Comparison of Fusion Rate Between Autogenous Tricortical Iliac Crest Bone Graft and Hydroxyapatite Block Graft in Anterior Cervical Discectomy and Fusion Surgery

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ABSTRACT

Objective: To compare the fusion rate between autogenous tricortical iliac crest bone graft and hydroxyapatite block graft in anterior cervical discectomy and fusion (ACDF) surgery. ***Methodology:*** Retrospective review of cases that underwent ACDF surgery between 2005 and 2008. They were divided into two groups based on the graft material used. Assessment of fusion at 6 months post-surgery was carried out based on the static lateral cervical radiograph. ***Results:*** 32 cases were reviewed; 16 in each arm. There were 29 discectomies performed in the hydroxyapatite group as compared to 22 in the iliac crest group. 18 levels in the hydrxyapatite group showed radiological fusion while in the iliac crest group there were 21 levels fused. Seven patients had donor site pain. ***Conclusion:*** The fusion rate for autogenous tricortical iliac crest bone graft in anterior cervical discectomy and fusion surgery was 95%, a more superior fusion rate than that of hydroxyapatite block graft which was 62.1%.

Key Words:
Iliac Crest Bone Graft, Hydroxyapatite, Cervical Discectomy

INTRODUCTION

One of the goals of anterior cervical discectomy and fusion (ACDF) surgery is to achieve solid fusion at the operated cervical levels. Different sources of bone graft have been used to achieve this goal. Each of the graft sources has a different rate of fusion and has its own advantages and disadvantages.

Autogenous bone graft is one of the sources of graft used in this procedure. It is commonly harvested from the anterior iliac crest. Although it is regarded as the gold standard source of graft in ACDF, it carries the disadvantage of potential donor site morbidity [1]. To eliminate complications and pitfalls associated with autologous donor site harvesting, allograft and various bone substitutes have been used for this procedure. Among the bone substitutes, hydroxyapatite had been extensively studied for its usage in ACDF surgery [2-6].

In this study, we will compare the fusion rate between the cases that used autogenous tricortical iliac crest bone grafts and those that used hydroxyapatite block grafts in anterior cervical discectomy and fusion surgery.

MATERIALS AND METHODS

We retrospectively reviewed the records of patients who underwent anterior cervical discectomy and fusion (ACDF) surgery in our institution between 2005 and 2008. The samples were divided according to the type of bone grafts that were used. Before 2007, we used hydroxyappatite blocks as the source of the bone graft but since 2007, we've used autogenous tricortical iliac crest bone grafts instead.

We included those cases that underwent one- and two-level surgery only. The cases had to have complete records and follow up lateral cervical radiographs -up to at least 6 months post-surgery. We excluded those cases with more than 2 levels of discectomies and those that underwent corpectomy.

The patients underwent surgery via standard anterior approach to the cervical spine. Levels operated were confirmed with image intensifier before discectomies were carried out. For the hydroxyappatite bone graft group, the synthetic bone grafts were sized and shaped accordingly before being inserted into the prepared disc spaces. For the tricortical iliac crest graft group, the bone grafts were harvested from the patients' iliac crest using an oscillating bone saw. Hemostasis was secured by coagulation and bone wax before closure in the standard manner. Following bone graft insertion, the operated levels were stabilized with anterior cervical plates.

Subject data collected included demographic profiles, cervical levels operated, type of graft used and evidence of fusion. In the tricortical iliac crest graft group, we also documented the donor site morbidity. If pain was the morbidity, then visual analogue score was used to grade the severity of pain.

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Table I: Cervical levels operated

Level of surgery	Hydroxyapatite Group	Iliac Crest Group
C4-C5	0	1
C5-C6	3	3
C6-C7	0	6
C4-C5 & C5-C6	8	3
C5-C6 & C6-C7	5	3
Total	16	16

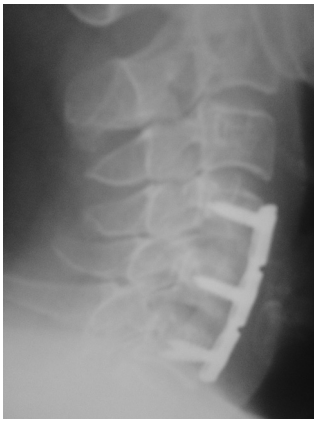

Fig. 1: Good radiological union seen at C4-C5 and C5-C6 levels as bridging trabeculae are across all graft-host bone interfaces.

Fig. 2: Poor union at C5-C6 whereby lucent line is clearly seen at the interface between the graft and inferior end plate of C5.

The assessment of fusion was based on the lateral cervical radiograph taken 6 months post-surgery. Fusion was determined by the radiographic observation of bridging trabeculae across all graft-host bone interfaces, the absence of a radiolucent gap between the graft and the endplate [7] and, when no radiolucencies were evident, encompassing the screws [8] (Figs 1 & 2).

The data were analysed using the SPSS program. The difference of fusion rate between these two groups was tested using the chi-square test whereby a p value of < 0.05 was considered significant.

RESULTS

There were 32 cases that met the inclusion criteria. They were separated into two groups of 16 cases each; the cases wherein hydroxyappatite blocks were used as bone grafts (hydroxyappatite group) and those using an autologous tricortical iliac crest bone graft (iliac crest group). There were 51 levels of fusion involved on these patients. More discectomies were performed in the hydroxyappatite group (29 levels) as compared to the iliac crest group (22 levels) simply because there were 13 cases of two-level discectomies in the hydroxyappatite group as compared to only 6 two-level discectomies in the iliac crest group.

The mean age of the patients in the iliac crest group was 51.3 years old (range, 33 to 67y) while in the hydroxyappatite group the mean age was 43.9 years old (range, 30 to 53y). There were 13 males in the iliac crest group as compared to 8 males in the hydroxyappatite group. Levels operated upon are described in Table I. Out of 29 levels in the hydroxyappatite group, 18 levels showed good fusion. This brings the radiological union rate of 62.1% in this group. For the iliac crest group, 21 out of 22 levels were fused which amounts to a 95% union rate. This difference was statistically significant (p value < 0.05).

If only cases of two levels fusion were considered, then there were 26 levels in hydroxyappatite group and 12 levels in iliac crest group involved. Calculated fusion rate in these subgroups of patients was 69.2% in the hydroxyappatite group and 100% in the iliac crest group. This difference was statistically significant (p value < 0.05).

Seven out of 16 patients (43.8%)complained of donor site pain in the iliac crest group at 6 months post-surgery. All except one patient had only mild pain (visual analogue pain score <4). One patient, a 60 year old man who had a degenerative disc disease at C4-C5 and C5-C6 levels with radiculopathic symptoms, had a pain score of 7. The operated levels showed good fusion. Apart from donor site pain, this patient also complained of persistent neck pain with a pain score of 7 as well. Another patient had donor site pain also had superficial wound infection at the donor site (6.3% superficial infection rate). This infection was successfully treated with antibiotic and wound dressing. No other donor site morbidity was documented.

DISCUSSION

In this study, we found that the fusion rate of ACDF procedures using autogenous tricortical iliac crest bone graft is far superior to the fusion rate of procedures using the hydroxyapatite block bone graft (95% compared to 62.1%). This high fusion rate with autograft demonstrated good correlation between its theoretical advantages and the clinical result. Among the advantages of tricortical iliac crest autograft is its superior osteogenic, osteoinductive and osteoconductive properties, and the structural integrity whereby it is incorporated more rapidly and is less likely to collapse. It has successful radiological and clinical results with long term follow-up and is regarded as the gold standard for anterior cervical interbody fusion [1].

Among many bone substitutes available, hydroxyapatite is one of the most extensively studied used in ACDF procedures [2-6]. We used the hydroxyapatite block for intended fusion in the early series (before 2007). Several studies found that the fusion rate was as high as 89% to 100% [2-4]. With this high rate of fusion together with the elimination of donor site morbidity with autograft, the authors recommended that it could effectively replace autograft in ACDF surgery. Furthermore hydroxyapatite had better histocompatibility when compared to allograft.

It should be noted however that there are also studies that demonstrated poor results with hydroxyapatite [5,6]. As a bone substitute, hydroxyapatite has poor osteogenic and osteoinductive properties, inferior structural integrity in axial loading as compared to autograft and allograft and structural integrity problems [5]. McConnel et al compared ACDF cases that received either hydroxyapatite or tricortical iliac crest as the sources of graft. They found more graft fragmentation in the hydroxyapatite group (89% as compared to 11% with autograft) as well as more graft settling (50% versus 11%) [5]. Ito *et al* reported 7 cases with morbidity related to hydroxyapatite usage [6]. These cases had radiolucent clear zone around the spacer and experienced severe neck pain. Four had fracture of the hydroxyapatite spacer and two had compression of the spinal cord by retropulsed fragments of broken hydroxyapatite spacers. In our series, we found more cases with radiolucent lines between the graft bone interfaces in the hydroxyapatite group. We also had one case with bent cervical plate with the usage of hydroxyapatite block. However none of the cases needed to be re-operated.

We selected only one- and two-levels ACDF cases in our series. We excluded cases of more than two levels. Multilevel ACDF is associated with lower rate of fusion [9,10]. This has been attributed to an increased number of grafts and interfaces that must consolidate and increased stresses on the multiple graft sites [7].

We instrumented all of our cases with anterior cervical plate fixation. Instrumentation has been found to increase the fusion rates for one- and two-level ACDF [11,12]. Caspar et al also found that instrumentation reduced the re-operation rate. The application of rigid plating results in improved fusion rates because of added stability/ [7]. It is a safe procedure with no significant increase in complication rates [7].

Although autograft has been regarded as the gold standard graft material, it has the disadvantages of donor site morbidity. Among the morbidities reported are injury to the lateral femoral cutaneous nerve, painful hematoma, superficial or deep wound infections and avulsion of the anterior superior iliac spine. Another disadvantage is that this procedure can increase operative time and blood loss. Two donor site morbidities were shown in our study. Out of our 16 patients that underwent iliac crest harvesting procedures, 7 complained of donor site pain (43.8%) and one had superficial donor site infection (6.3%). Only one patient in our series had more than mild pain. In a study by Gore and Sepic, of the 36 patients receiving iliac crest harvests, only 7 had harvest site complications, 5 experienced hematomas and 2 had wound infections [13]. Schnee et al reported a 6.3% rate of wound infections and dehiscence among 144 patients who had iliac crest harvest [14]. Other morbidities included were 2 hematomas and one anterosuperior iliac spine avulsion fracture with lateral femoral cutaneous nerve damage. Four (2.8%) of their patients had pain persisting beyond 3 months postoperative. Statistically significant risk factors for persistent pain and complications found by Schnee et al were obesity and female gender.

The assessment of fusion in our study is based on the static lateral cervical radiograph taken at 6 months post-surgery. This assessment could have been improved had dynamic lateral views and CT scans been used [5,7]. Dynamic radiographs were not used in our study because their availability was inconsistent among the cases. In flexion-extension lateral radiographs, fusion is judged by the absence of motion between spinous processes. CT scan gives more accurate evaluation of fusion with better images at the graft-end plate interface.

Another limitation in our study was that the two groups were heterogenous in their demographic profile. Race distributions were unequal among the groups. More females and younger patients were included in the hydroxyapatite group. Although the patients in the hydroxyapatite group were younger, they had a lower fusion rate. We also noted the bias of the difference in the number of levels fused between the two groups. 13 two-level ACDF's were performed in the hydroxyapatite group but there were only 6 in the iliac crest group. When we compare the fusion rate between these two subgroups however, the iliac crest subgroup still had statistically significant superiority to the hydroxyapatite subgroup.

CONCLUSION

The fusion rate for autogenous tricortical iliac crest bone graft in anterior cervical discectomy and fusion surgery was 95%, superior to that of the hydroxyapatite block which was 62.1%. With relatively minimum donor site morbidity, autogenous tricortical iliac crest bone graft remains the better option of graft material in ACDF surgery.

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