8.5.c in the Cochrane Handbook Higgins 2011)[17]. Disagreements were resolved first by discussion and then by consulting a third author for arbitration. For CCTs, MINORS tool for risk of bias assessment was used,[18] which covers; clarity of aim stated, inclusion of consecutive patients, prospective data collection, endpoints appropriate to the aim, unbiased assessment of the study endpoint, follow-up period appropriate to the aim of the study, loss to follow up less than 5%, prospective calculation of the study size, an adequate control group, contemporary group, baseline equivalence of groups, and adequate statistical analysis. SIGN risk of bias assessment was used for the 2 retrospective studies. Tables (4), (5), and (6) show the risk of bias assessments.

Summary Measures

Different measures for graft success were found throughout the studies including (graft volume, density, residual defect, Garib scale[19], need for revision). The diversity of measures was a limitation to the capability of performing meta-analyses.

III. RESULTS

Study Selection

The results of the search and screening are summarized in a prisma flow chart below. Search yielded a total of 2565 studies. Hand search yielded 35 papers. After Duplicate removal (2600 – 75) = 2525. After Initial screening with title and abstract (2523-2446) = 77. After full text screening (77 – 73) = 6 studies for qualitative analysis.

Study Characteristics

Of the 6 studies included, 2 focused on the effects of pre-grafting orthodontics on the grafting, 2 focused on the effects of post-grafting orthodontics on the grafting, and the final 2 compared both pre- and post-grafting orthodontics. For each, the study characteristics are discussed. A data extraction sheet was created to summarize these findings in tables (7), (8), (9).

All studies were performed on UCLP patients. The two studies on post-grafting orthodontics were performed at the age of late secondary alveolar bone grafting. The intervention was orthodontic treatment in the form of slow maxillary expansion, in the Uzel study, and BAMP, in the Gomes study.

There was a wide variety of outcomes used across the 6 studies with limited overlap. Outcomes measured were Alveolar bone defect, central incisor inclination, central incisor rotation, ABG Volume, residual defect, ABG Density, Garib scale, revision rates.

Risk of Bias Within Studies

Seen in Table (4) Table (5), and Table (6).

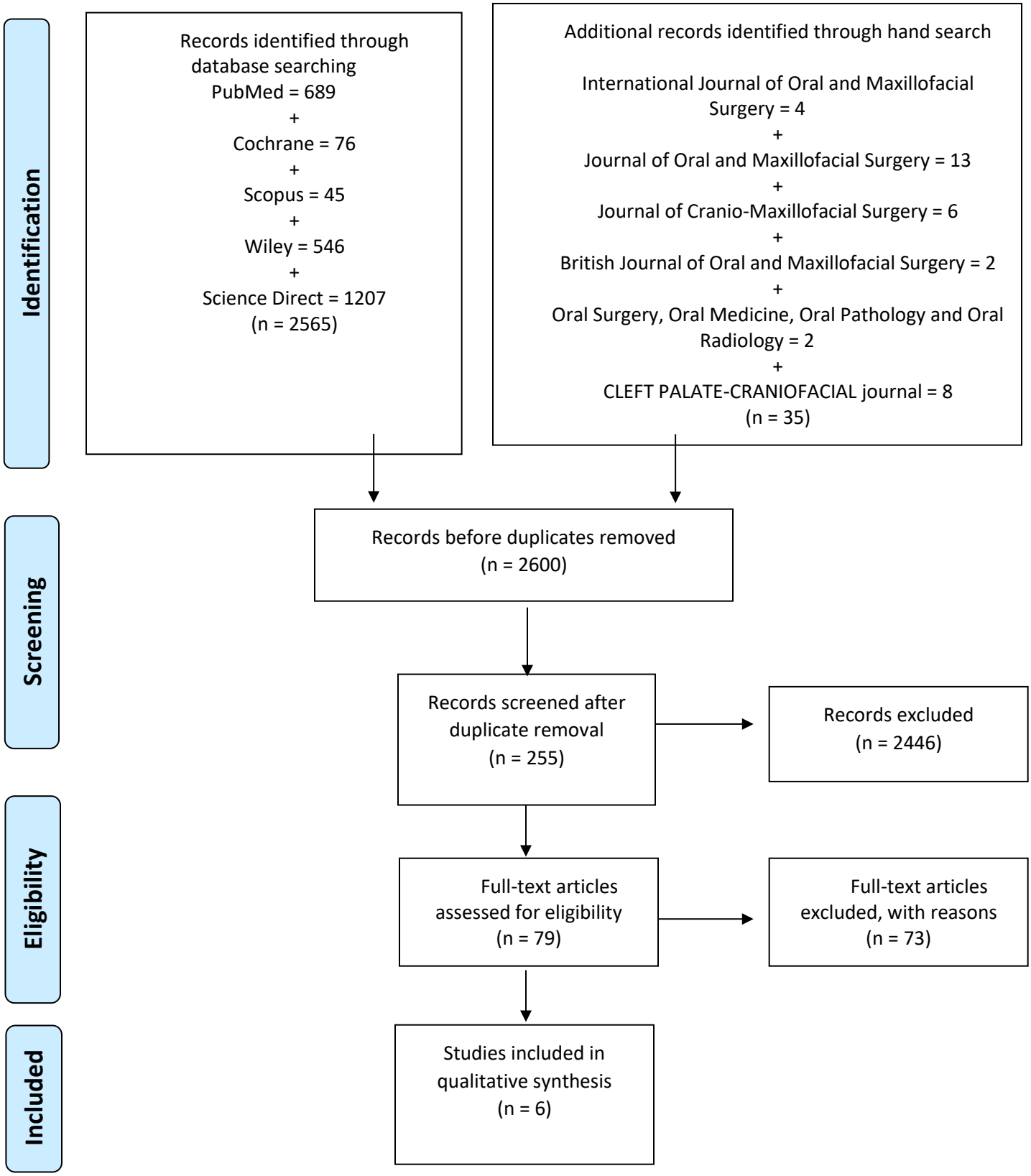
Results of Individual Studies

Of the studies included, 2 studies focused on the effects of pre-grafting orthodontics on the grafting and 2 studies focused on the effects of post-grafting orthodontics on the grafting. The final 2 retrospective studies compared both pre- and post-grafting. Three tables were made to summarize the measurements, results, and conclusions of the studies. Table (7,8,9) show measurements, results and conclusions of the studies.

Synthesis of Results

Since the included studies exhibited a wide variety of study designs and outcome measures, it was decided that focus on describing their findings, results, conclusions, and on the qualitative analysis of the results rather than meta-analysis is best.

PRISMA FLOW CHART



IV. DISCUSSION

Controversy in evidence is the strongest driver of reviews, this was the main fuel for the study. As far as this author's knowledge, there is no consensus to date on the ideal protocol for collaboration between orthodontists and surgeons in the management of alveolar clefts. We therefore aimed at gathering the available greatest number of RCTs, the strongest level of evidence as far as clinical research and attempt to answer the questions about the timing of alveolar cleft graft success and its relation to orthodontic expansion.

Summary of Evidence

Five research databases were used, namely, PubMed, Wiley, Scopus, Cochrane and ScienceDirect, to screen for papers discussing the relation between SABG success and timing of orthodontic treatment, then hand search was done in the main relevant journals. 2600 papers were screened leaving 79 papers for final screening. Only studies that included two groups, a control, and an intervention group, and assessed the success of alveolar bone grafts and its relevance to the timing of orthodontic expansion were included. Eventually, the decision was made to include only 6 of these papers. Of the 6 studies deemed relevant, only one was an RCT, 2 were retrospective and the rest were CCTs. The 6 studies were performed on patients in the age of "Secondary alveolar bone grafting" with autogenous bone from the anterior iliac crest. The 6 studies addressed the "success" of alveolar bone grafting using several assessment tools.

The paper by Chang et al, an RCT, included 22 cases divided into 2 groups (10 intervention and 12 Control, with the intervention being the pre-grafting orthodontic treatment) and assessed graft success using Computed tomography imaging pre-operatively and 6 month post-operatively. The images were then used to assess pre-op alveolar bone defects, central incisor inclination and rotation near the cleft site, alveolar bone graft volume, and residual alveolar defect. The study by Uzel et al., was a CCT including 30 patients divided equally into 2 groups with the intervention being post-grafting orthodontics. Uzel's group had the most thorough follow ups of the studies where they performed CBCTs at 1 week, 6 months and 12 months. They then compared Alveolar bone graft volume and density.

The study by Gomes et al was a CCT including 50 patients divided into 2 groups (26 control and 24 intervention, with intervention being the post-grafting orthodontics in the form of bone anchored maxillary protraction). They performed CBCTs at 6 months and 12 months post-grafting in the control group. In the intervention group CBCTs were performed 6 months post-grafting, before BAMP and 18 months post-BAMP. They assessed the graft success using the Garib scale.

The study by Montian et al was a CCT including 101 patients divided into 2 groups (67 control and 34 interventions, with the intervention being pre-grafting orthodontics). There was no clear statement of the follow up periods, but the research focused on assessing success of the grafts based on revision rates.

The final two studies by liao[20] and Lowry[21] had the lowest level of evidence as they are retrospective studies. They both presented evidence showing how post-grafting orthodontics could possibly increase the success of SABG. However, the study by Liao was lacking in detail on timing and specifics of the orthodontic treatment. The study by Lowry was more focused on the grafting and was set up better regarding analysis of graft success. The evidence showed by Lowry supports the post-grafting expansion and early grafting concepts.

A qualitative comparison of the results, conclusions, and level of evidence of the studies by Chang et al and Montian et al is the most relevant to pre-grafting orthodontics. Both researches presented contradicting conclusions as Chang et al concluded that pre-grafting orthodontics

produced an improved result in SABG, while Montian et al concluded that there was no evidence of difference in revision rates between orthodontically prepared and non-prepared cases of SABG. A quick look at the number of included cases would show a stronger case for the Montian study, however, a deeper comparison of the presented evidence would show that the claim by Chang et al was more solid. The study by Chang et al measured multiple parameters of success more sophisticated and relevant to the actual assessment of success of the graft, such as the residual defect and the alveolar bone graft volume, whereas Montian et al only assessed the "need for revision" which is a very subjective matter in alveolar cleft cases, as well as being subject to patient choice. Montian also failed to specify timing of follow ups while Chang mentioned a 6 month follow up using CT which arguably is sufficient to assess short term success of the graft but arguably not enough to assess long term success. Chang was also an RCT which compared to Montian, a CCT, is a stronger level of evidence. The other 2 researches were more focused on the post-grafting orthodontics and their effects on the grafting. Uzel et al's study concluded that in cases of UCLP, post-grafting expansion might provide stimulation to bone grafts and therefore could be a suitable option for late secondary alveolar bone grafting. Uzel's study looked at both bone volume and density on CBCTs which seems to be a relevant manner to assess the effect of loading forces on the graft. The timing of follow ups also seems suitable. Uzel's study provides good ground-work on which future studies could be used to assess the concept of stimulation of the graft. The study by Gomes et al concluded that there was no deleterious effect of the heavy elastics of the BAMP on the graft.

Limitations

Limitations of this study include the lack of studies in the literature, and the inability to find enough RCTs, as well as the diversity of the measure used to assess success of the grafts.

V. CONCLUSION

The qualitative analysis of the results suggests that multiple areas of research could be opened up by the conclusions of the 4 researches. The evidence they provide, although significant in the sense of opening doors for future research, is insufficient to draw a consensus for the effect of timing of alveolar bone grafting and orthodontic treatment.

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