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LITERATURE REVIEW

Outcomes following anterior odontoid screw versus posterior arthrodesis for odontoid fractures: a systematic review and meta-analysis

Pavlos Texakalidis, MD,[1] Stavros Matsoukas, MD,[2] Constantine L. Karras, MD,[1] Hyman G. Frankel, MD,[1] Kevin Swong, MD,[1] Geoffrey P. Stricsek, MD,[1] and Nader S. Dahdaleh, MD[1]

[1]Department of Neurosurgery, Northwestern Memorial Hospital, Chicago, Illinois; and [2]Department of Neurosurgery, Mount Sinai Hospital, New York, New York

OBJECTIVE Odontoid fractures can be managed surgically when indicated. The most common approaches are anterior dens screw (ADS) fixation and posterior C1–C2 arthrodesis (PA). Each approach has theoretical advantages, but the optimal surgical approach remains controversial. The goal in this study was to systematically review the literature and synthesize outcomes including fusion rates, technical failures, reoperation, and 30-day mortality associated with ADS versus PA for odontoid fractures.

METHODS A systematic literature review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines by searching the PubMed, EMBASE, and Cochrane databases. A random-effects meta-analysis was performed and the I^2 statistic was used to assess heterogeneity.

RESULTS In total, 22 studies comprising 963 patients (ADS 527, PA 436) were included. The average age of the patients ranged from 28 to 81.2 years across the included studies. The majority of the odontoid fractures were type II based on the Anderson-D'Alonzo classification. The ADS group was associated with statistically significantly lower odds to achieve bony fusion at last follow-up compared to the PA group (ADS 84.1%; PA 92.3%; OR 0.46; 95% CI 0.23–0.91; I^2 42.6%). The ADS group was associated with statistically significantly higher odds of reoperation compared to the PA group (ADS 12.4%; PA 5.2%; OR 2.56; 95% CI 1.50–4.35; I^2 0%). The rates of technical failure (ADS 2.3%; PA 1.1%; OR 1.11; 95% CI 0.52–2.37; I^2 0%) and all-cause mortality (ADS 6%; PA 4.8%; OR 1.35; 95% CI 0.67–2.74; I^2 0%) were similar between the two groups. In the subgroup analysis of patients > 60 years old, the ADS was associated with statistically significantly lower odds of fusion compared to the PA group (ADS 72.4%; PA 89.9%; OR 0.24; 95% CI 0.06–0.91; I^2 58.7%).

CONCLUSIONS ADS fixation is associated with statistically significantly lower odds of fusion at last follow-up and higher odds of reoperation compared to PA. No differences were identified in the rates of technical failure and all-cause mortality. Patients receiving ADS fixation at > 60 years old had significantly higher and lower odds of reoperation and fusion, respectively, compared to the PA group. PA is preferred to ADS fixation for odontoid fractures, with a stronger effect size for patients > 60 years old.

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KEYWORDS dens fracture; anterior dens screw; posterior C1–C2 arthrodesis; fusion; cervical; surgical technique

Fractures of the odontoid represent approximately 7%–15% of all cervical spine fractures.[1,2] The incidence of these fractures is bimodal, with a peak in young adults and the elderly population.[3,4] This incidence can increase substantially in elderly patients > 70 years old, representing the most prevalent cervical spine fracture type in this subset of patients.[5–7] Based on the Anderson-D'Alonzo classification, type II fractures—which occur at the base of the odontoid process—are the most common fractures of the dens, with a higher likelihood of nonunion and displacement.[8] Type I fractures occur at the tip of the dens and are usually considered stable. Type III fractures occur through the body of the axis and may be unstable.

Odontoid fractures can be managed conservatively with external immobilization with a halo vest or cervical collar versus with surgical stabilization when the fracture is considered unstable or at high risk for nonunion. The two most commonly performed procedures for surgical stabilization

ABBREVIATIONS ADS = anterior dens screw; PA = posterior C1–C2 arthrodesis; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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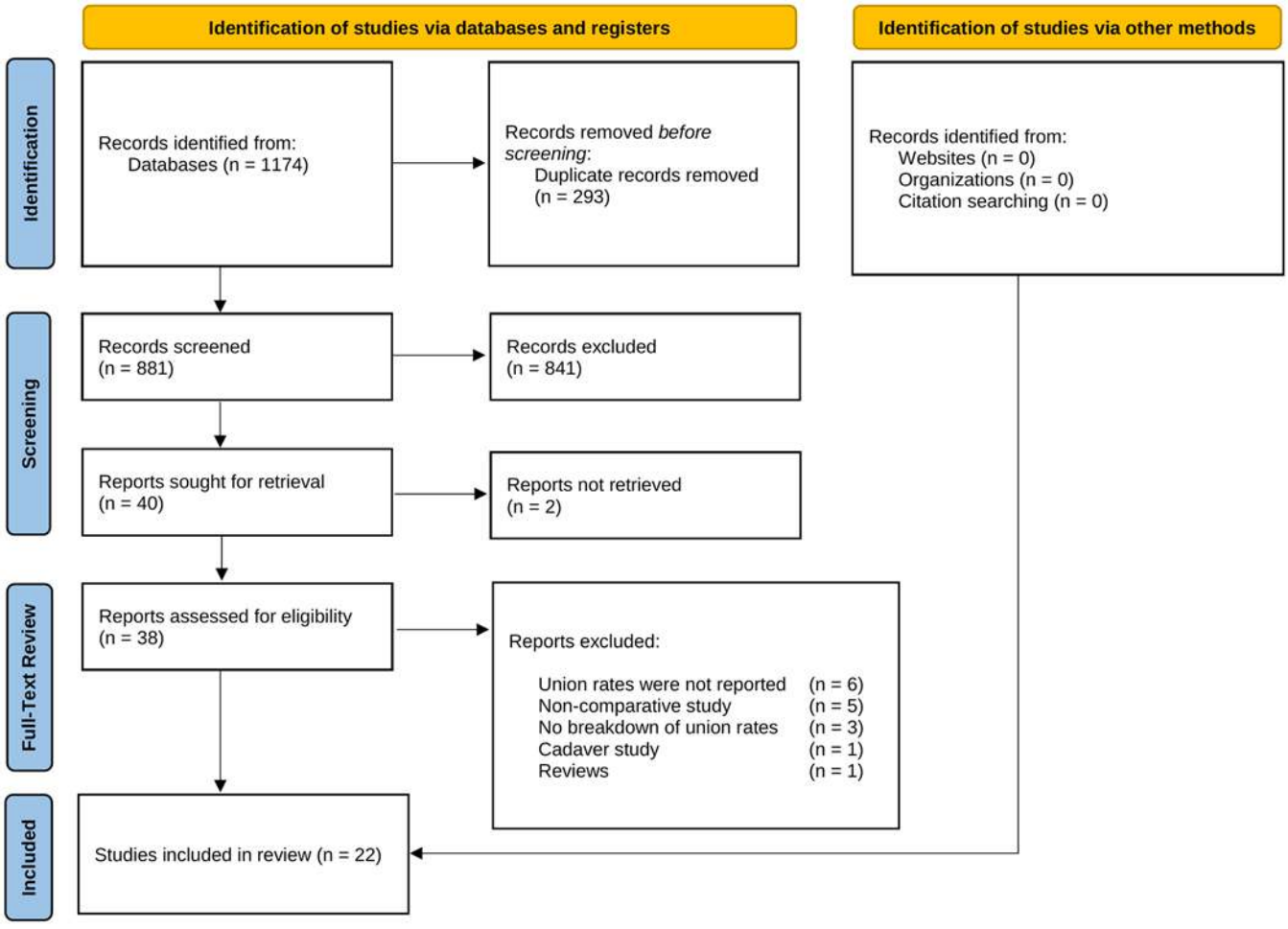

FIG. 1. PRISMA search flow diagram. Data added to the PRISMA template (from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71) under the terms of the Creative Commons Attribution (CC BY 4.0) License (https://creativecommons.org/licenses/by/4.0/). Figure is available in color online only.

are anterior dens screw (ADS) fixation or posterior C1–C2 arthrodesis (PA). ADS fixation has the advantage of preservation of the atlantoaxial motion, but is associated with high rates of postoperative dysphagia and thought to have lower union rates, especially in elderly patients. It requires an intact transverse ligament, reduced odontoid, favorable fracture line, and good alignment. In contrast, PA can be used when reduction of atlantoaxial subluxation or displaced fragments is required. The main disadvantages of this technique are the resultant loss of atlantoaxial motion, usually longer operative duration, increased postoperative pain, and prone positioning.

The objective of the present study was to systematically review all available literature and compare ADS fixation versus PA for odontoid fractures in terms of their safety profile—including reoperation rates and technical failures—as well as their efficacy profile, with the primary outcome being bony fusion at follow-up.

Methods

This systematic review and meta-analysis was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[9]

Search Strategy and Selection Criteria

Systematic searches were conducted in PubMed/MEDLINE, EMBASE, and Cochrane Central databases. The search algorithm used for PubMed was the following: ("odontoid" OR "dens" OR "odontoid process") AND fracture and (anterior OR "odontoid screw" OR "dens screw") AND (posterior OR "C1-C2" OR arthrodesis OR fixation OR transarticular OR interlaminar).

The search was conducted by two independent investigators (S.M., P.T.). Any disagreements or discrepancies were resolved by a third investigator (C.L.K.). The references of the included studies were also manually reviewed in order to identify further eligible articles.

A study was included in this meta-analysis if it fulfilled three predefined criteria: 1) randomized controlled trials or prospective or retrospective observational analyses comparing ADS fixation versus PA for fractures of the

TABLE 1. Risk of bias assessment with the ROBINS-I tool in 22 studies of odontoid fracture

Authors & Year	Confounding	Selection	Measurement of Interventions	Deviations From Intended Interventions	Missing Data	Measurement of Data	Selection of Reported Result
Andersson et al., 2000[13]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Ziai & Hurlbert, 2000[14]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Kim et al., 2011[15]	Moderate	Moderate	Low	Low	Moderate	Low	Moderate
Mashhadinezhad et al., 2012[16]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Platzer et al., 2007[17]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Konieczny et al., 2012[1]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Sawarkar et al., 2015[18]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Guo et al., 2017[19]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Omeis et al., 2009[20]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Chiba et al., 1996[21]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Cho & Sung, 2011[22]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Kuntz et al., 2000[23]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Moscolo et al., 2021[4]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Müller et al., 1999[24]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Pointillart et al., 1994[25]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Przkora et al., 2006[32]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Scheyerer et al., 2013[26]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Rizvi et al., 2012[27]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Shousha et al., 2019[28]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Steltzlen et al., 2013[29]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Yuan et al., 2018[30]	Moderate	Moderate	Low	Low	Low	Low	Moderate
Meyer et al., 2018[31]	Moderate	Moderate	Low	Low	Low	Low	Moderate

ROBINS-I = Risk of Bias in Nonrandomized Studies—of Interventions.

odontoid (including rigid and semirigid techniques); 2) comparative studies that report quantitative data on clinical outcomes of interest; and 3) studies published up to May 2022. Studies that did not compare the two surgical techniques or studies that did not report the primary outcome were excluded.

Data Extraction

Data extracted included the first author, title, date of publication, country of origin, patient number, demographics, age, type of fracture, conservative management, type of surgical technique, and follow-up duration. The primary outcome was fusion at follow-up. Fusion was defined as the presence of trabeculation across the fracture line on radiographs. Few studies used CT to evaluate bony fusion. Secondary outcomes were technical failure, reoperation, and all-cause mortality.

Risk of bias was assessed by two investigators (S.M., P.T.) using the Risk of Bias in Nonrandomized Studies—of Interventions (ROBINS-I) tool for observational studies by Cochrane.[10] Funnel plots and Egger's regression test were used for assessment of publication bias when more than 10 studies were included to synthesize the outcome of interest.

Statistical Synthesis and Analysis

Odds ratios with the corresponding 95% confidence intervals were used for categorical outcomes assessed using random-effects model meta-analysis. Heterogeneity was assessed with the Higgins I^2 statistic.[11] An $I^2 > 50\%$ indicated significant heterogeneity. Forest plots were used to graphically display the effect size in each study and the pooled estimates. Funnel plots and Egger's regression test were used for assessment of publication bias when at least 10 studies were included to synthesize the outcome of interest.[12] A p value < 0.05 was considered significant. Stata 14.1 (StataCorp) was used as statistical software.

Results

Literature Search and Characteristics of the Included Studies

The search strategy identified a total of 881 studies after duplicates were removed. After title and abstract screening, 38 studies underwent full-text evaluation. Twenty-two studies fulfilled the selection criteria and were included for quantitative analysis as shown in the PRISMA flow diagram (Fig. 1). The assessment of risk of bias is presented in Table 1.

All 22 studies were observational cohort analyses (20 retrospective, 2 prospective).[1,4,13–32] A total of 963 patients undergoing surgical stabilization (ADS 527, PA 436) of their odontoid fracture were included in this systematic review and meta-analysis. Based on studies with available data, the majority of the odontoid fractures were type II, with only 86 fractures being reported as type III based on the Anderson-D'Alonzo classification. The average

TABLE 2. Baseline characteristics of the patients, surgical techniques, and fractures in 22 studies of odontoid fracture

Authors & Year	Mean Age (yrs)	AOSF Technique	Type of PA	Type of Fx*		Chronicity of Fx		Avg FU (mos)
				ADS Group	PA Group	ADS Group	PA Group	
Andersson et al., 2000[13]	78	Böhler technique	NR	10 II, 1 III	7 II, 0 III	NR	NR	51
Ziai & Hurlbert, 2000[14]	57	NR	NR	13 II	6 II, 1 III	11 acute, 2 chronic	5 acute, 2 chronic	6
Kim et al., 2011[15]	43.3	4.0-mm cannulated screws	Transarticular screws or C1 lat mass–C2 transpedicular screw fixation (Harms' technique) using polyaxial screws & rods	NR	NR	NR	NR	25.1
Mashhadinezhad et al., 2012[16]	33	NR	C1–C2 pst wiring, or C1–C2 transarticular screw, or pst clamping techniques	15 II	31 II	NR	NR	9
Platzer et al., 2007[17]	71.4	2 cannulated small-fragment screws	Modification of technique of pst wiring & bone grafting by Brooks & Jenkins	37 II	11 II, 8 III	NR	NR	12–24
Konieczny et al., 2012[1]	64.5	Single cannulated screw	Transarticular screw fixation of C1–C2 w/ modification of technique of Magerl & Seemann	11 II, 2 III	21 II, 4 III	Acute	Acute	9.7
Sawarkar et al., 2015[18]	28	AOSF (no info about screws)	Magerl technique & C1–2 cable/bone graft; Magerl or Goel/Harms technique; C1–2 cable/bone graft; OCF; or OCF w/ transoral odontoidectomy	79 II, 6 III	40 II, 17 III	55 acute, 30 chronic	19 acute, 38 chronic	3–9
Guo et al., 2017[19]	NR	NR	Pst temporary fixation w/ C1 lat mass screws combined w/ C2 pedicle/laminar screws	20 II	20 II	Acute	Acute	43.6
Omeis et al., 2009[20]	79.9	NR	C1–2 lat mass screw fixation; C1–3 lat mass screw fixation; or transarticular screws w/ modified Gallie fusion technique	16 II	13 II	NR	NR	9
Chiba et al., 1996[21]	35	NR	NR	36 II, 10 III	16 II, 3 III, 2 UK	35 acute, 10 chronic, 1 NR	5 acute, 16 chronic	5.8
Cho & Sung, 2011[22]	47.9	NR	Pst C1–2 transarticular screw fixation, or C1 lat mass & C2 pedicular screw fixation	5 II, 3 III	3 II, 5 III	NR	NR	19.7
Kuntz et al., 2000[23]	76.3	NR	Transarticular screws w/ modified Gallie fusion	2 II	9 II	NR	NR	14
Moscolo et al., 2021[4]	73.5	Single 3.5-mm screw	C1–C2 arthrodesis	21 IIb	2 IIc	NR	NR	3–6
Müller et al., 1999[24]	64.3	NR	NR	20 II, 1 III	1 III	NR	NR	45.8
Pointillart et al., 1994[25]	54	NR	C1–2 arthrodesis ± pst wiring, as described by Dickman	NR	NR	Acute	Acute	>6
Przkora et al., 2006[32]	80.5	Double screw	O–C2 fusion combined w/ a C1–C2 fusion per Magerl	7 II	1 II	NR	NR	18
Scheyerer et al., 2013[26]	81.2	1 cannulated partially threaded traction screw	Harms technique	17 II	16 II	NR	NR	31.1
Rizvi et al., 2012[27]	73	Single screw	Pst wiring of C1–C2 + bone graft; pst wiring of C1–C2; pst screw osteosynthesis; OCF; or combined odontoid screw fixation & ant C1–C2 plate fixation	35 II, 5 III	36 II, 16 III	NR	NR	37
Shousha et al., 2019[28]	76.2	Double screw	Transarticular C1–C2 screws per Magerl, & bone graft	47 IIb	86 IIb	NR	NR	30
Steltzlen et al., 2013[29]	60.1	Single noncannulated 3.5-mm screw	Transarticular C1–C2 screws per Magerl; ant Vaccaro approach; Harms' technique; or OCF	13 II, 1 III	6 II, 2 III	NR	NR	11

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TABLE 2. Baseline characteristics of the patients, surgical techniques, and fractures in 22 studies of odontoid fracture

Authors & Year	Mean Age (yrs)	AOSF Technique	Type of PA	Type of Fx*		Chronicity of Fx		Avg FU (mos)
				ADS Group	PA Group	ADS Group	PA Group	
Yuan et al., 2018[30]	41.5	Single cannulated screw	Pst temporary instrumentation of C1–2 w/ screws, w/o fusion	11 II	25 II	Acute	Acute	42.6
Meyer et al., 2018[31]	70.7	2 cannulated screws	NR	34 II	5 II	NR	NR	7–12

Ant = anterior; AOSF = AO screw fixation; avg = average; FU = follow-up; Fx = fracture; NR = not reported; OCF = occipitocervical fusion; pst = posterior; UK = unknown.
* Per Anderson-D'Alonzo classification.

reported age had the following ranges among the studies (ADS 30–81 years, PA 22–82.4 years). Important baseline patient, surgical technique, and fracture characteristics are summarized in Table 2. The range of the average follow-up across the included studies was 3–51 months postoperatively.

Outcomes of Interest

The ADS group was associated with statistically significantly lower odds to achieve bony fusion at last follow-up compared to the PA group (ADS 84.1%; PA 92.3%; OR 0.46; 95% CI 0.23–0.91; I^2 42.6%) (Fig. 2). The ADS group was associated with statistically significantly higher

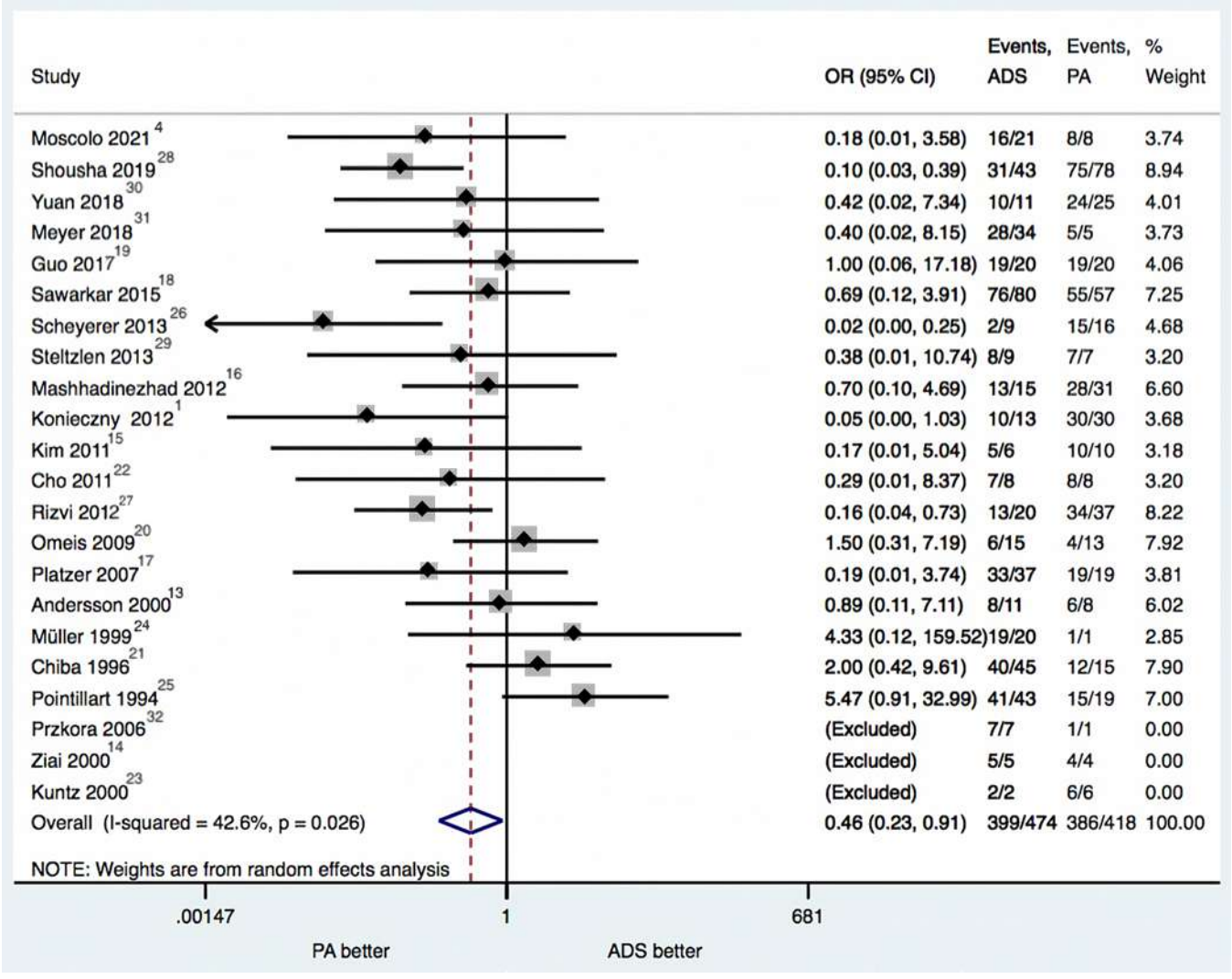

FIG. 2. Forest plot showing the comparison of ADS versus PA in terms of fusion. Figure is available in color online only.

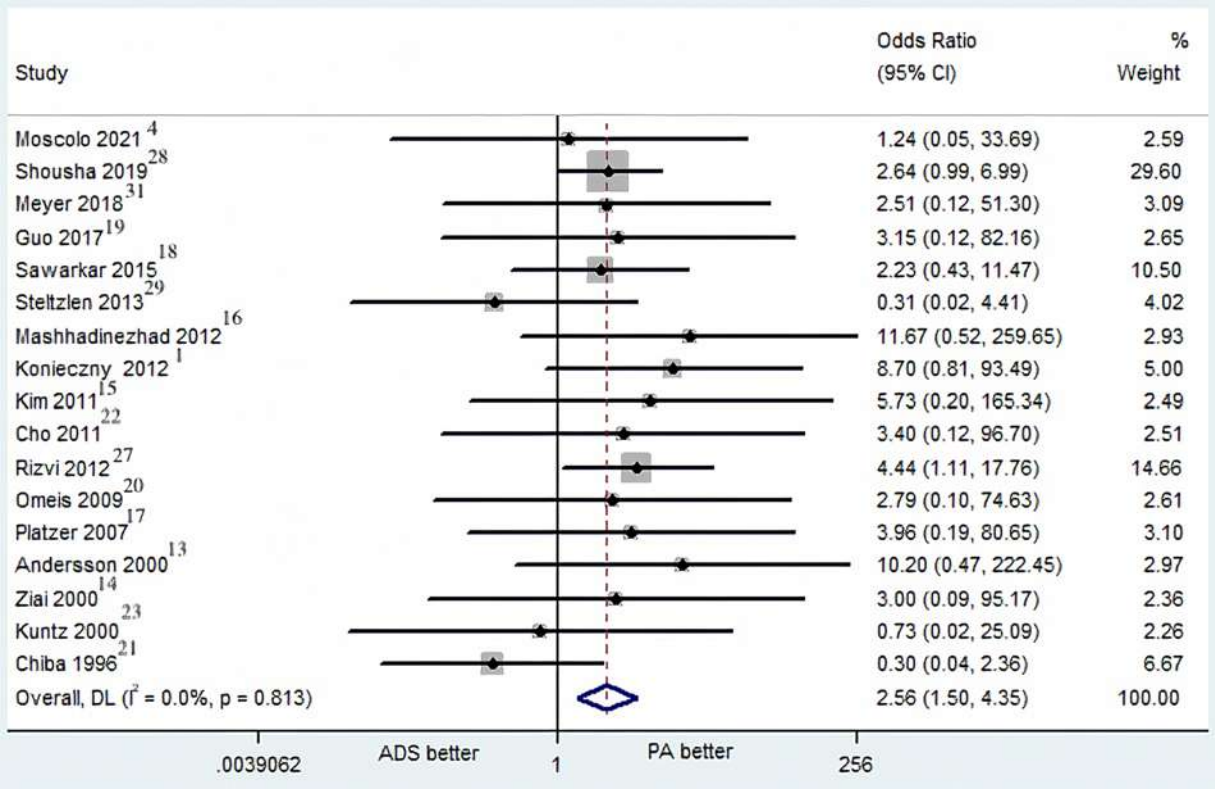

FIG. 3. Forest plot showing the comparison of ADS versus PA in terms of reoperation. Figure is available in color online only.

odds of reoperation compared to the PA group (ADS 12.4%; PA 5.2%; OR 2.56; 95% CI 1.50–4.35; I^2 0%) (Fig. 3). The rates of technical failure (ADS 2.3%; PA 1.1%; OR 1.11; 95% CI 0.52–2.37; I^2 0%) (Fig. 4) and all-cause mortality (ADS 6%; PA 4.8%; OR 1.35; 95% CI 0.67–2.74; I^2 0%) were similar between the two groups. Publication bias was not detected for the above outcomes, which was validated with Egger's test (fusion, p = 0.638; reoperation, p = 0.993; technical failure, p = 0.359; and mortality, p = 0.815).

Subgroup Analysis of Patients > 60 Years Old Only

A subgroup analysis was conducted by including studies with patients only > 60 years old. Five studies included patients > 65 years old, whereas 1 study each included patients > 60, > 70, and > 72 years old in each category, respectively. Table 3 presents the important baseline characteristics (age, ADS, PA) of patients in these studies. The ADS group was associated with statistically significant lower odds of fusion at follow-up compared to the PA group (ADS 72.4%; PA 89.9%; OR 0.24; 95% CI 0.06–0.91; I^2 58.7%) (Fig. 5). Reoperation rates were significantly higher in the ADS group compared to the PA group (ADS 13.8%; PA 6.7%; OR 2.67; 95% CI 1.19–6.00; I^2 0%). Technical failure (ADS 5%; PA 1.9%; OR 1.21; 95% CI 0.39–3.75; I^2 0%) and all-cause mortality rates (ADS 9.7%; PA 8.2%; OR 1.55; 95% CI 0.41–5.87; I^2 12.3%) were similar between the study groups.

Discussion

This systematic review and meta-analysis of comparative studies only, included 963 patients in total who underwent surgical treatment for odontoid fracture. Patients in the ADS group were associated with statistically significantly lower odds of fusion and higher odds of reoperation compared to PA. The rates of all-cause mortality and technical failure were similar between the two groups. In patients > 60 years old the same trend persisted although with a stronger effect size in terms of fusion at follow-up; OR of 0.46 for the entire patient cohort versus OR of 0.24 for patients > 60 years old only.

Odontoid fractures and especially type II fractures are associated with particularly high rates of nonunion, reported as high as 40% in the literature if managed conservatively with a halo vest or cervical collar.[33] The goal of surgical stabilization is to increase the rates of bony fusion and can be performed either via an ADS fixation or PA approach. Surgery can be considered especially in patients > 50 years old—noting the risk of complications in elderly patients, type II fractures, dens displacement > 5 mm, and lack of acceptable reduction and alignment while in a cervical collar. Selection of the approach is not always interchangeable and depends on patient-specific factors, fracture characteristics, and surgeon's preference. ADS fixation is an osteosynthetic approach with the major benefit of preserving C1–C2 motion. However, it should be noted that comminuted fractures, cervicothoracic kyphosis, severe osteoporosis, transverse ligament rupture, late fractures, and a fracture line that is not anterosuperior to posterosuperior are considered to be contraindications to the anterior approach. In addition, obesity associated with

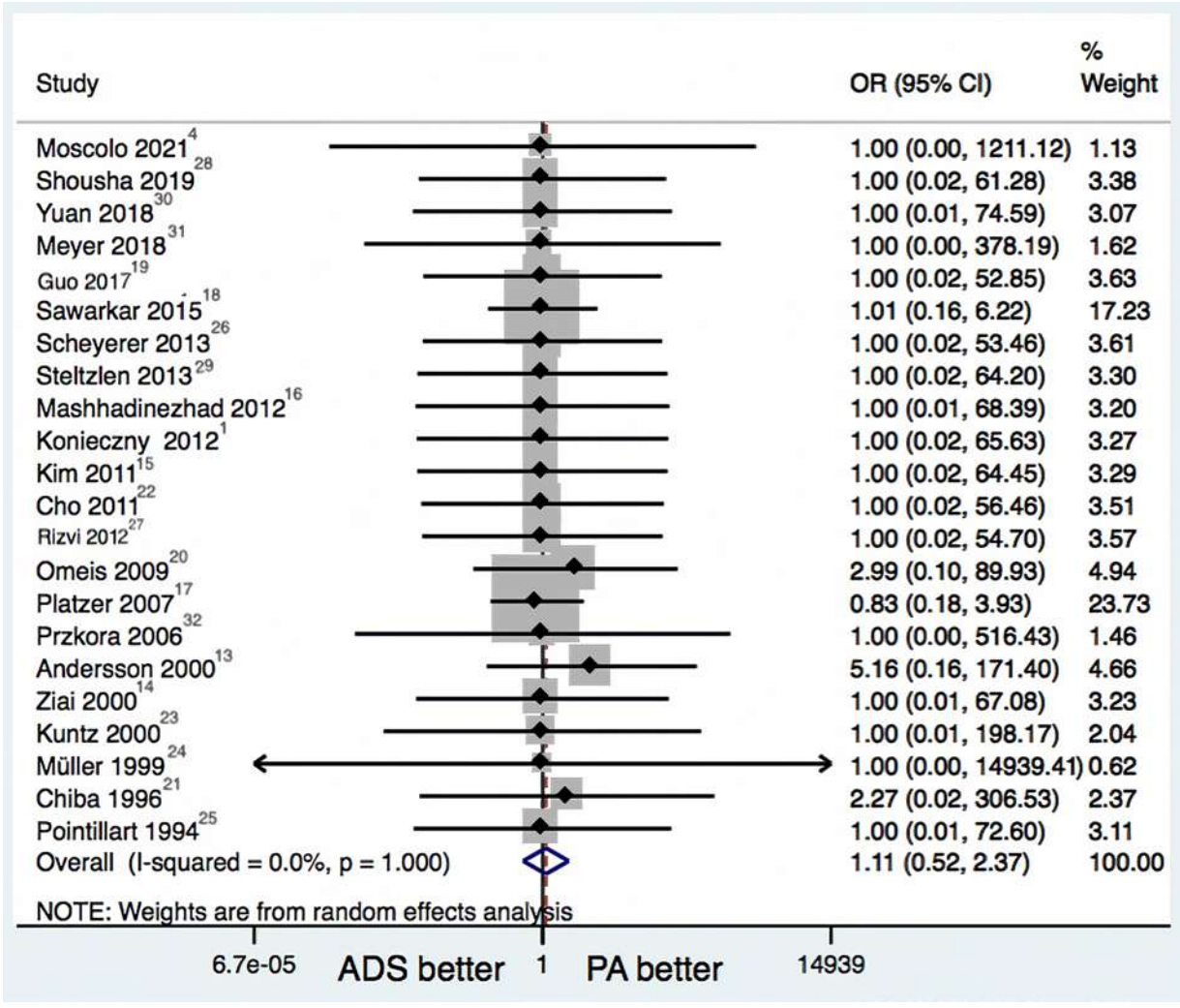

FIG. 4. Forest plot showing the comparison of ADS versus PA in terms of technical failure. Figure is available in color online only.

unsuitable body habitus may have an inherently higher risk of postoperative dysphagia and aspiration pneumonia, which can subsequently increase length of stay, morbidity, and mortality.

With this meta-analysis of comparative studies only, we showed that the posterior approach was associated with increased likelihood of bony fusion at last follow-up, with the cumulative rates being 84.1% and 92.3% for the ADS and PA groups, respectively. Interestingly, in our subgroup analysis including patients > 60 years old only, the effect size was even stronger—OR 0.46 for the entire patient cohort versus OR 0.24 for patients > 60 years old only. The cumulative rates of bony fusion in this subgroup were 72.4% for the ADS and 89.9% for the PA groups. Considering the above findings, it would have been useful to perform a subgroup analysis for younger patients (i.e., age < 50 years); it is possible that the statistically significant differences in fusion rates would disappear given that there is a stronger effect size in elderly patients. Unfortunately, that was not statistically feasible with the given data from the included studies. Compared to prior meta-analyses,[8,34] our study has provided almost double the sample size and has provided further evidence that the PA is superior to ADS fixation in terms of fusion and reoperation rates. In addition, our study used a random-effects model meta-analysis; given the heterogeneity of patients/surgical approaches, we believe that this is more appropriate than a fixed-effects model, which was used by prior studies.

The rates of reoperation were higher in the ADS compared to the PA group, both in the entire cohort and in the subgroup of patients > 60 years old only. The cumulative rates and effect sizes were similar when comparing outcomes for the entire cohort and for patients > 60 years old only (entire cohort: ADS 12.4%, PA 5.2%, OR 2.56; > 60 years old only: ADS 13.8%, PA 6.7%, OR 2.67). Even though the rates of technical failure were not statistically different in our analyses, the cumulative rates show a potentially important clinical difference. More specifically, in our cohort analysis 2.3% of the ADS and 1.1% of the PA groups experienced a technical failure. This trend persisted in the subgroup analysis of patients > 60 years old only (ADS 5%, PA 1.9%). It is likely that statistical power was too low to detect a statistically significant difference

TABLE 3. Baseline characteristics of studies of odontoid fracture included in the subgroup analyses for patients ≥ 60 years old

Study	Age (yrs)	No. Ant	No. Pst
Andersson et al., 2000[13]	66–99	11	7
Platzer et al., 2007[17]	>65	37	19
Omeis et al., 2009[20]	70–94	16	13
Kuntz et al., 2000[23]	66–92	2	9
Moscolo et al., 2021[4]	65–88	21	2
Przkora et al., 2006[32]	72–93	7	1
Scheyerer et al., 2013[26]	≥60	17	16
Shousha et al., 2019[28]	>60	47	86
Total		158	153

between the two groups. All-cause mortality rates were similar between the two groups in both our cohort and subgroup analysis.

Limitations

Our results should be interpreted in the context of several limitations. First, results stemming from analyses of observational studies are subject to their inherent risk of bias due to the nonrandomized design and nonblinded nature. Second, in the real-world setting, even though all studies included in this meta-analysis reported a direct head-to-head comparison of ADS fixation versus PA, the inherent selection bias due to patient-related factors, surgeons' preference, and fracture characteristics could not be adjusted for. Third, even though it appears that age might be a significant factor affecting the rates of fusion, it would be interesting to investigate whether in younger patients ADS fixation can perform equally well or if it is superior to PA in terms of fusion rates. In addition, there is increased heterogeneity in the surgical approaches used by the included studies especially in the PA group. Unfortunately, the included studies did not consistently report outcomes based on the different PA techniques; therefore, whether a specific dorsal approach technique is superior to the other cannot be investigated in the present study. The majority of patients in the PA group underwent C1–C2 arthrodesis, and a smaller percentage underwent other rigid (C1–C3, occipitocervical fusion) versus semirigid (cables/wires) versus temporary fixation techniques. Including the semirigid techniques in the PA group could in theory decrease the rate of bony fusion and, therefore, if we were able to perform a subgroup analysis excluding these cases, the effect size of bony fusion favoring the PA group would only be stronger. Also, three of the studies reported included both acute and chronic fractures but did not provide outcomes based on the chronicity of the fracture, which precludes us from performing further subgroup analyses. Attempts to obtain additional information were unsuccessful. Last, the range for duration of follow-up across the studies and was rather limited in some. Future prospective studies or national registries are required to validate our results. These studies should provide patient-level data to allow for identification of potential confounders and significant factors that can affect outcomes, including reporting outcomes based on the specific PA technique used.

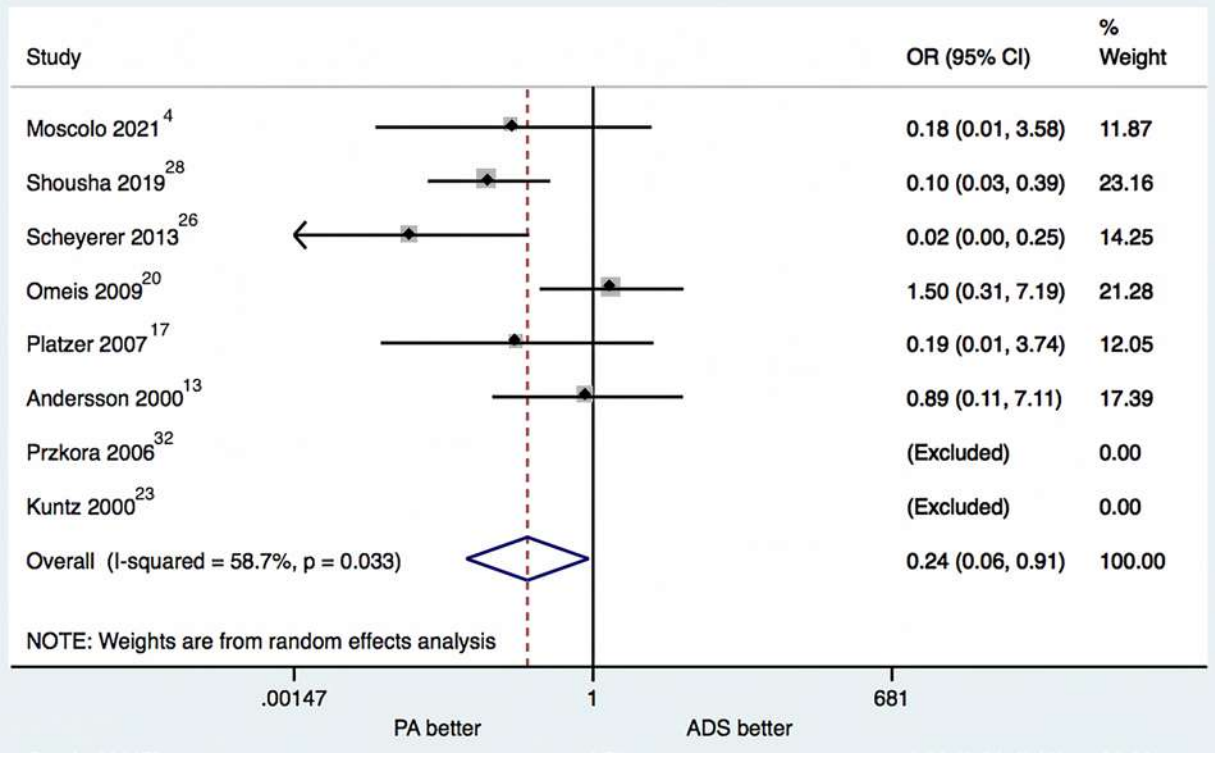

FIG. 5. Forest plot showing the comparison of ADS versus PA in terms of fusion for patients > 60 years old. Figure is available in color online only.

Conclusions

This systematic review and meta-analysis of ADS fixation versus PA for odontoid fractures included 963 patients in total. Patients in the ADS group were associated with statistically significantly lower odds of fusion and higher odds of reoperation compared to PA, and the former would therefore be the preferred approach. The rates of all-cause mortality and technical failure were similar between the two groups both in the entire cohort and in the subgroup analysis. In patients > 60 years old only, ADS fixation was still associated with lower odds of fusion, with an even stronger effect size. Reoperation rates were still significantly higher in the ADS versus PA group in patients > 60 years old.

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Dr. Dahdaleh reported personal fees from DePuy and from Stryker Spine during the conduct of the study.

Author Contributions

Conception and design: Texakalidis, Matsoukas, Karras, Frankel, Dahdaleh. Acquisition of data: Texakalidis, Matsoukas, Karras, Frankel. Analysis and interpretation of data: Texakalidis, Frankel. Drafting the article: Texakalidis, Swong. Critically revising the article: Texakalidis, Karras, Frankel, Swong, Stricsek, Dahdaleh. Reviewed submitted version of manuscript: Texakalidis, Frankel, Swong, Stricsek, Dahdaleh. Approved the final version of the manuscript on behalf of all authors: Texakalidis. Statistical analysis: Texakalidis. Administrative/technical/material support: Swong. Literature search and screening: Matsoukas.

Correspondence

Pavlos Texakalidis: Northwestern Memorial Hospital, Chicago, IL. pavlos.texakalidis@northwestern.edu.