Fusion rates following Anterior Cervical Decompression and Fusion (ACDF) Using Polyether Ether Ketone (PEEK) - An Assessment of the Current Best Available Evidence

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Abstract

The Ovid Medline database was searched for English language articles published between 2005 and 2015 on PEEK Cages and ACDF. Eleven studies were included: eight Level 1 and three Level 2 studies. Using pooled averages weighted by sample size, the PEEK and non-PEEK cohorts were similar in age (50.0 years vs 51.4 years) and percentage of smokers (58.5% vs 56.4%). The PEEK cohorts had a lower fusion rate (81.3%) at final follow-up compared to the non-PEEK cohorts (93.3%). Inconsistencies in fusion assessment method and data reporting restricted further meta-analysis. Although systematic review of level 1 and 2 studies on PEEK interbody in ACDF showed lower fusion rates compared to non-PEEK interbody, this was based on a very limited number of studies as well as a wide variability in study design, especially with regard to fusion assessment methods, and the reporting styles of authors. As such, results on PEEK fusion rates in ACDF surgery remain inconclusive. Our results suggest a need for a consensus regarding study design and reporting to enable accurate interpretation of studies regarding ACDF fusion rates.

ABBREVIATIONS

PEEK: Polyetherether Ketone; ACDF: Anterior Decompression and Fusion; BG: Bone Graft; PMMA: Polymethyl Methacrylate; HA: Hydroxyapatite; DBM: De-Mineralized Bone Matrix; β-TCP: beta Tricalcium Phosphate; CT: Computed Tomography; AIBG: Autogenous Iliac Bone Graft

INTRODUCTION

Anterior Cervical Discectomy and Fusions (ACDF) are widely performed to treat degenerative and compressive neuropathies of the cervical spine [1,2]. Historically, the interbody graft used to enable fusion has been autologous bone or structural allografts [3,4]. However, donor site morbidity has been a concerning complication following autologous bone graft harvest from the iliac crest [5-7]. As such, a myriad of technologies have been developed in an effort to minimize or completely bypass this undesirable complication and still obtain similarly high fusion rates [8,9]. One technology that has gained popularity is the use of a Poly-ether-ether-ketone (PEEK) cage interbody device for cervical fusion.

Attractive features of the PEEK implant are its immunological inertness [10-13], radiolucency and similar modulus of elasticity to that of cortical bone [14]. However, there is ongoing debate on whether PEEK implants truly facilitate ‘fusion’ given its biochemical composition, and if fusion rates are comparable to bone grafts and other cervical interbody implants. Such debates were provoked by recent reports of a higher incidence of dislodgement, pseudoarthrosis, subsidence, and suggest an inferior substrate for arthrodesis [15]. The objective of this study is to ascertain the ‘true’ fusion rate for PEEK interbody implants used for ACDF using strict, well-accepted radiographic criteria through a systematic review of high-level evidence studies.

Secondary objectives are 1) to ascertain the time to fusion following ACDF with PEEK interbody implants using strict, well-accepted radiographic criteria through a systematic review of the available literature and 2) to compare PEEK with other interbody devices/structural bone graft used for ACDF with regard fusion rates and time to fusion.

MATERIALS AND METHODS

Identification of studies

A comprehensive literature search was performed with the...
assistance of a professional medical librarian. The Ovid Medline database (Wolters Kluwer) was searched for English language articles published between 2005 and 2015 on PEEK Cages and ACDF. The search strategy consisted of using a combination of keywords for the term “PEEK” with a combination of keywords relevant to ACDF. The following keywords were used to search these databases. Keywords (PEEK OR Polyetherether ketone OR polyether-ether-ketone OR poly-ether-ether-ketone) were matched with the keywords (ACDF OR anterior cervical discectomy and fusion). The Cochrane Database of Systematic Reviews was also searched. No Cochrane reviews have been published on this topic.

Eligibility criteria

Only prospective cohort studies and randomized controlled trials (RCTs) were included for final review. All studies with lower level evidence as well as duplicate studies were excluded. Due to the heterogeneity in reported time points and fusion rate, fusion assessment, surgical technique, as well as use of biologics and bone graft enhancers or extenders, the following were excluded: Studies without explicit reported fusion rates, ACDF without plate fixation, arthroplasty, and combined antero-posterior surgeries [16]. Additionally, only studies that explicitly described the use of dynamic radiographs (XR) and/or CT for assessment of cervical fusion were included [17]. Furthermore, studies were only limited to those performed on in vivo human subjects, and were complete and published by the time this review was initiated (Figure 1).

Assessment of eligibility and credibility

Once duplicates, animal and in vitro studies were excluded, two independent reviewers evaluated all studies based on the Jadad scoring system which assess the methodological quality of all clinical trials, with a score of 0 being ‘very poor’ and a score of 5 as ‘rigorous’ or very good [18]. Disputes regarding inclusion/exclusion were resolved by group consensus, with preference given to inclusion in unresolved cases.

RESULTS

A total of 11 studies were included in the final analysis (Table 1), eight Level 1 and three Level 2 studies published from 2004 to 2015. Only one study had a Jadad score of 5, two had a score of 4 and two each had a score of 1 or 2. Using pooled averages weighted by sample size, the PEEK and non-PEEK cohorts were similar in age (50.0 years vs 51.4 years) and percentage of smokers (58.5% vs 56.4%). The PEEK cohorts had a lower fusion rate (81.3%) at final follow-up compared to the non-PEEK cohorts (93.3%). However, there was a wide variation on the methods to determine the presence of fusion. Four studies used only radiographs, three studies used only CTs and five studies used a combination of radiographs, CTs and/or MRIs. In addition, the length of follow-up varied widely with a range of 3 to 102 months.

Chen et al. [19], performed a randomized controlled trial comparing the performance of PEEK to titanium implants in the treatment of cervical spondylotic myelopathy. A total of 80 patients with 3-level cervical spondylotic myelopathy were enrolled, and randomized to the PEEK or Titanium group in a 1:1 fashion. There was a 25% dropout rate leaving a total of 60 patients available at final follow-up (N= 29 in Titanium and 31 in PEEK). Mean follow up was 99.7 months (Range: 86 to 116 months). No significant differences in demographic variables were detected. Fusion assessment was based on: (1) absence of motion between the spinous processes at dynamic lateral radiographs, (2) absence of a radiolucent gap between the graft and endplates, (3) presence of continuous bridging bony trabeculae at the graft-endplate interface. Fusion rates were equal in both PEEK and Titanium, 100% at final follow up. Time to fusion (arthrodesis) was not reported. Patients belonging to the PEEK group were described to have superior clinical outcomes to the titanium group. Cage subsidence rates were higher in the Titanium group (34.5 vs. 5.4 %). Additionally, two incidents of dislodgement were reported in the titanium group.

Cho et al. [20], performed a randomized control trial comparing two treatment groups, group A: PEEK cage containing a biphasic calcium phosphate ceramic (PEEK+Triosite, n = 50), and group B: PEEK cage containing an autogenous iliac bone graft (PEEK+AG, n = 50). No significant differences in patient demographics or diagnosis were reported. Plain radiographs, with an as needed adjunct of computed tomography (CT) and / or MRI were the methods employed for assessing fusion. Evidence of fusion was assessed every month for the first 6
<table>
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<tr>
<th>Study</th>
<th>LOE</th>
<th>Jadad Score</th>
<th>Fusion Assessment Method</th>
<th>Cohort</th>
<th>Sample Size</th>
<th>Total Levels</th>
<th>Mean Age</th>
<th>Percent-Males</th>
<th>Percent-Smokers</th>
<th>Mean Follow-up (mos)</th>
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<th>3</th>
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<th>Final follow-up</th>
<th>Mean Time to fusion mo.</th>
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<td>&quot;absence of motion between spinous processes at dynamic lateral radiographs, absence of radiolucent gap between graft and endplates, presence of continuous bridging bony trabeculae at the graft-endplate interface&quot;</td>
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<td>&quot;bony specula across fusion level on x-ray film and no change in position of fusion levels as seen by dynamic view...if question-able, thin-slice CT scan was used&quot;</td>
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<td>Farrokhi, 2015</td>
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<td>&quot;Dynamic radiographs and CT scans were conducted to assess fusion status. Fusion status was graded as good, average, and poor by assessing radiographs in the patients of the two groups. Good fusion= no motion on flexion/extension radiographs, no radiolucent zones between the cage and vertebrae, and trabecular bridging at both end plates.&quot;</td>
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<td>Source</td>
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<td>3 mo</td>
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<td>Mobbs, 2012</td>
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<td>Flex/Ext Radiographs - &quot;fusion was considered successful if bridging bone incorporating the graft and adjoining endplates was apparent, with additional loss of radiolucency, restoration of interbody space and no hardware failure. Lack of movement on flexion/extension x-rays were also used to confirm status. If required, CT was performed to verify the fusion status.&quot;</td>
<td>PEEK w/biphasic CaP04 + ant plate</td>
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<td>Orief, 2010</td>
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<td>Radiographs and CT at 3 and 6 mo. - &quot;absence of motion on flexion-extension lateral plain radiograph, absence of radiolucent gap between implant or graft and the host vertebral endplates; and the presence of continuous, bridging, osseous trabeculation at the graft-host vertebral endplate junction&quot;</td>
<td>PEEK w/iastic BG</td>
<td>18</td>
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<td>Iliac BG + ant plate (2)</td>
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<td>Yl, 2015</td>
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<td>Flex/Ext Radiographs (less than 2mm on dynamic lateral radiographs) &amp; CT</td>
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<td>38</td>
<td>38</td>
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<td>PEEK+ β-TCP and HA</td>
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<td>PEEK w/iastic BG + plating</td>
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BG= bone graft; PMMA= polymethyl methacrylate; HA= hydroxyapatite; DBM= de-mineralized bone matrix; β-TCP= beta tricalcium phosphate
In the PEEK+Triosite group fusion was 57%, 67%, 77%, 82%, 92%, and 100% within the first 6 months, and 81%, 86%, 95%, 95%, 100%, and 100% for the PEEK+AG group. Time to fusion was significantly slower in PEEK+Triosite than PEEK+AG with the later achieving 100% fusion as early as 5-months post-op. Additionally the results showed correlation between increasing fusion levels and a longer time to fusion. Higher volumes of blood loss as well as an extended operative time were seen in the PEEK+AG group, likewise a higher incidence of donor site complications. The Triosite group had a significantly shorter hospital stay than the AG cohort (4 vs. 7 days), \( P = 0.001 \).

Cho et al. [21], performed a randomized control trial of three treatment groups. A total of 180 cervical spondylolisthesis patients were enrolled from 1997 to 2001 and randomized to one of three treatment arms, group A: underwent anterior disectomy and Polyetherether ketone (PEEK) fusion augmented with iliac crest bone marrow aspirate (N= 60), group B: anterior disectomy, autogenous iliac crest graft (AICG) fusion and plate fixation (N= 50), and group C: anterior disectomy and AICG only (N= 70). No significant difference between patient demographics. Fusion was assessed at a max of 3-month intervals using dynamic radiographs (absence of gross change in fusion levels and presence of bony bridge =fusion) with occasional use of CT when radiographs were inadequate. Group A achieved 100% fusion ~ 4-months post-op (= estimated time to fusion). Group B achieved near perfect fusion in all patients (98%) between the 4- and 5-month time-points and failed to reach 100% even at 12 months. Group C had a significantly smaller proportion of patients who went on to fusion rate of (87%) with no improvement in this rate even after 4-months. Complication rates among the groups were 3.3% (2/60) in group A, 16% (8/50) in group B, and 54.3% (38/70) for group C, and included graft, instrument and donor site complications.

Farokhkh et al [22], performed a randomized prospective trial comparing PEEK to a novel Acrylic cage device for the treatment of single-level cervical spondylolisthesis with neural symptoms. A total of 64 patients were enrolled between 2011 and 2012, and randomized to PEEK cage device (N= 32) or Acrylic cage filled with bone substitute (N= 32). No significant differences in patient demographics between the two groups were reported. Fusion was assessed at 2-, 6- and 12-months follow-up using dynamic radiographs and CT scans. Fusion in the Acrylic cage group was higher than PEEK cages at final follow up, 96.9% vs. 93.8%. Important disclosure by the authors of the study is that they were the inventors of the Acrylic cage used in the study and this acknowledgment may suggest an implicit bias and / or conflict of interest that favor the use of Acrylic cage over PEEK cages.

Mashhadinezhad et al. [23], compared two variations in the application of the PEEK device in ACDF - PEEK cage packed with autograft (AG) versus hydroxyapatite (HA) granules. Two-hundred and sixty-three patients (291 cages) were enrolled in the study between 2008 and 2011, and 27 were lost to follow-up leaving 236 patients at final follow-up. At the initiation of the study randomization included 112 patients belonging to the PEEK+AG cohort and 124 to PEEK+HA. No significant differences in patient demographics existed between both groups. Clinical and radiographic follow-up was recorded at 3- and 12-month follow-up and cervical fusion assessment included two factors: bony bridges surrounding the cage at the surgical level and segmental motion less than 3° in dynamic cervical radiographs. "Bony bridges were present in 16.6% in the auto graft group and 8% in the granule group at three months and in 54% in the auto graft group and in 47% in the granule graft at 12 months after surgery. Segmental motion > 3° was found only in one patient at the follow up period (three months after surgery in the granule group)." Complications (2) included post-op cervical hematoma and dysphonia in the HA granule group, both HA and AG groups had patients with transient dysphagia, AG group had patients who experienced non-severe donor site pain symptoms. All complications in both groups were managed without need for additional surgery.

Mobbs et al. [24], performed a prospective cohort study to evaluate the efficacy of biphasic calcium phosphate (Biph-CaPO4) as a bone substitute within PEEK cages for ACDF. Seventy-five patients were originally enrolled in the study, 17 were lost to follow-up and excluded from final analyses (N= 58 patients). Of the 58 patients available at final follow-up 32 underwent ACDF with PEEK+Biph-CaPO4 cages with anterior plate fixation (Group 1) and 26 patients also with PEEK+Biph-CaPO4 without plate fixation (Group 2). Diagnoses included traumatic or degenerative cervical disc disease causing neural symptoms that were unresponsive to conservative treatment. Surgery included both single- and two-level fusion in both cases. No significant difference was reported between both groups. Mean follow-up was 12.4 and 10.5 months in the Plated (Group 1) and Non-Plated (Group 2) cohorts, respectively. Dynamic radiographs and PRN CT scans were used to evaluate fusion at 6 weeks, 3 months, 6 months and one year postoperatively. Fusion was present if bridging bone between endplates was present, “loss of radiolucency”, restoration of interbody space, no hardware failure, and lack of motion on flexion/extension radiographs. There was a 100% fusion rate in Group 1 and 74.6% in Group 2. Time to fusion was estimated at 3-months for this study and beyond this time-point fell into the category of delayed or nonunion. There was a 6.3% complication rate in group 1 which consisted 2 patients with postoperative dysphagia with one requiring surgical explanation of the plate. On the other hand, the non-plated cohort (Group 2) had a higher complication rate at 26.7%, and included a variety of surgical- and implant-related complications with the exception of dysphagia.

Orief et al. [25], performed a prospective randomized control trial comparing three treatment groups: the bone-filled PMMA (Polyethylmethylecylate) implant, autologous bone graft (ABG) and PEEK cage for ACDF. Sixty consecutive patients were enrolled and stratified to the above three treatment arms, 20, 22, and 18, respectively. Indications for surgery were single level radicular symptoms with no significant difference in reported patient demographics between the three groups. Fusion was defined as the absence of motion on dynamic radiographs, absence of radiolucency between the implant / graft and host endplates, and the presence of bridging bone at the graft host endplate junction. A combination of dynamic radiographs and CT were obtained at 3- and 6-months post-operatively. Evidence of fusion was seen in only the ABG and PEEK cohorts at the 3-month
time point (40.9% and 22.2%, respectively), with significantly inferior fusion rates in the PMMA cohort (30%) compared to ABG (86.3%) and PEEK cages (77.7%) at 6 months follow-up. No significant surgery-related complications except for mild transient dysphagia which were prevalent in all three groups and quickly resolved. Fourteen of the 22 patients in the ABG group experienced donor site pain, and complete resolution of symptoms was reported at 2 months. One case of subdural and no dislodgement was observed in the PEEK group (N=18), and no such complications were reported in the PMMA group.

Vanek et al. [26], performed a prospective study comparing three different techniques for ACDF, namely: autologous tricortical iliac crest bone graft (AICBG) (Group 1, N=28), AICBG + anterior plating (Group 2, N=18), and PEEK cage with beta-tricalcium phosphate and anterior plating (Group 3, N=29). No significant difference in surgical indications: symptomatic cervical degenerative disc disease involving 1 or 2 levels. Follow-up was at 6 weeks, 3- and 6-months, and 1 and 2 years following surgery. Bony fusion was assessed by 2-D CT reconstruction at the end of the follow-up. Fusion was defined as 2 or more trabecular bridging bone between superior and inferior end plates. There were no significant differences in patient demographics across the groups. All groups achieved 100% fusion at the time of final follow-up (2 yrs after surgery). Of note 3/28 patients in Group 1 were excluded from final analyses due to respective reoperations indicated for symptomatic graft collapse or ventral migration during the first 2 months following surgery (10% reoperation rate in Group 1). No incidence of reoperation in Groups 2 or 3. An additional 3 patients were lost to follow-up and thus were not included in final analyses.

Yi et al. [27], performed a randomized controlled trial comparing the use of a PEEK cage containing a hydroxyapatite/beta-calcium triphosphate mixture (HA/beta-TCP) to the use of a PEEK cage containing a hydroxyapatite/demineralized bone matrix mixture (HA/DBM) in ACDF. Eighty-five patients were randomly assigned to one of the two groups and there were no significant differences in demographic variables. Of these, 77 patients completed full one-year follow-up (N=38 in HA/DBM and N=39 in HA/beta-TCP). Fusion was defined as less than 2 mm inter-spine distance on dynamic lateral radiographs (taken at 3-, 6-, and 12 months) and presence of a continuous fusion mass on reconstructed CT scans taken at 6- and 12 months. Using dynamic radiographs, fusion was achieved in 69% of HA/DBM patients and in 74% of HA/beta-TCP patients at 3 months post-operatively (p=0.60); in 76% of HA/DBM patients and in 74% of HA/beta-TCP patients at 6 months post-operatively (p=1.00); in 87% of HA/DBM patients and in 87% of HA/beta-TCP patients at 12 months post-operatively (p=1.00). Computerized Tomography scans at 6 months post-operatively showed fusion in 74% of HA/DBM patients and 67% of HA/beta-TCP patients (p=0.062) and those at 12 months showed fusion in 87% of HA/DBM patients and in 72% of HA/beta-TCP patients (p=0.16). At 12 months post-operatively, there were no significant differences in the two groups with respect to posterior neck pain (VAS=1.6 in HA/DBM vs. VAS=1.7 in HA/beta-TCP; p=0.82), radiating pain (VAS=1.6 vs. VAS=2.3; p=0.27) or NDI (17 vs. 18; p=0.62). There was no post-operative infection in any patient.

Nemoto et al. [28], performed a randomized controlled trial comparing ACDF using PEEK cage + anterior plating with ACDF using stand-alone PEEK cage. Anterior iliac crest autograft was used in both groups. A total of 50 patients with single-level radiculopathy were randomly assigned to the PEEK + plating or the stand-alone PEEK group. Fusion was evaluated using multiplanar reconstruction CT at 12- and 24 months post-operatively. During follow-up, 46 patients with no significant demographic differences (N=24 stand-alone PEEK and N=22 PEEK + plating) underwent clinical and radiographic evaluation. There were no significant differences in fusion rates between the two groups. At 12 months, 22 patients (92%) in the stand-alone PEEK group and 21 patients (96%) in the PEEK + plate group had undergone fusion. At 24 months, 96% of the stand-alone PEEK group and 100% of the PEEK + plate group had undergone fusion. The subsidence rate at 12 and 24 months was higher in the stand-alone PEEK group (12 months:12.5% vs. 9.1%; 24 months: 16.7% vs. 13.6%) but these results were non-significant (p=0.711 at 12 months; p=0.775 at 24 months). At 24 months, newly developed adjacent-level degeneration was observed in 63.6% of the PEEK + plate group and 12.5% of the stand-alone PEEK group (p=0.01). In the early post-operative period, 38% of the stand-alone PEEK group and 46% of the PEEK + plate group complained of dysphagia (p=0.584). At 3 months post-operative, no patients complained of dysphagia.

Xie et al. [29], performed a randomized controlled trial comparing PEEK cages + autograft (AIB) to PEEK cages using calcium sulphate + demineralized bone matrix (CS/DBM) in ACDF. Between 2006 and 2008, 60 patients with one- or two-level cervical radiculopathy and/or myelopathy were randomly assigned to one of the treatment groups (N=35 CS/DBM; N=33 AIB). Demographic data between groups were not significantly different. Fusion status was evaluated using fine cut CT performed 12 months post-operatively, and no significant difference in fusion rate was found. The fusion rate was 94.3% in the CS/DBM group and 100% in the AIB group at 12 months follow-up. The fusion rate was 100% at 24 month follow-up in both groups. The mean blood loss was significantly lower in the CS/DBM group than in the AIB group (75 ml vs. 100 ml, p<0.01). There was no significant difference in hospital stay between the two groups (6.5 days vs. 7 days, p>0.05).

DISCUSSION & CONCLUSION

The purpose of this study was to evaluate the "true" fusion rate using PEEK interbody cages after anterior decompresion of the cervical spine. Secondary objective was to ascertain the mean time to fusion when PEEK cages were used. The above studies in aggregate suggest that when ACDFs with PEEK interbody are compared to ACDFs with non-PEEK interbody, those with PEEK interbody had fusion rates that were lower (81.3%) at final follow-up compared to the non-PEEK cohorts (93.3%). However, due to the very limited high-level evidence data available in the literature, and the wide variability in reporting, follow-up time points, and fusion assessment results following this review remain inconclusive.

Some studies showed PEEK to have more favorable fusion results compared to other synthetic materials (i.e. PMMA), particularly when augmented with autologous bone or synthetic
bone substitute [25]. Additionally, use of autologous grafts (alone or as an adjunct to an implantable synthetic device) was consistently associated with good fusion rates, especially when supplemented with anterior plate fixation [21]. Similarly, when PEEK spacers were packed with autograft and supplemented with anterior plating, higher fusion rates were observed compared to PEEK cages packed with hydroxyapatite (HA) granules [23].

When fixation was supplemented with anterior plating the performance of PEEK cages was better than tricortical iliac crest bone graft (without plate fixation) with respect to fusion. Our results showed no obvious difference in subsidence or dislodgement rate in PEEK implants compared to other non-PEEK interbody spacers (autografts, allografts, or titanium alloy cages). In fact, risk of dislodgment was observed more in the absence of anterior plating than the PEEK device itself. The addition of anterior plating, irrespective of implant or bony augments, was associated with higher fusion rates compared to no plating in the plurality of cases reviewed.

Other factors potentially influencing fusion rates i.e. steroid use and bone density were not consistently documented in the above studies. Likewise implant characteristics such as size / surface area available for fusion, external coating with osteoconductive properties and other favorable nanotopography for bony on-growth (Titanium coated PEEK) were not exclusively described.

Surgical technique i.e endplate preparation may play a role in pseudoarthrosis. Similarly incomplete decompression in patients with persistent symptoms, despite adequate fusion, may cause persistent pain. Although fusion is a primary objective in ACDF, its direct impact on clinical outcomes appears to vary among patients. Bohman et al., observed that younger patients with pseudoarthrosis following ACDF are more likely to be symptomatic than their elderly counterparts, as such, not all patients with pseudoarthrosis will need further surgery, even up to 5 years from index procedure. Prior cervical arthrodesis is a reliable treatment in the setting of pseudoarthrosis with excellent results, however, complete alleviation of symptoms is not guaranteed despite adequate fusion [30].

The advent of Computed Tomography has provided better quality and a quantitative method for evaluating bone morphology. However, its efficacy in assessing fusion following ACDF is not as reliable as the traditional dynamic (flexion and extension) radiographs [31,32.] Some investigators have demonstrated an overestimation of fusion using CT scans in the post operative period, and defer to dynamic radiographs (> 1mm of cervical spinous process distraction on flexion / extension X-ray)in this setting [33]. Given that CT scans only provide a static image, it does not account for angular planes where pseudoarthrosis may exist and be revealed with motion. As such, the presence of bridging bone in a given plane should not conclude fusion. It is advised that CT scans when used should be coupled with dynamic imaging to get the best results [33].

Limitations to this study include those inherent with any systematic and or meta-analytic study. Such reviews are restricted only to the data presented in the literature. Heterogeneously reported variables include but are not limited to: surgical technique, inter body device use, cage size and diameter applications, bony augments / substitutes, use of a cervical collar, clinical indications, reported time-points, fusion assessment or variability in imaging modalities employed, and definition of fusion. Reconciliation of such wide variability in reporting on a single subject presents an unfeasible challenge that significantly limits one’s ability to accurately deduce meaningful conclusions. Nevertheless, we find our results to be an important and provocative step towards better spine research.

1. As such we make the following recommendations for future reporting of ACDF “fusion assessment” studies A universal method for anterior cervical fusion assessment using dynamic radiographs with less than 1 mm change in interspinous process distance as recommended by Rhee et al.

2. Follow-up time points should at a minimum, include 3 months, 6 months and 12 months following surgery. Addition of earlier time-points should be considered to assess time to healing.

CONCLUSION

Despite widespread use, the current literature lacks adequate data to enable a meta-analysis of fusion rates following ACDF with PEEK interbody devices. Additional studies using consistent fusion assessment methods and follow-up intervals are needed.

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