Cancellous Bone Versus Tricalcium Phosphate (TCP) in Bone Grafting: A Literature Review And Case Report of Alveolar Bone Grafting

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Background
Cancellous bone is commonly used as bone graft in various plastic surgery procedure due to its osteogenesis capability and osteoconductivity. Its several disadvantages include pain, longer duration of surgery, and longer length of stay. The use of synthetic bone graft can be another solution to cover the weakness of autogenous bone graft. The synthetic materials were made by using tissue engineering so that the materials have similar properties as human bone. Tricalcium phosphate is a synthetic material that is frequently used during surgery. Its capability of substituting cancellous bone graft in alveolar bone grafting is being studied.

Methods
The paper focused on comparing the utility of autograft materials and tricalcium phosphate in various bone grafting procedure. The literature searching was conducted by searching the databases of PubMed during February 2017. The inputted keywords included ‘bone graft OR bone grafting’ AND ‘cancellous bone OR iliac crest OR tibia’ AND ‘tricalcium phosphate OR tri-calcium phosphate’. The inclusion criteria were any kind of research paper that compared the utility of TCP synthetic graft and autograft, any published paper between 2010-2017, and English written articles. The exclusion criteria included case report only, discussion, prevalence study, and editorial.

Results
There were 139 of records identified through database searching. After doing careful selection, 8 articles were obtained to be reviewed by the authors (Table 1). Those included 3 articles that used TCP graft in alveolar bone graft, 3 articles used TCP graft in orthopedic procedure, and 2 articles used TCP graft in spinal procedure, as seen in Table 1.

Table 1. Extracted Data from the Literature Regarding Usage of TCP graft on surgery

<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
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<th>Subjects (N)</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
<td>Ruiter A et al (2015)</td>
<td>Alveolar Bone Graft</td>
<td>Goat (20)</td>
<td>Autograft graft (incisive crest)</td>
<td>From surgical, orthodontic, histologic, and radiologic standpoint that in the repair of alveolar clefts created in goats, the bone substitute TCP (CortX) is at least as effective as autogenous iliac crest bone.</td>
</tr>
<tr>
<td>2</td>
<td>Ruiter A et al (2015)</td>
<td>Alveolar Bone Graft</td>
<td>Human (7)</td>
<td>Bone volume acquired was satisfactory. Average bone volume percentage of 73% ± 6% compared with the original cleft volume.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Xu N et al (2010)</td>
<td>Alveolar Bone Graft</td>
<td>Rat (60)</td>
<td>Natural bone cancellous bone particles (Bio-Oss) and no graft</td>
<td>TCP had better osteoconductive potential and biomechanical properties and induces less root resorption compared with Bio-Oss grafting and naturally recovered extraction site.</td>
</tr>
<tr>
<td>5</td>
<td>Johannes et al (2013)</td>
<td>Bone Grafting in Segmental Bone Defect</td>
<td>Sheep (12)</td>
<td>Autograft graft, medical grade polylactide graft.</td>
<td>The highest amounts of bone neomodification with highest torsional moment values were observed in the autograft group and the lowest in the medical grade polylactide and tricalcium phosphate composite group.</td>
</tr>
<tr>
<td>6</td>
<td>Martinkevich et al (2015)</td>
<td>Cancellous Bone Grafting</td>
<td>Human (12)</td>
<td>Autograft graft (incisive crest)</td>
<td>At six months the data showed that the ostotomy had been compressed by a mean 1.97 mm more in the HATCP group than in the autograft group. Migration of the CGT grafted with HATCP stabilized at six months rather than six weeks with autograft.</td>
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<td>7</td>
<td>Delai et al (2015)</td>
<td>Spine Fusion Surgery</td>
<td>Goat (5)</td>
<td>Ilac crest autograft, fresh-frozen allograft, TCP combined with local autograft</td>
<td>TCP is capable of achieving fusion at a similar rate to iliac crest autograft in posterolateral fusions, while almost completely resisting within 36 weeks. Despite the lower fusion volumes, the TCP is a promising alternative despite the disadvantages of autograft and allograft.</td>
</tr>
<tr>
<td>8</td>
<td>Yamagata et al (2015)</td>
<td>Anterior Cervical Discectomy and Fusion</td>
<td>Human (100)</td>
<td>Autograft graft (incisive crest)</td>
<td>Significant neurological recovery after surgery was obtained in both groups. Cage subsidence was noted in 14 of 32 cages (43.8 %) in the autograft group and 12 of 64 cages (18.8 %) in the TCP group. A total of 68 cages (37.7 %) in the autograft group showed osseous or partial union, and 58 cages (38.6 %) in the TCP group showed osseous or partial union by 2 years after surgery. There were no significant differences in cage subsidence and the bone fusing rate between the two groups.</td>
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Case Report
The patient had complete unilateral cleft lip and palate. The cleft lip and palate were repaired at 2 months and 2 years respectively. A residual alveolar cleft was present and periodically evaluated. Patient had 6 months orthodontic treatment and evaluation prior alveolar bone grafting. Secondary alveolar bone graft was done at 9 years. The alveolar bone grafting procedure lasted for 3 hours. The length of stay for post-operative care was 7 days. Patient had moderate mobilization in 2 weeks after surgery. Alveolar bone graft using autograft.

Discussion
TCP graft has been widely used in various kinds of bone grafting procedure. Moreover, the outcomes of TCP graft usage in alveolar bone graft procedure in human and animal experiments are good in quality. The alveolar graft in RSCM gives superior results although some disadvantages such as pain and scar in the donor site, long duration of stay for post-operative care, and longer time to recover remains exist. TCP graft offers excellent results and overcomes the disadvantages which may benefit the patient and lower the morbidity.

Conclusion
1. TCP graft can be used as substitution for autograft in particular clinical conditions and surgical methods.
2. The use of TCP graft may reduce the morbidity of the patients, shorten the duration of surgery, and limit the cost to be paid.

Reference

FIGURE 1. Panoramic photographs (A) Pre-alveolar bone graft. Notice there is no canine eruption and left incisor agenesis; (B) 4 years post-alveolar bone grafting. Notice the excellent canine eruption replace the agenesis second incisor. Notice there is bone tissue at the cemento-enamel junction adjacent to cleft side (Chelsea type A). Interdental septum height close to normal (Bergland scale 1: Resolution <25%)
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TCP graft has been widely used in various kinds of bone grafting procedure. Moreover, the outcomes of TCP graft in alveolar bone graft procedure in human and animal experiments are good in quality. The alveolar bone graft in RSCM gives superior results although some disadvantages such as pain and scar in the donor site, long duration of stay for post-operative care, and longer time to recover remains exist. TCP graft offers excellent results and overcome the disadvantages which may benefit the patient and lower the morbidity.

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<td>1</td>
<td>Butler A et al (2015)</td>
<td>Alveolar Bone Graft</td>
<td>Goat (30)</td>
<td>Autograft (TCP cured)</td>
<td>Surgical, orthodontic, histologic, and radiologic standpoints that in the repair of alveolar clefts created in goats, the bone substitute b-TCP (Curobond) is as least as effective as autologous iliac crest bone.</td>
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<td>3</td>
<td>Ru N et al (2016)</td>
<td>Alveolar Bone Graft</td>
<td>Rat (60)</td>
<td>Natural bone (cancellous bone, particles (Bio-Oss), and infected)</td>
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<td>Martinacovitch P et al (2016)</td>
<td>Cancellous Bone Grafting Autograft</td>
<td>Human (11)</td>
<td>Autograft (TCP cured)</td>
<td>At six months the data showed that the osteotomy had been compressed by a mean 1.97 mm more in the HATCP group than in the autograft group. Migration of the CLO graft with HATCP stabilized at six months rather than at six weeks with autograft.</td>
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<td>TCP is capable of achieving fusion at a similar rate to iliac crest autograft in posteroaxial fusion, while almost completely resolving within 16 weeks. Despite the lower fusion volume, the TCP is a promising alternative despite the disadvantages of autograft and allograft.</td>
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<td>Significant neurological recovery after surgery was obtained in both groups. Cage subsidence was noted in 44 of 72 cages (60.4%) in the autograft group and 12 of 64 cages (18.8%) in the TCP group. A total of 66 cages (91.7%) in the autograft group showed motion or partial union, and 58 cages (90.5%) in the TCP group showed motion or partial union by 2 years after surgery. There were no significant differences in cage subsidence and the bone fusion rate between the two groups.</td>
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