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Review Article

The Use of Allograft in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis: A Systematic Review and Meta-analysis

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Abstract

Posterior spinal instrumentation and fusion (PSIF), with bone grafting, is the most accepted surgical treatment in Adolescent Idiopathic Scoliosis (AIS). Many different options are used as a bone graft, but the difference in the rate of infection and pseudoarthrosis has not been fully documented. This study aimed to compare the outcomes of the use of the allograft in adolescent idiopathic scoliosis (AIS) compared to no graft or autograft alone. A literature search was performed in PubMed, EMBASE, CINAHL, CENTRAL, and Web of Science, using the set inclusion/extrusion criteria. A meta-analysis was performed on select articles with RevMan TM (Review Manager 5) software. Six studies were included for each outcome. In total, the odds of getting a pseudoarthrosis if allograft was used were 1.1 (95% CI: 0.41, 3.09) times the odds of getting a pseudoarthrosis if allograft was not used, which was not statistically significant (p = 0.81). The odds of getting an infection if allograft was used were 1.2 (95% CI: 0.33, 4.72) times the odds of getting an infection if allograft was not used, which was not statistically significant (p = 0.74). There is limited evidence to either strongly support using, or not using allograft bone graft for posterior spinal fusion in cases of AIS when compared to the use of autograft alone or no graft.

Keywords: Adolescent Idiopathic Scoliosis; Posterior Spinal Instrumentation; Fusion; Allograft; Autograft; Pseudoarthrosis; Infection

Introduction

The most accepted and routinely performed surgical procedure for Adolescent Idiopathic Scoliosis (AIS) is posterior spinal fusion (PSF), with bone grafting to aid fusion [1,2]. The goal of surgery is to halt the progression of the curve by obtaining fusion of the involved vertebral segments. Instrumentation is a method to stabilize the spine, in an improved position, while fusion occurs (Figure 1). Bone grafting is an addition of supplemental bone to the decorticated cortical bone to aid fusion, which in theory is thought to decrease the time to union/fusion, increase the rate of fusion and strengthen the fusion.

Figure 1: 15 year oldMale with AIS, Cobb angle of 74degrees,pre-and6 monthspost-operative.

Pseudarthrosis and infection, although rare, can cause significant problems to patients and health systems leading to increased morbidity, and health care costs [1,3]. This can often result in the need for reoperation [4-6]. Recent literature has reported that the rate of infection in AIS patients undergoing PSF ranged between 0.9% - 3% while the rate of pseudoarthrosis ranged between 0.9 to 1.8% [7,8]. To decrease the rate of pseudarthrosis, an autogenous bone graft is considered the standard of care [1,9]. To gain more graft than what is available from the surgical site, surgeons traditionally harvested iliac crest bone graft (ICBG), but studies showed there is significant morbidity (prolonged pain and limp, increased bleeding, scar, and damage to the lateral femoral cutaneous nerve) associate with it, thereby fallen out of favor in recent years [10-14]. Many different options are now used, including local autograft, (spinous processes, inferior articular processes), irradiated cancellous allograft, and bone graft substitutes. Autograft and allograft are two common adjuncts. The potential benefit of the allograft is that it is readily available, simple to add, and may decrease rates of pseudoarthrosis. Compared to harvesting iliac crest bone, it has less morbidity, less blood loss, and less surgical time. Potential limitations may include higher rates of infection, added expenses and may not decrease pseudoarthrosis rates [8].

The purpose of this study was to conduct a systematic review of the literature to analyze and compare the outcomes of the use of allograft in cases of adolescent idiopathic scoliosis in terms of infection and pseudoarthrosis.

Methodology

This systematic review and meta-analysis was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines. We searched Medline (PubMed), EMBASE, CINAHL, CENTRAL, and Web of Science (Knowledge). Keywords and MeSH terms are included in table 1. Surgery and the outcome measures were not used in the search, to increase the yield of potentially relevant publications. All citations with abstracts were exported into RefWorks for each reviewer, and subfolders were created to track and record excluded studies (ProQuest, Ann Arbor, MI, www.refworks.com) [15]. Within RefWorks, duplicates were identified and excluded. A title search, followed by an abstract screen resulted in further exclusion.

	Concept 1 Allograft*	Concept 2 And Scolios*	Concept 3 And Adolescen*
Or	Homologous Transplant*	Spine Curvature*	Child*
Or	Allogeneic Transplant*	Spinal Deform*	Pediatric*
Or	Homograft*	Spinal Malform*	Paediatric*
Or	Bone Graft*	Spine Deform*	
Or	Bone Transplant*	Spine Malform*	
Or	Allotransplant*	Spinal Curvature*	

Table 1

Inclusion criteria

Adolescent idiopathic scoliosis, use of allograft with or without local autograft, any type of instrumentation, posterior approach alone, English literature, comparison group with local autograft alone or ICBG, infection, and pseudoarthrosis reported, and a minimum 2-year follow-up.

Exclusion criteria

Adults (Surgery after age 25), non-adolescent, non-idiopathic scoliosis (e.g., early-onset, congenital, neuromuscular, syndromic, dystrophies), use of rib/iliac autograft or bone substitutes, animal studies or biomechanical Studies, disc arthroplasty/replacement, trauma, tumor, spondylolysis/spondylolisthesis, anterior approach (thoracotomy, thoracoscopic, thoracoabdominal, direct lateral lumbar), thoracoplasty and/or rib autograft, non-English Studies, review articles/editorials/commentaries, less than 2 years of follow-up.

Search results and screening

Two reviewers performed screening, data abstraction, critical appraisal, and manuscript preparation. The exclusion flowcharts for each reviewer are seen in figure 2. In total from the five databases, 948 studies were identified. There were 391 duplicates. Reviewer 1 excluded 391 studies based on the title alone, while reviewer 2 excluded 405 based on the titles. Reviewer 1 eliminated 135 studies based on their abstracts, while reviewer 2 eliminated 119 studies. Reviewer 1 screened 31 full articles and eliminated 25 articles. Reviewer 2 reviewed 33 full articles and eliminated 27. Both reviewers had 6 articles remaining. These were the same 6 articles.

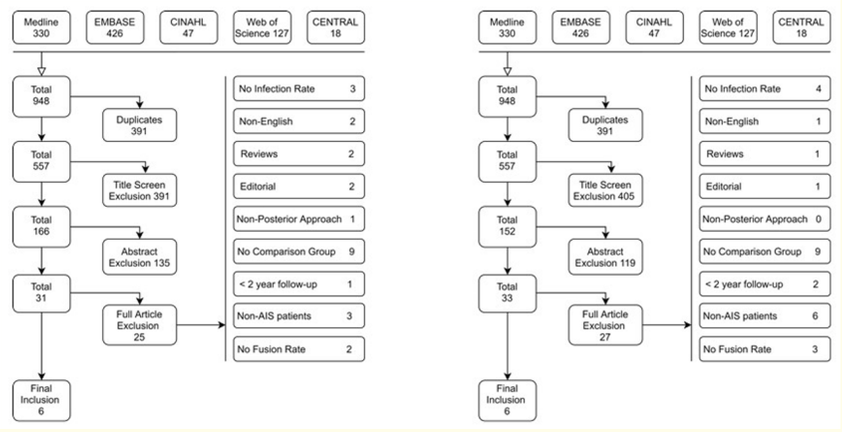

Figure 2: Flow chart of reviewer 1 and reviewer 2.

Data abstraction

Data abstraction was then performed on all six studies (addendum). A thorough screening process was conducted to ensure the study met all inclusion and exclusion criteria. Pseudarthrosis was defined as a non-union, or implant failure, within 2 years and post-operative curve progression (with-in the instrumented levels), greater than 10 degrees. Infection was defined as any superficial or deep drainage which requires a return to the operating room for a surgical procedure.

Study design, setting, diagnosis, and bone graft type were abstracted. Patient demographics included age, gender, pre-and post-operative Cobb angle, number of levels fused, and duration of follow-up.

Statistical analysis

The information abstracted was then uploaded to RevMan 5. Outcomes were dichotomous, and odds ratios (with 95% confidence intervals) were calculated using Mantel-Haenszel, fixed-effects.

Critical appraisal

The six studies were then, subjected to critical analysis and this was recorded on the Risk of Bias Form from the EPOC Group (Effective Practice and Organization of Care group by Cochrane). The results are tabulated in figure 3. The study by Betz., *et al*. [16], was the only randomized control trial, but as the population is fairly specific and the surgical indications generally agreed upon, the baseline characteristics were similar in most groups. The remaining groups were cohort studies. Lost follow-up numbers and reasons were poorly (or not) reported in all studies. The nature of the study did not allow for contamination, and all studies reported the outcome measures listed in the methods sections.

Figure 3: Risk of Bias results.

Results

There were six studies included for each outcome. The Forest plots for pseudarthrosis and infection are seen in figures 4 and 5, respectively. In the six studies, 7/570 allograft and 7/730 non-allograft patients had pseudoarthrosis. In total, the odds of getting a pseudarthrosis with the use of allograft was 1.13 (95% CI: 0.41, 3.09) times the odds of getting a pseudarthrosis if no graft or autograft alone (local/ICBG) was used. This finding had no statistically significant difference (p = 0.81). The studies by Le Huec., *et al*. [17] and Recht., *et al*.. [18], had zero cases of pseudarthrosis, therefore were not included in the total odds ratio calculations. There was heterogeneity in the pseudarthrosis outcome.

Figure 4: Pseudoarthrosis forest graph.

Figure 5: Infection forest graft.

4/570 allograft and 4/730 non-allograft patients had clinically-important infections. The odds of getting an infection with the use of allograft was used were 1.25 (95% CI: 0.33, 4.72) times the odds of getting an infection if no graft or autograft (local/ICBG). This finding had no statistically significant difference (p = 0.74). The studies by Le Huec., *et al*. [17], Recht., *et al*. [18]. and Price., *et al*. [19] had zero cases of infection, therefore were not included in the total odds ratio calculations. Overall, there was no significant difference in risks of pseudarthrosis (95% CI: 0.41, 3.09) or infection (95% CI: 0.33, 4.72) if allograft was used.

Discussion

Although all papers that were reviewed had participants who received allograft, the controls within all of these papers were inconsistent. Aurori., *et al*. [20] and Recht., *et al*. [17] compared allograft with ICBG. Price., *et al*.. [19] also compared allograft and ICBG, however, they had a third group who received bone marrow and demineralized bone matrix. The participants from the third group were excluded from our review. Le Huec., *et al*. [17] compared participants who received allograft and Tri-calcium

Phosphate. Crawford., *et al*. [21] had two population groups: ICBG and non-ICBG. The non-ICBG group included Allograft, local graft, DMB, BMP, ceramics, and bone marrow aspirate. For our review, we combined the ICBG and local autograft patients and compared the pseudoarthrosis and infection outcomes from those participants who received allograft only. The authors were contacted directly to collect the raw numbers, as they were not published explicitly in their paper. There is only one randomized control trial, by Betz., *et al*. [16], which compared allograft to no graft (the harvested autograft was discarded), showing no difference in the rate of infection or pseudoarthrosis.

In all studies, and for all outcomes, the confidence intervals spanned 1.0, which is not surprising, considering the number of events per study number was so low. Price., *et al*. [19], found a 28% (all-cause) failure rate in those treated with allograft alone, versus 12.5% in those with autograft. This was a retrospective study, with small numbers (25 and 16), and the differences were non-significant. Another study of 227 patients found that allograft had a relative risk of 9.6 ($p < 0.001$, 95% CI 2.21-42.11) to develop an infection. This study was a mixed population with 139 idiopathic types [22]. Another study looked at 1435 patients, and compared infection rates between allograft (3.1%) and autograft (4.3%). The differences were not significant [23]. A case-control study analyzing risk factors for infections in AIS found no effect of allograft on the infection [6]. Thus, conflicting studies are supporting both sides of the argument.

The results of this systematic review and meta-analysis, point toward the lack of good quality comparison studies on this topic. It is surprising how many narrative reviews there are, considering the lack of studies with a control group. There are also many studies without control groups (case series), which makes it difficult to generalize, as the internal validity is low. This study highlights the need for multi-center, RCTs or prospective cohort studies, and national or international study groups to properly answer these questions.

Based on our analysis, the overall grade of recommendation for the use of allograft for fusion procedure for AIS is low since the majority of the studies are observational and narrative.

Conclusion

Although there is no added risk of pseudarthrosis or infection with the use of allograft there is also limited evidence to either support using, or not using allograft bone graft posterior spinal instrumentation and fusion, in adolescent idiopathic scoliosis.

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