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Presentation and Outcomes After Medical and Surgical Treatment Versus Medical Treatment Alone of Spontaneous Infectious Spondylodiscitis: A Systematic Literature Review and Meta-Analysis.

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Presentation and Outcomes After Medical and Surgical Treatment Versus Medical Treatment Alone of Spontaneous Infectious Spondylodiscitis: A Systematic Literature Review and Meta-Analysis

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Abstract

Study Design: Systematic literature review.

Objectives: The aims of this study were to (1) describe the clinical features, disabilities, and incidence of neurologic deficits of pyogenic spondylodiscitis prior to treatment and (2) compare the functional outcomes between patients who underwent medical treatment alone or in combination with surgery for pyogenic spondylodiscitis.

Methods: A systematic literature review was performed using PubMed according to PRISMA guidelines. No year restriction was put in place. Statistical analysis of pooled data, when documented in the original report (ie, number of patients with desired variable and number of patients evaluated), was conducted to determine the most common presenting symptoms, incidence of pre- and postoperative neurologic deficits, associated comorbidities, infectious pathogens, approach for surgery when performed, and duration of hospitalization. Outcomes data, including return to work status, resolution of back pain, and functional recovery were also pooled among all studies and surgery-specific studies alone. Meta-analysis of studies with subgroup analysis of pain-free outcome in surgical and medical patients was performed.

Results: Fifty of 1286 studies were included, comprising 4173 patients undergoing either medical treatment alone or in combination with surgery. Back pain was the most common presenting symptom, reported in 91% of patients. Neurologic deficit was noted in 31% of patients. *Staphylococcus aureus* was the most commonly reported pathogen, seen in 35% of reported cases. Decompression and fusion was the most commonly reported surgical procedure, performed in 80% of the surgically treated patients. Combined anterior-posterior procedures and staged surgeries were performed in 33% and 26% of surgeries, respectively. The meta-analysis comparing visual analog scale score at follow-up was superior among patients receiving surgery over medical treatment alone (mean difference −0.61, CI −0.90 to −0.25), while meta-analysis comparing freedom from pain in patients receiving medical treatment alone versus combined medical and surgical treatment demonstrated superior pain-free outcomes among surgical series (odds ratio 5.35, CI 2.27-12.60, P < .001), but was subject to heterogeneity among studies ($I^2 = 56\%$, $P = .13$). Among all patients, freedom from pain was achieved in 79% of patients, and an excellent outcome was achieved in 73% of patients.

Conclusion: Medical management remains first-line treatment of infectious pyogenic spondylodiscitis. Surgery may be indicated for progressive pain, persistent infection on imaging, deformity or neurologic deficits. If surgery is required, reported literature

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shows potential for significant pain reduction, improved neurologic function and a high number of patients returning to a normal functional/work status.

Keywords
discitis, spondylodiscitis, osteodiscitis, pyogenic, back pain, outcome

Introduction

Spondylodiscitis is an infectious disease of the intervertebral disc space and adjacent vertebral end plates.[1] Most patients with discitis present initially with back pain and often have significant delays in time to diagnosis.[2] Severity of back pain can be quite significant, resulting in poor quality of life and disability scores.[3] Continued bone and disc destruction from prolonged, chronic infection may progress to significant spinal deformity in a subset of patients, with resultant worsening quality of life.[4] The goals of this study were first to describe the clinical features, disabilities and neurologic deficits of pyogenic spondylodiscitis on presentation, and second to compare the functional outcomes between patients who underwent medical and surgical management for pyogenic spondylodiscitis.

Methods

Inclusion and Exclusion Criteria

In an effort to maximize inclusion of relevant literature regarding medical and surgical management of primary pyogenic spondylodiscitis, the following inclusion criteria were used: (1) study must contain at least 10 patients, (2) the primary focus of the study must be surgical or medical management with reported outcome of spontaneous discitis, (3) article must be written in English, (4) the study must involve human subjects, and (5) the articles must be found in MEDLINE journal categories. Case reports, reviews, technical notes, or studies involving primarily pediatric patients (age <18 years), vertebral abscess, iatrogenic discitis, or those focusing on one specific pathogen were excluded. If multiple studies were published by a single author, only the largest series was included.

Literature Search

For the present systematic review, a focused search on PubMed was considered sufficient. A systematic review was performed on March 21, 2018 using PubMed with the following search term: ("discitis" OR "spondylodiscitis" OR "diskitis") and ("management" OR "treatment" OR "surgery" OR "surgical"). Results were restricted to Medline journal categories regarding human subjects and published in English, of which 1286 articles resulted. Article titles were evaluated to identify those related to the medical or surgical management and outcomes of discitis or vertebral osteomyelitis. Studies not meeting the aforementioned inclusion criteria were excluded (Figure 1). A total of 111 abstracts were reviewed and application of inclusion criteria was repeated, which excluded an additional 55 studies. For the remaining 56 studies, we reviewed the full-text journal articles, and 48 achieved criteria for inclusion. Following, a search was performed on Cochrane Review for additional articles using the same inclusion and exclusion criteria, identifying 2 additional articles. Finally, 50 full-text journal articles were available for evaluation.

Literature Review and Data Extraction

A protocol was registered with PROSPERO for this review (CRD42018092268), and the review follows the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[5] When provided by the original article, demographic, clinical, pathological, surgical, and outcome data was extracted from selected studies. Demographic data included the number of patients, sex, age, and associated comorbidities. Clinical data included time to diagnosis, imaging modality, presenting symptoms, relevant laboratory values, culture source, and results. Outcome data included duration at follow-up, pain at follow-up, presence of neurologic deficits, and return to work. A composite score of excellent functional outcomes was created to capture the various reports of return to work with normal activity, freedom from pain at last follow-up, Oswestry Disability Index (ODI) score less than 20, or a Kirkaldy-Willis Score of 3 or greater. Surgery-specific series were further evaluated to determine type of surgery (decompression alone, decompression and fusion, combined anterior-posterior approach, or staged surgery).

Statistical Analysis

Pooled data were gathered from all available articles and continuous variables were summarized with means calculated based on the numbers of patients pooled from each article. When available, comparison of pain outcomes after medical and surgical treatment versus medical treatment alone was performed using Review Manager (RevMan), version 5.3 (Copenhagen: The Nordic Cochrane Centre, the Cochrane Collaboration, 2012). Odds ratios for individual studies and the sum of studies were computed using the Mantel-Haenszel test. Mean difference was determined using RevMan as well. Study heterogeneity was detected using the chi-square and I^2 test statistics. Given the limitations on the power of the chi-square test by the small number of studies in the analyses, significant heterogeneity was considered to be present when both the chi-square value was within 10% level of significance ($P < .10$) or the I^2 value exceeded 50%.

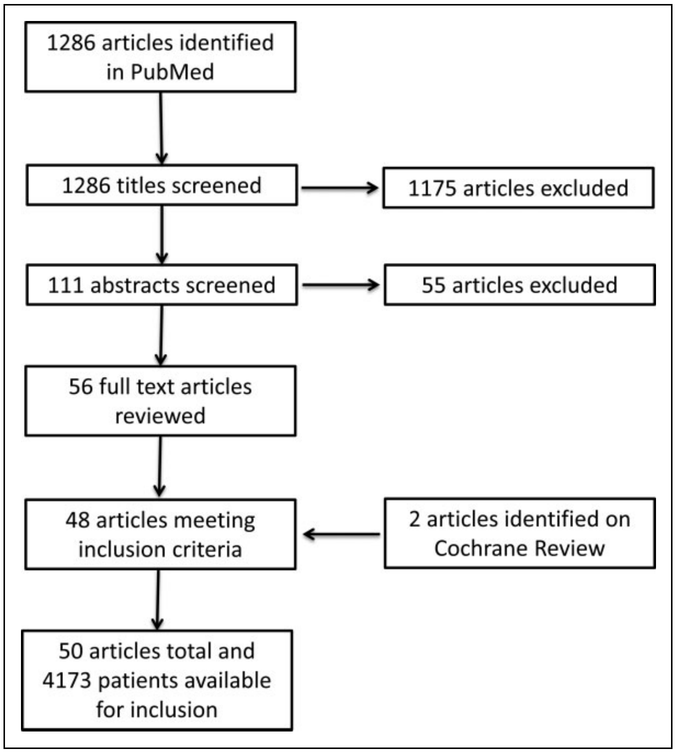

Figure 1. Flowchart outlining the systematic review process. The initial PubMed search resulted in 1286 articles. Subsequent screening and application of inclusion and exclusion criteria yielded 50 total articles to undergo detailed review and pooling of data. Two additional articles were identified after similar process through Cochrane Review.

Results

Study Selection

The search term resulted in 1286 articles for review. Among these, 111 articles were selected for further review of abstracts based on title and relevance to inclusion and exclusion criteria. Application of inclusion and exclusion criteria to study abstracts yielded 56 articles. The full-text articles for these 56 studies were then reviewed and subjected to our inclusion criteria, after which 48 articles were eligible for systematic review.[3,6-52] (Figure 1) Following an additional search on Cochrane Review, 2 additional studies[53,54] were found, and a total of 50 articles were eligible for final systematic review (Tables 1 and 2) 16 studies reported both surgical and medical outcomes. All but 3 studies were retrospective in nature.

Demographic and Presenting Clinical Data

Demographic and clinical data for the 4173 patients from the 50 studies included in this systematic review are summarized in Table 3. The mean patient age at presentation was 58.3 years, and 60% of the patients were men. The mean time to diagnosis from initial symptom onset was 54.93 days. Back pain was the most commonly reported presenting symptom, occurring in 91% (2101/2299) of patients. Other commonly observed findings included fever (35%, 748/2125) and focal neurologic deficits (29%, 1009/3422. Among the patients treated surgically, back pain (88%, 674/770) and focal neurologic deficits (39%, 475/1224) were the most commonly reported findings. Concurrent infection (35%, 207/834) and cardiovascular disease (24%, 260/1083) were the most common comorbidities associated with infectious discitis. Other common comorbidities included intravenous drug abuse (IVDA) (15%, 226/1379), diabetes mellitus (20%, 651/3272), immunosuppression (11%, 274/2429), and end stage renal disease (9%, 111/1263) (Table 3).

Laboratory and diagnostic data are summarized in Table 4. C-reactive protein (CRP) was elevated (>10 mg/L) in 85% (1083/1272) of patients, and erythrocyte sedimentation rate (ESR) was elevated in 69% (464/672) of patients. Leukocytosis was found in 43% (457/1052) of patients. Magnetic resonance imaging (MRI) and nuclear bone scan were diagnostic in 94% (980/1045) and 93% (14/15) of patients, respectively. Computed tomography (CT) was positive in in 87% (127/146) of patients and plain radiographs in 70% (129/185) of patients. Infection occurred in the cervical region in 12% of reported sites (459/3824), 31% in the thoracic spine (1219/3919), and 62% in the lumbar spine (2463/3943). Blood cultures were positive in only 51% of 930 reported cases, compared to 57% (149/261) of percutaneous biopsies and 58% (296/511) of surgical biopsies. Commonly isolated pathogens were *Staphylococcus aureus* (38%, 1268/3360), *Mycobacterium tuberculosis* (15%, 126/866), and *Streptococcus* species (12%, 181/1472). Blood cultures were negative in 28% of cases (Table 4).

Treatment and Outcomes

Decompression with instrumented fusion was the most commonly performed intervention reported (79%, 1049/1321), compared to decompression alone (22%, 223/1024) based on the respective series reporting each variable. Combined anterior and posterior approach was performed in 33% (448/1364) of surgical patients, and staged surgery was performed in 26% (128/485) of surgical patients. Repeat surgery was necessary in 13% (119/891) of patients among the surgery-specific series (Table 5).

Follow-up was reported in 33 articles, with an average follow-up of 26.14 months. Outcome was reported in various ways (no pain, treatment success, etc), but functional outcome was reported sparingly and using various metrics (return to work, ODI, visual analog scale [VAS] score, Kirkaldy-Willis [KW]). Four studies (all surgical) reported return-to-work outcomes, with 88% (83/94) of patients reported as returning to normal work activities at last follow-up. Neurologic deficits decreased among all patients from 29% at presentation to 12% at follow-up, and from 39% among all surgical patients to 15% at follow-up. A composite score was made to identify all patients with a KW score of 3 or greater, ODI <20%, pain freedom, or return to normal work status. Excellent functional outcomes were reported in 73% (895/1234) of all patients, and in 68% (376/555) of surgical patients. Mortality rate was 8% among all patients, and 6% among surgical patients.

Two studies reported pain outcome of surgical and medical management cohorts separately at last follow-up, with 85%

Table 1. Summary of the 50 Studies Included in Pooled Data for Presenting Features of Pyogenic Spondylodiscitis.

		Demographics			Presentation			Lesion Location		
First Author, Year	Paper Type	Patients (n)	Men (n)	Mean Age (Years)	Time to Diagnosis (Days)	Back Pain	Neurological Findings	Cervical	Thoracic	Lumbar
Aagaard, 2013	Retrospective review	100	37	60	32			25	26	65
Asamoto, 2005	Retrospective review	21	13	66		19	12	5	7	11
Ascione 2017	Retrospective review	30	13	64	28	30	5	0	2	20
Bernard, 2015	Randomized controlled trial	351	242	61		337	57	52	96	246
Bettini, 2009	Retrospective review	56	21	48	34	56	18	3	8	48
Butler, 2006	Retrospective review	48	24	59		47	14	4	11	30
Bydone, 2014	Retrospective review	118		57		67	61	35	40	43
Cebrian, 2012	Retrospective review	108	49	68		97	27	4	38	66
Chung, 2011	Retrospective review	20	13	60		20	14	0	8	12
Citak, 2014	Retrospective review	183	99	63			80	14	66	97
D'Agostino, 2010	Prospective series	81	51	58	55.4	79	12	10	59	12
D'Aliberti, 2012	Retrospective review	40	29	56		39	16	13	18	9
Dennis, 2017	Retrospective	84	49	62		68	19	29	79	156
Eysel, 1997	Retrospective review	55	28	52						
Ha, 2007	Retrospective review	24	14			23	7	0	0	24
Hadjipavlou, 2000	Retrospective review	101	76	46			40	10	33	55
Heyde, 2006	Retrospective review	20	11	60	84		9			
Homagk, 2016	Retrospective review	270	153		64		101	30	103	149
Hopf, 1998	Retrospective review	72	39	52				0	40	49
Karadimas, 2008	Retrospective review	163	101	56				13	72	88
Kaya, 2014	Retrospective review	107	64	53		97	18	7	14	90
Kehrer, 2015	Retrospective review	298	182	66			33	38	95	203
Klockner, 2003	Retrospective review	71	38	54			18	0	33	39
Krodel, 1991	Retrospective review	24		50						
Legrand, 2001	Retrospective review	110	67	61	40		18	3	23	69
Lemaignen, 2017	Retrospective review	394	267	63	40	369	130	71	137	281
Lin CP, 2012	Retrospective review	48	19	67	144	48	28	0	16	38
Lin TY, 2014	Retrospective review	45	25	62				0	9	36
Lin Y, 2015	Retrospective review	22	13	55		22	8	0	0	22
Lu, 2015	Retrospective review	28	13	60			6	0	2	28
Mann, 2004	Prospective series	24	14	63		24	13	4	10	10
Nasto, 2014	Retrospective review	27	18	60	33			0	5	22
Noh, 2017	Retrospective review	31	27	68		18		3	8	20
Pee, 2008	Retrospective review	60	36	59		58	16	0	0	60
Rath, 1996	Retrospective review	43	24	60	46		35	0	19	24
Shinkel, 2003	Retrospective review	32	18	61		32	17	21	19	35
Schomacher, 2014	Retrospective review	37	24	62		37		6	6	25
Shetty, 2016	Retrospective review	27	19	48			6			
Shiban, 2014	Retrospective review	113	78			104	40			
Shousha, 2012	Retrospective review	30	19	65		24	12	30	0	0
Sobottke, 2009	Retrospective review	20	14	43	23		3	2	6	12
Srinivasan, 2014	Retrospective review	48	29	56						
Suess, 2007	Retrospective review	24	15	65	9	24	7	3	14	7
Tsai, 2017	Retrospective review	90	61	61						
Valancius, 2013	Retrospective review	196	106		52.5	177	47	9	42	125
Vcelak, 2014	Retrospective review	31	20	61			9		6	25
Viale, 2009	Prospective series	48	36	60			9	6	9	29
Wirtz, 2000	Retrospective review	59	29	61	90	46				
Yaldz, 2015	Retrospective review	39	19	47	105	37	18	0	15	24
Ziu, 2014	Retrospective review	102	87	45		102	26	9	24	59

(50/59) of surgical patients reporting freedom from pain compared with 52% (37/72) of medical patients (odds ratio [OR] 5.35, CI 2.27-12.60, $P < .001$)[6,20] (Figure 2). Two articles also reported VAS at follow-up in medical and surgical patients, with surgical patients experiencing a significantly lower VAS score compared with medical patients (mean difference −0.61, CI −0.98 to −0.25).[35,47] Significant study heterogeneity was observed in both meta-analyses (Figures 2 and 3).

Table 2.

First Author, Year	Surgical Treatment: Decompression or Decompression and Fusion	Follow-up: Patients (n)	Duration (Months)	Neurologic Deficits	Return to Work	Pain Free	Oswestry Disability Index <20%	Excellent Functional Outcome
Aagaard, 2013		94	3	26				
Asamoto, 2005		21					11	11
Ascione, 2017		30	30	8		22	4	22
Bernard, 2015		283	12	10				
Bettini, 2009	3	56	12					
Butler, 2006				0				
Bydone, 2014	118		15	23				
Cebrian, 2012		108	6			35		35
Chung, 2014	20	20	36	4	20	20		20
Citak, 2011	102	183						
D'Agostino, 2010	10	72						65
D'Aliberti, 2012	40	40	43	13		17		17
Eysel, 1997	55		42					
Ha, 2007				1				
Hadjipavlou, 2000	62	47		14				
Heyde, 2006			37	3				
Homagk, 2016								
Hopf, 1998		72	38	1				
Karadimas, 2008	93	163	12	22				
Kaya, 2014							94	94
Klockner, 2003	71	71	64					
Krodel, 1991			36					
Legrand, 2001		99	3				42	42
Lemaignen, 2017	58	378	5	26				
Lin CP, 2012	48	48	64		32		32	32
Lin TY, 2014	45	45	24					
Lin Y, 2015	22	22	31	0			19	19
Lu, 2015	28	28	20	0	10		15	25
Mann, 2004		24			15			15
Nasto, 2014	12	27	9					
Pee, 2008	60	60	36	5				
Rath, 1996	45	41		15				
Shinkel, 2003	32	20	49	10				
Schomacher, 2014	37	37	20					
Shiban, 2014	106		3	16				
Shousha, 2012	30	27	28					
Sobottke, 2009		11	13					
Srinivasan, 2014		48						
Suess, 2007	24	24	18					
Tsai, 2017	43							
Valancius, 2013	117	80	12			64		64
Vcelak, 2014	31	30	12				27	27
Wirtz, 2000		59	26					
Yaldz, 2015	12	39	96	1				
Ziu, 2014	24	66	7					

Discussion

Spondylodiscitis is an infectious disease of the intervertebral disc space and adjacent bone that occurs secondary to hematogenous seeding or direct spread from an adjacent infection site.[1] Though epidural abscess may be seen in patients with pyogenic discitis, neurologic symptoms in the setting of abscesses are often dealt with through prompt surgical evacuation and not necessarily as a means of source control, spinal stabilization, or resolution of infection, and thus must be thought of separately from management of vertebral osteomyelitis and discitis.[55] Thus, we did not include articles primarily discussing management of epidural abscess.

In the pathogenesis of discitis, bacteria seed the arterioles of the vertebral end plates, resulting in pathogen deposition into the relatively avascular intervertebral disc or adjacent vertebral

Table 3.

Demographic and Clinical Data (n = Number of Studies)			
No. of patients (n = 50)		4173	
Percent men (n = 48)		60	
Age (years) (n = 46)		58.28	
Time to diagnosis (days) (n = 16)		54.93	
Length of follow-up (months) (n = 33)		26.14	
Comorbidities	**Number**	**Total**	**Percent**
Concurrent infection (n = 14)	207	834	35
Cardiovascular disease (n = 13)	260	1083	24
Intravenous drug abuse (n = 14)	226	1379	15
Diabetes (n = 33)	651	3727	20
Immunosuppression (n = 20)	274	2429	11
End-stage renal disease (n = 17)	111	1263	9
Back pain on presentation (n = 28)	2101	2299	91
Fever on presentation (n = 21)	748	2125	35
Neurologic deficits on presentation (n = 38)	1009	3422	29

Table 4.

Laboratory and Diagnostic Data (n = Number of Studies)	Number	Total	Percent
Imaging			
MRI positive (n = 14)	980	1045	94
Bone scan positive (n = 1)	14	15	93
CT positive (n = 4)	127	146	87
X-ray positive (n = 4)	129	185	70
Levels involved			
Cervical (n = 40)	459	3824	12
Thoracic (n = 42)	1219	3919	31
Lumbar (n = 42)	2863	3943	62
Associated abscess (n = 18)	567	1924	29
Labs			
Elevated CRP (>10 mg/L) (n = 16)	1083	1272	85
Elevated ESR (>20 mm/h) (n = 12)	464	672	69
Leukocytosis (n = 16)	457	1052	43
Culture yield			
Surgical biopsy positive (n = 13)	296	511	58
Percutaneous biopsy positive (n = 8)	149	261	57
Blood culture positive (n = 13)	475	930	51
Negative cultures (n = 27)	447	1583	28
Culture results			
Staphylococcus aureus (n = 42)	1268	3360	38
Mycobacterium tuberculosis (n = 23)	126	866	15
Gram-negative rods (n = 28)	214	1810	12
Streptococcus (n = 26)	181	1472	12
Enterococcus (n = 22)	55	913	6

Abbreviations: CRP, C-reactive protein; CT, computed tomography; ESR, erythrocyte sedimentation rate; MRI, magnetic resonance imaging.

Table 5. Surgical Procedures Performed Among Surgical Reports.

Surgery Demographics (n = Number of Studies)	Number	Total	Percent
Decompression and fusion among surgical patients (n = 27)	1049	1321	79
Treated surgically (n = 46)	2133	3384	63
Decompression alone among surgical patients (n = 22)	223	1024	22
Anterior and posterior combined approach (n = 22)	448	1364	33
Staged surgery (n = 13)	128	485	26
Reoperation rate (n = 24)	119	891	13

endplate.[2,8] The poor vascularity of this region results in a relatively safe haven for seeding bacteria and consequently often requires prolonged antibiotic treatment.[8,56] This can be complicated by the natural history of osteomyelitis (a frequent accompanying feature of discitis), in which bacterial growth and purulence within vascular channels results in increased intraosseous pressure and further worsening blood flow.[57]

Diagnosis of discitis begins with the clinical presentation, whereby the vast majority of patients (91% in this series) present with back pain. Serum studies have low specificity for disease and may be unreliable in diagnosis.[57] Still, ESR and CRP are frequently elevated, and C-reactive protein levels may be useful in determining clinical response after diagnosis is made.[57] Ultimately diagnosis requires advanced imaging, with MRI demonstrating superiority in specificity compared with CT.[1,57,58] Antibiotics are typically withheld until after percutaneous or surgical biopsy has been performed, unless a patient demonstrates evidence of septicemia or neurologic deficit.[56] Withholding antibiotics is of particular importance as biopsy yield can decrease considerably following initiation of antibiotics.[56] *Staphylococcus aureus* was the most common organisms isolated among pyogenic causes of discitis. This organism was found in 38% of the cases in this systematic review. Of particular concern with pyogenic discitis is the rising prevalence of methicillin-resistant species of *Staph aureus* and the implications associated with prolonged disease due to poor bone penetrance of vancomycin.[2]

With treatment resistant pathogens arises the possibility of prolonged infection and continued destruction of the vertebral end plates and disc, which can result in progressive spinal deformity and poor functional outcomes.[1,4,56,57,59] Among historical series, in which tuberculosis accounted for a substantial portion of spondylodiscitis cases, as many as 61% of patients developed spinal deformity.[2,8] With further osseous and discoligamentous destruction and deformity, kyphosis and worsened focal spinal alignment may result in increased back pain and overall global sagittal malalignment, which has been repeatedly shown to increase disability scores and reduce quality of life.[60] Among patients with deformity, and in particular segmental kyphosis, surgery offers an opportunity for debridement, source control, and correction of deformity.

Unfortunately, reporting of functional outcome or return-to-work data among both medical and surgical literature is lacking. In the current review functional outcomes were reported in only 20 studies (13 surgical) and return to work status was reported in only 4 studies.[3,13,34,41] Among the included surgical series, 88% of patients were able to return to normal work activity. Surgical

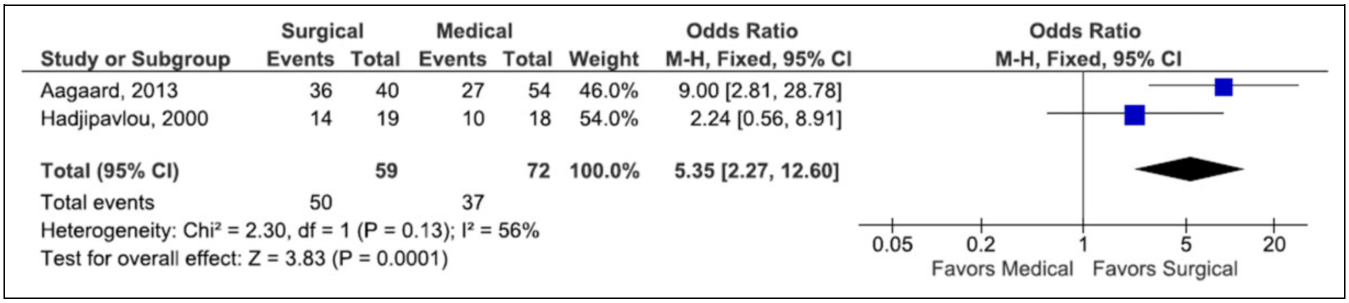

Figure 2. Forest plot of the odds ratios (ORs) of pain free outcomes among surgical and medical cohorts with infectious spondylodiscitis. The estimated OR and 95% confidence interval (CI) of each included study are represented by the center of the squares and the horizontal line, respectively. The summary OR and 95% CI are represented by the diamond. Heterogeneity and overall effect are given below the summary statistics.

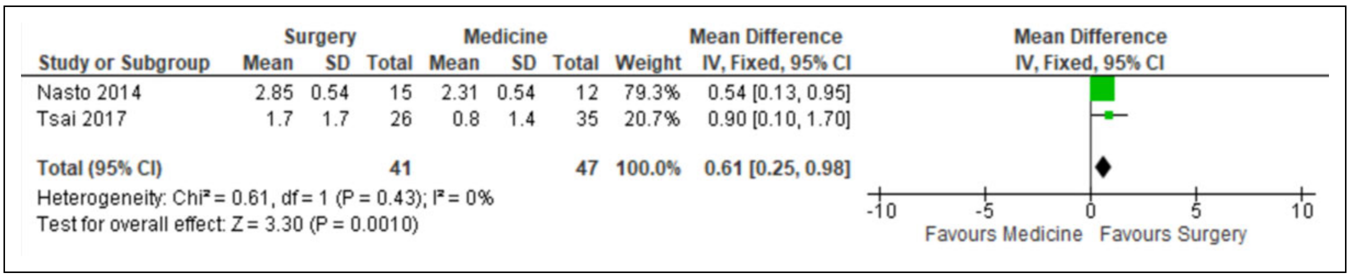

Figure 3. Forest plot of the mean difference in visual analog score among surgical and medical cohorts with infectious spondylodiscitis. The estimated mean difference and 95% confidence interval (CI) of each included study are represented by the center of the squares and the horizontal line, respectively. The summary mean difference and 95% CI are represented by the diamond. Heterogeneity and overall effect are given below the summary statistics.

patients experienced excellent outcomes in 68% of those reported at follow-up, which is comparable to all patients where an excellent outcome was achieved in 73% of patients. Pain outcomes and VAS scores for both surgical and medical management were investigated by 2 separate meta-analyses. While the results from the available data suggest improved pain ratings with surgery compared with the medical treatment alone, significant heterogeneity ($I^2 = 56\%$, $P = .13$; $I^2 = 0\%$, $P = .43$) was detected in both studies preventing definitive determination of the influence of surgery on pain outcomes. For both analyses, these results can be attributed to the small sample sizes and it must be noted that lack of control of treatment strategy (operative vs nonoperative) and surgical procedure performed further obscures interpretation of outcome data.

The reports by Nasto et al[35] and Tsai et al[47] suggest a more rapid recovery and improvement in functional scores following surgery when compared with medical treatment alone, but with diminishing significance over time. These results suggest that surgery may have a role in enhancing patient's short-term recovery but may be unlikely to change long-term results as most patients will have substantial improvement in back pain regardless of treatment modality. Lemaignen et al[30] also demonstrated that surgery was protective of functional outcome on univariate analysis but not on multivariate analysis. These findings support the need for additional research to delineate what role surgery may have in improving functional outcomes.

This study is also limited by the availability of pooled data from mostly retrospective studies, each with their own inherent biases and a general lack of uniformity in reporting of outcomes. The lack of consistent reporting of outcomes for surgical and medical series, as well as for particular surgical procedures (instrumentation vs decompression alone), limits our ability to perform further meta-analysis or subgroup analysis. Furthermore, the retrospective case series may suffer from selection bias as patients who were treated surgically tended to be those who suffered intractable back pain, neurologic deficit or progressive spinal deformity, and thus outcome comparison between medical and surgical treatments may be inherently biased. Furthermore, the limitation of the search to English may lead to reporting bias. No randomized studies were identified in this literature review comparing surgical and medical therapies. Future prospective studies limiting comparison of surgical and medical patients to those with similar clinical features may reduce errors due to selection bias and provide further insight into clinical outcomes.

Conclusions

Spondylodiscitis is a disease with increasing prevalence that can result in poor functional outcome and progressive spinal deformity. According to this study, most patients with spondylodiscitis present with back pain. MRI and bone scan are the most sensitive imaging modalities for detecting infectious spondylodiscitis, and *Staph aureus* is the most common organism isolated from cultures. Medical treatment is often first-line management for infectious discitis, but surgery may be indicated in cases of significant or worsening neurologic deficit, recalcitrant infections, or progressive spinal deformity. Functional outcomes suggest surgery may result in a greater reduction in pain compared to medical treatment alone, but substantial patient heterogeneity prevents definitive conclusions. Further, this meta-analysis included retrospective studies, and so its conclusions should be interpreted with caution. Direct comparison in prospective trials is needed to reduce selection bias and definitively determine the appropriate treatment algorithm.

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