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Systematic Review

# Spinal Endoscopic Adhesiolysis in Post Lumbar Surgery Syndrome: An Update of the Assessment of the Evidence

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**Background:** Post lumbar surgery syndrome refers to pain occurring or present after lumbar surgery. While the causes of pain after lumbar surgery are multi-factorial, scarring is a significant source of that pain. Low back and/or leg pain after lumbar surgery can persist despite appropriate conservative therapy. Spinal endoscopy allows direct visual evaluation of the epidural space, along with mechanical lysis of any adhesions present.

**Study Design:** A systematic review of the effectiveness of spinal endoscopic adhesiolysis in post lumbar surgery syndrome.

**Objective:** To evaluate and update the effectiveness of spinal endoscopic adhesiolysis in treating post lumbar surgery syndrome.

**Methods:** The available literature on spinal endoscopic adhesiolysis in treating post lumbar surgery syndrome was reviewed. The quality assessment and clinical relevance criteria utilized were the Cochrane Musculoskeletal Review Group criteria as utilized for interventional techniques for randomized trials and the criteria developed by the Newcastle-Ottawa Scale criteria for observational studies.

The level of evidence was classified as good, fair, and limited or poor based on the quality of evidence developed by the U.S. Preventive Services Task Force (USPSTF).

Data sources included relevant literature identified through searches of PubMed and EMBASE from 1966 to September 2012, and manual searches of the bibliographies of known primary and review articles.

**Outcome Measures:** Pain relief and functional improvement were the primary outcome measures. Other outcome measures were improvement of psychological status, opioid intake, and return to work.

Short-term effectiveness was defined as improvement of 12 months or less; whereas, long-term effectiveness was defined 12 months or longer.

**Results:** For this systematic review, 21 studies were identified. Of these, one randomized controlled trial (RCT) and 5 observational studies met the inclusion criteria. Two of the observational studies were excluded because of other methodological issues, despite showing positive outcomes.

Using current criteria for successful outcomes, these studies indicate that there is fair evidence for the effectiveness of spinal endoscopy in the treatment of persistent low back and/or leg pain in post lumbar surgery syndrome.

**Limitations:** The limitations of this systematic review include the paucity of literature.

**Conclusion:** The evidence is fair that spinal endoscopy is effective in the treatment of post lumbar surgery syndrome.

**Key words:** Spinal pain, chronic low back pain, post lumbar surgery syndrome, epidural scarring, adhesiolysis, endoscopy

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Spinal endoscopy is a minimally invasive procedure that allows directed visualization and treatment of pathology in the epidural space. This review focuses on the treatment of epidural scarring causing pain after lumbar spinal surgery. The use of spinal endoscopy is being expanded to include the diagnosis and treatment of other pathologies, including disc herniations and spinal stenosis. These applications are beyond the focus of this review.

Pain after lumbar surgery is common (1-9). With the increasing amount and complexity of surgery being done, persistent back and leg pain after surgery can be expected to increase (10). There are multiple suggested causes for pain after back surgery, including adhesions, secondary stenosis, internal disc disruption at adjacent levels, recurrent disc herniation, facet or sacroiliac joint pain, arachnoiditis, failure to fuse, diagnostic error, and finally, idiopathic despite proper indications and technique (1).

Epidural scarring has several causes, the most common being spine surgery (11-26). The incidence of epidural scar formation in laminectomy without fusion is estimated at 5% to 30% (27). Bosscher and Heavner (28) found that using epiduroscopy as the diagnostic tool, 83% of all post lumbar surgery patients with persistent pain had severe epidural scarring. In patients with more extensive surgery, severe scarring was present in 91% of patients. Using MRI, only 16% of these patients were diagnosed with fibrosis, suggesting that fibrosis is significantly underdiagnosed in this population.

Other causes of scarring include annular tears with nuclear leakage, including after percutaneous procedures, infection, and the cumulative effect of otherwise clinically insignificant venous microbleeds that occur as the spine degenerates (29-35). Epidural scarring can lead to pain (31,36-39), and may be, given its ubiquity after spinal surgery, a cause of pain after surgery (6,40-42). There are several causes of pain after scarring, including tethering of the nerve root, preventing its free movement in the spinal canal and foramen; entrapment of the nerve or of a vein which in turn entraps the nerve, leading to swelling of the nerve with attendant pain, either in the back or legs; sequestration of the nerve, so that medications applied to the nerve cannot reach it (43,44). While some have questioned whether scarring does lead to radicular pain (45,46), others claim the association of radicular pain with scarring (1,44,47-49). Bosscher and Heavner (28) found that concordant pain was found in 84% of patients with post lumbar surgery syndrome and concluded that epidural fibrosis is the underlying pathology in most of these patients. Consequently, post lumbar surgery syndrome with resultant problems contributes to the increasing prevalence of chronic low back pain and associated exploding diagnostic and therapeutic modalities and a disproportionate increase of health care expenditures in the United States and across the world (50-110).

Scarring from post lumbar surgery syndrome has been treated with epidural injections and percutaneous adhesiolysis (1,25,105-113). Imaging techniques, such as computed tomography (CT) and magnetic resonance imaging (MRI) are limited in their ability to either visualize epidural fibrosis or to identify the causes of pain. Spinal endoscopic adhesiolysis offers the advantage of directly visualizing pathology and often in documenting the causes of that pain.

The role of treating adhesiolysis has been evaluated in several systematic reviews, narrative reviews, and guidelines (1,24,77,79,106,109,110,114-117). Hayek et al (1), in 2009, evaluated the effectiveness of endoscopic adhesiolysis in post lumbar surgery syndrome. Van Boxem et al (114) rated the evidence for adhesiolysis as 2 C+, effectiveness only demonstrated in observational studies. The American College of Occupational and Environmental Medicine (ACOEM) found adhesiolysis and, by extension, endoscopic adhesiolysis, was not to be recommended due to insufficient evidence (115). However, these conclusions were contradicted in a reassessment (116). The American Pain Society (APS) guidelines indicate that the level of evidence is poor for spinal endoscopy (77), criticized for flawed synthesis in critical analysis (79,118,119). The National Institute for Health and Clinical Excellence (NICE) has reviewed adhesiolysis, with a description of the procedure, but provided no specific recommendation (117).

It is essential to update systematic reviews to assess current evidence (120,121). Consequently, this systematic review was undertaken to determine the effectiveness and update the current evidence of percutaneous endoscopic adhesiolysis in the treatment of post lumbar surgery syndrome and to determine the risks and adverse effects associated with treatment. The update is from a previous systematic review (1).

## 1.0 Methods

### 1.1 Research Protocol

A systematic review of randomized trials, observational studies, and reports of complications dealing with spinal endoscopy for the treatment of pain of at least 6 months duration in post lumbar surgery patients was

performed. Attendant to this review was an assessment of complications of these procedures.

### 1.2 Eligibility Criteria (Criteria for Including and Excluding Studies in the Systematic Review)

Inclusion criteria were patients suffering with chronic intractable low back pain due to post lumbar laminectomy syndrome with or without radicular findings of at least six months duration. Only spinal endoscopic procedures were evaluated. All studies providing appropriate management with outcome evaluations of 6 months or longer and statistical evaluations were reviewed. Reports without appropriate diagnosis, non-systematic reviews, book chapters, and case reports were excluded. The patients must be at least 18 years old.

### 1.3 Outcomes

The primary outcome was pain relief. Secondary measures were functional improvement, change in psychological status, return to work, and reduction in opioid use or interventions. Historically, a 2-point improvement in the 11-point (0-10) visual analog scale (VAS) was felt to be clinically significant (122-125). However, this standard of relief has changed, so that clinically meaningful improvement is currently defined as a 50% improvement in pain relief or a 40% improvement in functional status (25,107,108,125-141). In this review, either a 3-point or a 50% improvement in VAS or a 40% improvement in functional status was used as the threshold for clinically meaningful improvement.

Short-term effectiveness was defined as less than 12 months; whereas, long-term effectiveness was defined as 12 months or longer.

### 1.4 Key Questions and Analytic Framework

#### *1.4.1 Key Questions*

The first question was whether spinal endoscopy is effective in the treatment of chronic low back and/or lower extremity pain of at least 6 months duration in post-surgical patients non-responsive to conservative treatment, including fluoroscopically guided epidural injections.

The second question to be addressed was the severity and risk of complications associated with these techniques.

#### *1.4.2 Databases and Other Information Sources Used to Identify Relevant Studies*

The review included English language randomized trials, observational studies, and reports of complications published from 1966 to September 2012. Databases included in the search are Medline, EMBASE, Cochrane Review Database, and Google Scholar. Other sources include Clinical Trial Registry, systematic reviews, narrative reviews, and cross-references to the reviews. Bibliographies of reviewed papers were also examined. In addition, authors known to be active in the field were contacted.

#### *1.4.3 Search Strategy*

The search strategy focused on chronic low back pain secondary to post surgery syndrome treated with spinal endoscopy.

Search terms included post lumbar surgery syndrome, failed back surgery syndrome, epidural fibrosis, chronic low back pain, adhesiolysis, epidural neuroplasty, epidural neurolysis, lysis of adhesions, and spinal endoscopy.

### 1.5 Study Selection Process

Only studies of clinical relevance were assessed. Clinical relevance was assessed according to the Cochrane Back Review Group (142,143). Table 1 shows the questions used to assess clinical relevance. At least 3 clinical relevance questions had to be positive for a study to be considered clinically relevant.

### 1.6 Methodological Quality Assessment

The quality of each individual article used in this analysis was assessed by modified Cochrane review

Table 1. *Clinical relevance questions*.

| | P (+) | N (-) | U (unclear) |
|---|---|---|---|
| A) Are the patients described in detail so that one can decide whether they are comparable to those who are treated in practice? | | | |
| B) Are the interventions and treatment settings described in sufficient detail to apply its use in clinical practice? | | | |
| C) Were clinically relevant outcomes measured and reported? | | | |
| D) Is the size of the effect clinically meaningful? | | | |
| E) Are the likely treatment benefits outweigh the potential harms? | | | |

Scoring adapted and modified from Staal JB, et al. Injection therapy for subacute and chronic low-back pain. Cochrane Database Syst Rev 2008; 3:CD001824 (143).

criteria (Table 2) (144) for randomized trials and the Newcastle-Ottawa Scale for observational studies (Tables 3 and 4) (145-147). The case series format for the Newcastle-Ottawa Scale was used for all studies with

Table 2. *Randomized controlled trials quality rating system.*

| | | | |
|---|---|---|---|
| A | 1. Was the method of randomization adequate? | A random (unpredictable) assignment sequence. Examples of adequate methods are coin toss (for studies with 2 groups), rolling a die (for studies with 2 or more groups), drawing of balls of different colors, drawing of ballots with the study group labels from a dark bag, computer-generated random sequence, pre-ordered sealed envelopes, sequentially-ordered vials, telephone call to a central office, and pre-ordered list of treatment assignments. Examples of inadequate methods are: alternation, birth date, social insurance/ security number, date in which they are invited to participate in the study, and hospital registration number. | Yes/No/ Unsure |
| B | 2. Was the treatment allocation concealed? | Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient. | Yes/No/ Unsure |
| C | Was knowledge of the allocated interventions adequately prevented during the study? | | |
| | 3. Was the patient blinded to the intervention? | This item should be scored "yes" if the index and control groups are indistinguishable for the patients or if the success of blinding was tested among the patients and it was successful. | Yes/No/ Unsure |
| | 4. Was the care provider blinded to the intervention? | This item should be scored "yes" if the index and control groups are indistinguishable for the care providers or if the success of blinding was tested among the care providers and it was successful. | Yes/No/ Unsure |
| | 5. Was the outcome assessor blinded to the intervention? | Adequacy of blinding should be assessed for the primary outcomes. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful or:<br>–for patient-reported outcomes in which the patient is the outcome assessor (e.g., pain, disability): the blinding procedure is adequate for outcome assessors if participant blinding is scored "yes"<br>–for outcome criteria assessed during scheduled visit and that supposes a contact between participants and outcome assessors (e.g., clinical examination): the blinding procedure is adequate if patients are blinded, and the treatment or adverse effects of the treatment cannot be noticed during clinical examination<br>–for outcome criteria that do not suppose a contact with participants (e.g., radiography, magnetic resonance imaging): the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed when assessing the main outcome<br>–for outcome criteria that are clinical or therapeutic events that will be determined by the interaction between patients and care providers (e.g., co-interventions, hospitalization length, treatment failure), in which the care provider is the outcome assessor: the blinding procedure is adequate for outcome assessors if item "4" (caregivers) is scored "yes"<br>–for outcome criteria that are assessed from data of the medical forms: the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed on the extracted data. | Yes/No/ Unsure |
| D | Were incomplete outcome data adequately addressed? | | |
| | 6. Was the drop-out rate described and acceptable? | The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and drop-outs does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias a "yes" is scored. (N.B. these percentages are arbitrary, not supported by literature). | Yes/No/ Unsure |
| | 7. Were all randomized participants analyzed in the group to which they were allocated? | All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values) irrespective of non-compliance and co-interventions. | Yes/No/ Unsure |
| E | 8. Are reports of the study free of suggestion of selective outcome reporting? | In order to receive a "yes," the review author determines if all the results from all pre-specified outcomes have been adequately reported in the published report of the trial. This information is either obtained by comparing the protocol and the report, or in the absence of the protocol, assessing that the published report includes enough information to make this judgment. | Yes/No/ Unsure |
| F | Other sources of potential bias: | | |
| | 9. Were the groups similar at baseline regarding the most important prognostic indicators? | In order to receive a "yes," groups have to be similar at baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurological symptoms, and value of main outcome measure(s). | Yes/No/ Unsure |
| | 10. Were co-interventions avoided or similar? | This item should be scored "yes" if there were no co-interventions or they were similar between the index and control groups. | Yes/No/ Unsure |
| | 11. Was the compliance acceptable in all groups? | The reviewer determines if the compliance with the interventions is acceptable, based on the reported intensity, duration, number and frequency of sessions for both the index intervention and control intervention(s). For example, physiotherapy treatment is usually administered over several sessions; therefore it is necessary to assess how many sessions each patient attended. For single-session interventions (e.g., surgery), this item is irrelevant. | Yes/No/ Unsure |
| | 12. Was the timing of the outcome assessment similar in all groups? | Timing of outcome assessment should be identical for all intervention groups and for all important outcome assessments. | Yes/No/ Unsure |

Adapted and modified from Furlan AD, et al. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine (Phila Pa 1976)* 2009; 34:1929-1941 (144).

Table 3. *Newcastle-Ottawa quality assessment scale: Case control studies.*

| **Selection** |
|---|
| 1) Is the case definition adequate? |
| a) yes, with independent validation * |
| b) yes, e.g. record linkage or based on self reports |
| c) no description |
| 2) Representativeness of the cases |
| a) consecutive or obviously representative series of cases * |
| b) potential for selection biases or not stated |
| 3) Selection of Controls |
| a) community controls * |
| b) hospital controls |
| c) no description |
| 4) Definition of Controls |
| a) no history of disease (endpoint) * |
| b) no description of source |
| **Comparability** |
| 1) Comparability of cases and controls on the basis of the design or analysis |
| a) study controls for post-surgery syndrome |
| b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.) |
| **Exposure** |
| 1) Ascertainment of exposure |
| a) secure record (eg surgical records) * |
| b) structured interview where blind to case/control status * |
| c) interview not blinded to case/control status |
| d) written self report or medical record only |
| e) no description |
| 2) Same method of ascertainment for cases and controls |
| a) yes * |
| b) no |
| 3) Non-Response rate |
| a) same rate for both groups * |
| b) non respondents described |
| c) rate different and no designation |

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.
Adapted and modified from Wells GA, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis. www.ohri.ca/programs/clinical_epidemiology/oxford.asp (145).

more than one group; otherwise, the cohort format was used. Non-randomized observational studies were included only if at least 50 subjects were enrolled or at least 25 in each group if there were comparison groups.

Randomized trials meeting the inclusion criteria utilizing the Cochrane review criteria, as shown in Table

Table 4. *Newcastle-Ottawa quality assessment scale for cohort studies.*

| **Selection** |
|---|
| 1) Representativeness of the exposed cohort |
| a) truly representative of the average _____ (describe) in the community * |
| b) somewhat representative of the average _____ in the community * |
| c) selected group of users e.g. nurses, volunteers |
| d) no description of the derivation of the cohort |
| 2) Selection of the non exposed cohort |
| a) drawn from the same community as the exposed cohort * |
| b) drawn from a different source |
| c) no description of the derivation of the non exposed cohort |
| 3) Ascertainment of exposure |
| a) secure record (eg surgical records) * |
| b) structured interview * |
| c) written self report |
| d) no description |
| 4) Demonstration that outcome of interest was not present at start of study |
| a) yes * |
| b) no |
| **Comparability** |
| 1) Comparability of cohorts on the basis of the design or analysis |
| a) study controls for post-surgery syndrome* |
| b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.) |
| **Outcome** |
| 1) Assessment of outcome |
| a) independent blind assessment * |
| b) record linkage * |
| c) self report |
| d) no description |
| 2) Was follow-up long enough for outcomes to occur |
| a) yes (select an adequate follow up period for outcome of interest) * |
| b) no |
| 3) Adequacy of follow up of cohorts |
| a) complete follow up - all subjects accounted for * |
| b) subjects lost to follow up unlikely to introduce bias - small number lost - > ____ % (select an adequate %) follow up, or description provided of those lost) * |
| c) follow up rate < ____% (select an adequate %) and no description of those lost |
| d) no statement |

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability.
Adapted and modified from Wells GA, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis. www.ohri.ca/programs/clinical_epidemiology/oxford.asp (145).

2, with at least 9 of 12 criteria were considered high quality. Studies with Cochrane scores of 6 to 8 were considered moderate quality and studies with Cochrane scores less than 6 were excluded.

Observational studies had to meet a minimum 7 of 9 criteria for case-controlled studies. Cohort studies with a comparison group had a maximum score of 9 and had to have a score of at least 5 to be included; cohort studies without a comparison group had a maximum score of 6 and had to have a maximum score of 4 to be included.

### 1.7 Data Extraction and Synthesis

Each study was evaluated by at least 2 authors for stated criteria and any disagreements were discussed by a third reviewer. If there was a conflict of interest with the reviewed manuscript with authorship or any other type of conflict, the involved authors did not review the manuscript for quality assessment, clinical relevance, evidence synthesis, or grading of evidence.

If the literature search provided at least 5 randomized trials meeting the inclusion criteria for each condition evaluated, no observational studies were utilized.

#### *1.7.1 Methods for Handling Missing Information*

Missing information was evaluated on a case by case basis. If the data available was insufficient to evaluate the study or if it did not meet the endpoint criteria, the study was excluded.

### 1.8 Analysis of Evidence

The analysis of the strength of evidence was conducted using 3 levels of evidence; good, fair, and limited or poor as adopted from the U.S. Preventative Services Task Force (USPSTF), as shown in Table 5 (147). These criteria have been utilized in multiple systematic reviews (77,79,106,111,112,148-160).

## 2.0 Results

Figure 1 shows a flow diagram of study selection as recommended by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (161). The literature search found 310 articles potentially dealing with the key questions of either the effectiveness of spinal endoscopy in treating low back pain or complications related to this procedure. Of these, 49 were accepted based upon title. Of the articles accepted by title, 22 were accepted for full manuscript review. Of the excluded articles, 10 were systematic or other reviews (1,44,53,55,77,79,115-117,162-164). Ten more reports were excluded because they were case reports, descriptions of the procedure, or otherwise did not meet the criteria for potentially being high quality evidence evaluating the efficacy of spinal endoscopy (165-174). Seven articles dealt with complications (175-181). Two studies dealt with overlapping patient groups (182,183). Only the report with the longer follow up was evaluated (182). One study was a preliminary report (184).

The remaining 21 studies were evaluated as to whether they met the inclusion criteria. Table 6 details the 13 observational and 2 RCT studies that were excluded (185-198).

Table 7 shows the characteristics of studies considered for inclusion. There was one RCT (199), with a duplicate publication of preliminary results (184), and 5 observational studies (182,200-203).

### 2.1 Clinical Relevance

Of the one RCT (199), with a duplicate publication (184), and 5 observational studies (182,200-203) meeting the inclusion criteria, all 6 passed the screen for clinical relevance, with a score of at least 3 out of 5. The clinical relevance findings are shown in Table 8.

Table 5. *Method for grading the overall strength of the evidence for an intervention.*

| Grade | Definition |
|---|---|
| Good | Evidence includes consistent results from well-designed, well-conducted studies in representative populations that directly assess effects on health outcomes (at least 2 consistent, higher-quality RCTs or studies of diagnostic test accuracy). |
| Fair | Evidence is sufficient to determine effects on health outcomes, but the strength of the evidence is limited by the number, quality, size, or consistency of included studies; generalizability to routine practice; or indirect nature of the evidence on health outcomes (at least one higher-quality trial or study of diagnostic test accuracy of sufficient sample size; 2 or more higher-quality trials or studies of diagnostic test accuracy with some inconsistency; at least 2 consistent, lower-quality trials or studies of diagnostic test accuracy, or multiple consistent observational studies with no significant methodological flaws). |
| Limited or Poor | Evidence is insufficient to assess effects on health outcomes because of limited number or power of studies, large and unexplained inconsistency between higher-quality trials, important flaws in trial design or conduct, gaps in the chain of evidence, or lack of information on important health outcomes. |

Adapted and modified from methods developed by U.S. Preventive Services Task Force (147).

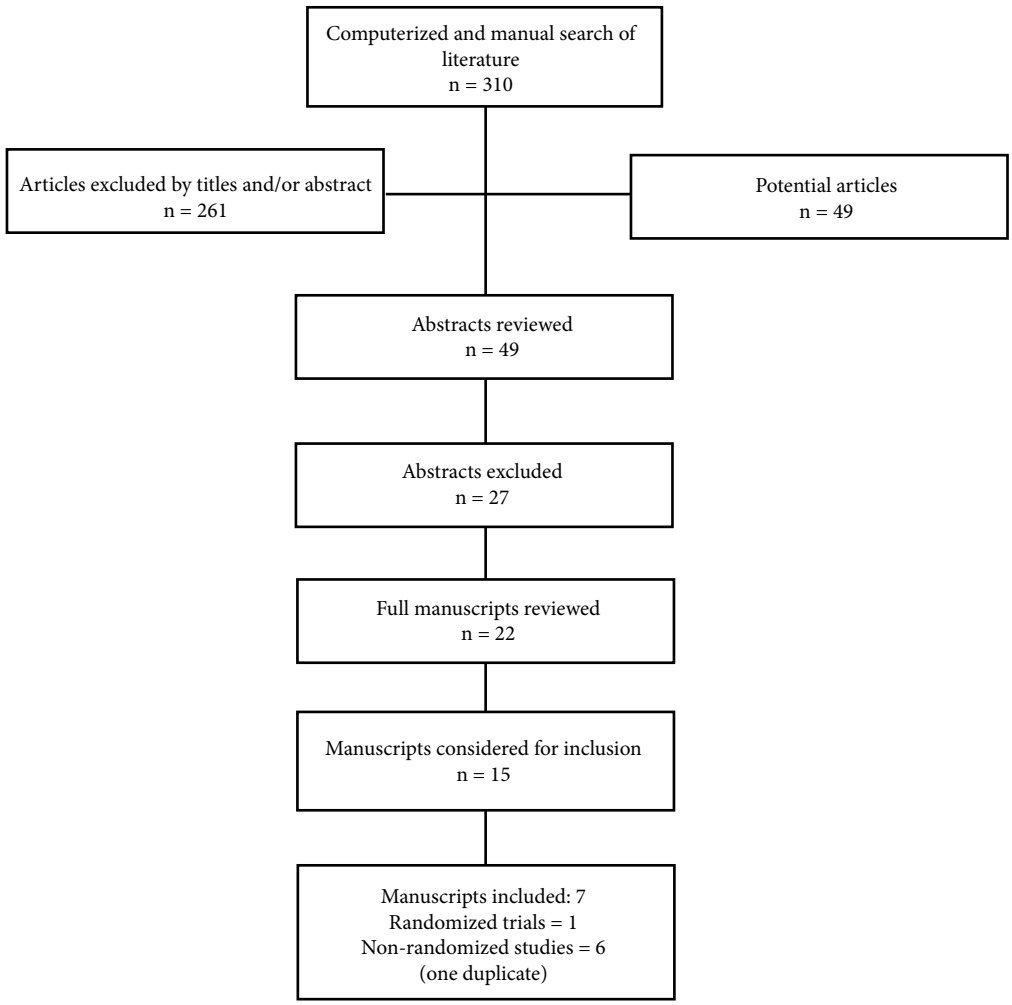


Fig. 1. *The flow diagram illustrating published literature evaluating spinal endoscopic adhesiolysis.*

## 2.2 Quality Assessment

A methodological quality assessment of the RCT meeting the inclusion criteria was carried out using the Cochrane review criteria as shown in Table 9. Studies achieving Cochrane scores of 67% or higher were considered to be high quality, studies scoring 50% or higher were considered moderate quality, and studies scoring less than 50% were considered to be of poor quality and excluded.

The one RCT evaluated was of high quality. Eighty percent of the patients in this study had post lumbar surgery syndrome.

A methodological quality assessment of the 5 observational studies meeting the inclusion criteria was carried out utilizing the Newcastle-Ottawa Scales as illustrated in Tables 10 and 11. One study (202) was case control and 4 studies (182,200-203) were cohort studies.

For cohort studies, studies achieving scores of 67% or higher were considered high quality, 50% or higher were considered moderate quality, and studies scoring less than 50% were considered low quality and were excluded. Table 10 presents the scoring for the case-controlled study.

Table 6. *List of excluded randomized trials and observational studies.*

| Manuscript Author(s) | Number of Patients | Treated vs. Control | Reason for Exclusion | |
|---|---|---|---|---|
| | | | Follow-up Period | Other Reason(s) |
| **Randomized Controlled Trials** | | | | |
| Dashfield et al, 2005 (185) | 60 patients | 30 with endoscopically placed local anesthetic and steroid<br><br>30 with caudal epidural injection of local anesthetic and steroid | 6 months | Inclusion criteria were sciatica in the absence of lumbar surgery; no patients had post lumbar surgery syndrome. Intent was specifically to study patients without adhesions. |
| **Observational Studies** | | | | |
| Richardson et al, 2001 (186) | 38 | Epiduroscopy | 12 months | Failure to have 50 patients.<br>Only 50% of patients had post lumbar surgery syndrome. |
| Warnke & Mourgela, 2007 (187) | 23 | Subarachnoid endoscopy (thecaloscopy) | 24 months | Failure to have 50 patients.<br>Procedure was subarachnoid, not epidural.<br>Patients without post lumbar surgery syndrome were included. |
| Richter et al, 2011 (188) | 154 | Laser epiduroscopy | Not provided | Post lumbar surgery patients were excluded. |
| Richter & Rothstein, 2011 (189) | 24 | Laser epiduroscopy | 3 months to 6 months, mean 4 months | Failure to have 50 patients.<br>15 of 24 patients did not have post lumbar surgery syndrome. |
| Ruetten et al, 2003 (190) | 93 | Epiduroscopy | 2 months | Only 21 of 93 patients had post lumbar surgery syndrome. |
| Saberski, 2000 (191) | 35 | 22 epiduroscopy<br>13 laminectomy and discectomy | 2 months | Failure to have > 25 patients in each group.<br>No patients had post lumbar laminectomy syndrome; only disc herniation was evaluated. |
| Sakai et al, 2008 (192) | 19 | Epiduroscopy | 3 months | Failure to have > 50 patients.<br>No patients had post lumbar laminectomy syndrome; only sciatica was evaluated. |
| Tobita et al, 2003 (193) | 55 | Epiduroscopy and subarachnoid endoscopy in all patients | None | Procedure was done for diagnosis only, with no therapy provided.<br>No patients had post lumbar laminectomy syndrome. |
| Avellanal & Diaz-Reganon, 2008 (194) | 19 | Interlaminar epiduroscopy | 6 months | Failure to have > 50 patients. |
| Geurts et al, 2002 (195) | 24 | Epiduroscopy | 12 months | Failure to have > 50 patients. |
| Igarashi et al, 2004 (196) | 58<br>34 monosegmental<br>24 multisegmental | Epiduroscopy | 12 months | Only patients with spinal stenosis were studied; no patients had post lumbar surgery syndrome. |
| Takeshima et al, 2009 (197) | 28 | Epiduroscopy | 6 months | Failure to have > 50 patients.<br>All patients did have post lumbar surgery syndrome. |
| Mavrocordatos & Cahana, 2011 (198) | 32 | Epiduroscopy with targeted O2/O3 and steroid delivery | 2 years | Failure to have > 50 patients.<br>Chronic refractory low back pain. |

Table 7. *Assessment of randomized trials and observational studies for inclusion criteria.*

| Manuscript Authors | Type of Study | Number of patients | Treatment vs. Comparator | Length of Follow up | Outcome Parameters | Comments |
|---|---|---|---|---|---|---|
| Manchikanti et al, 2005 (199) | RA, PC, AC | 83 patients with chronic, refractory low back and lower extremity pain were randomized 2:3 into an active control or interventional group. 73% of group one and 84% of group two had post lumbar surgery syndrome. | Control group received endoscopy to S3 with steroid/ local anesthetic injection; interventional group received epiduroscopic adhesiolysis with targeted steroid/ local anesthetic injection. | Up to 12 months | Pain relief VAS, ODI, P-3 psychological evaluation, ROM measurements, work status and opioid intake | Significant pain relief (50%) at 3 months 80%, 6 months 56%, and 12 months 48% compared to 33% of controls at 1 month only; improvements in ODI, ROM, and psychological status were noted over controls. Epiduroscopic adhesiolysis with targeted steroid/local anesthetic administration is more effective than control treatment for chronic low back and lower extremity pain without major adverse effects. |
| Di Donato et al, 2010 (182) | P | 350 patients with chronic low back pain attributable to FBSS, spondylolisthesis, stenosis, or hernia, who failed conservative therapies, divided into 3 groups based on ODI scores | Epiduroscopy with the injection of ozone and ciprofloxacin | 60 months | Relief of pain VAS, disability evaluated by ODI up to 60 months. VAS < 5 and ODI < 40% were considered positive outcomes. | Short-term follow-up revealed significant pain relief in all patients and a ODI of < 40% in 79% of cases; at 60 months, 65% had significant pain relief with a ODI < 40% in 78% of patients. Epiduroscopy with adhesiolysis and targeted hyaluronidase, ozone is effective in providing pain relief and improvement in disability in the short and long-term treatment of chronic spinal low back pain. |
| Manchikanti et al, 1999 (200) | RE | 120 patients, postlaminectomy; nonresponsive to conservative therapy | 2 treatment groups: Group 1, 60 patients nonendoscopic adhesiolysis; Group 2, 60 patients endoscopic; 2 procedures were performed in each group. | 12 months | No pain relief, pain relief < or > 50% | Percutaneous adhesiolysis had average 3 procedures/year; endoscopic, 1.3/ year. Both procedures provided significant pain relief, mean 15 weeks for percutaneous and 20 weeks for endoscopic, but percutaneous was more cost effective. |
| Manchikanti et al, 2000 (201) | RE | 85 patients with refractory low back pain. 86% of patients had prior lumbar surgery. | Endoscopic adhesiolysis | Minimum 12 months | No pain relief, pain relief < or > 50% | Significant pain relief for a mean of 19 weeks; All had significant relief after the initial procedure, then declined to 52% at 3 - 6 months and 21% at 6 - 12 months. |
| Murai et al, 2007 (202) | P, AC | 183 patients with refractory low back and leg pain. 37 patients had previous lumbar surgery; 87 had not had surgery. | Endoscopic adhesiolysis | 3 months | RMDQ, VAS, Japanese Orthopedic Association (JOA) scores, dissatisfaction with ADLs | Both groups had a 50% reduction in VAS scores at 3 months. VAS and JOA scores were significantly lower at 1 and 3 months for the non-operated group compared to the operated group. |
| Kim et al, 2011 (203) | P, AC | 109 patients with refractory chronic low back and radicular pain. Group 1 had 18 spinal stenosis, 1 disc herniation, and 1 post lumbar surgery syndrome; Group 2 had 42 spinal stenosis, 25 disc herniation, 8 post lumbar surgery syndrome, and 3 idiopathic | 2 treatment groups: Group 1, 20 patients for endoscopy; Group 2, 78 patients for laser endoscopy. Both groups received a local injection of triamcinolone. | 6 months minimum | Pain relief using VAS and functional status using RMDQ scores and MacNab criteria | The mean VAS for Group 1 went from 8.5 to 4.6 at one month and then 6.1 at 6 months. Group 2 went from 7.6 to 4.9 at one month and then 3.6 at 6 months. Both groups had significant relief, but the laser procedure provided lasting relief, while epiduroscopy alone had loss of relief over time. |

RA = randomized; PC = Placebo control; AC = Active-control; P = Prospective; RE = Retrospective; VAS = Visual analog scale; ODI = Oswestry Disability Index; RMDQ = Roland Morris Disability Questionnaire; P-3 = Pain Patient Profile; FBSS = Failed back surgery syndrome; ROM= Range of motion; ADLs – Activities of Daily Living

Table 8. *Clinical relevance of included studies.*

| Manuscript Author(s) | A) Patient description | B) Description of interventions and treatment settings | C) Clinically relevant outcomes | D) Clinical importance | E) Benefits versus potential harms | Total Criteria Met |
|---|---|---|---|---|---|---|
| Manchikanti et al (199) | + | + | + | + | + | 5/5 |
| Di Donato et al (182) | + | + | + | + | + | 5/5 |
| Manchikanti et al (200) | + | + | + | + | + | 5/5 |
| Manchikanti et al (201) | + | + | + | + | + | 5/5 |
| Murai et al (202) | + | + | + | + | + | 5/5 |
| Kim et al (203) | + | + | + | + | + | 5/5 |

+ = positive; - = negative ; U = unclear

Scoring adapted from Staal JB, et al. Injection therapy for subacute and chronic low-back pain. Cochrane Database Syst Rev 2008; 3:CD001824 (143).

Table 9. *Methodological quality assessment of randomized trials.*

| | Manchikanti et al (199) |
|---|---|
| Randomization adequate | Y |
| Concealed treatment allocation | Y |
| Patient blinded | Y |
| Care provider blinded | N |
| Outcome assessor blinded | Y |
| Drop-out rate described | Y |
| All randomized participants analyzed in the group | Y |
| Reports of the study free of suggestion of selective outcome reporting | Y |
| Groups similar at baseline regarding most important prognostic indicators | Y |
| Co-interventions avoided or similar | Y |
| Compliance acceptable in all groups | Y |
| Time of outcome assessment in all groups similar | Y |
| SCORE | 11/12 |

Y=yes; N=no; U=unsure

Scoring adapted from Staal JB, et al. Injection therapy for subacute and chronic low-back pain. Cochrane Database Syst Rev 2008; 3:CD001824 (143).

For case-control studies, 67% or higher was considered as high quality, 50% or higher was considered as moderate quality, and less than 50% was considered low quality, and excluded. Two studies (200,202) were of high quality and 3 studies (182,201,203) were of moderate quality.

## 2.3 Study Characteristics

Table 12 presents the study characteristics of the one RCT (199), with a duplicate publication (184), and the 5 observational studies (182,200-203) of percutaneous endoscopic adhesiolysis meeting inclusion criteria.

Four studies including one RCT with 2 publications (184,199), and 3 observational studies (200,201,203) had sufficient methodological strength to be used to address the question of the efficacy of endoscopic adhesiolysis in the treatment of low back and leg pain caused by post lumbar surgery syndrome (Table 13).

Based upon one high quality RCT (199), with a duplicate publication (184), one high quality observational study (200), and 2 moderate quality observational stud-

Table 10. *Methodological quality assessment of case control studies utilizing Newcastle-Ottawa quality assessment scale.*

| **Selection** | **Murai et al (202)** |
|---|---|
| 1) Is the case definition adequate? | |
| a) yes, with independent validation * | X |
| b) yes, e.g. record linkage or based on self reports | |
| c) no description | |
| 2) Representativeness of the cases | |
| a) consecutive or obviously representative series of cases * | X |
| b) potential for selection biases or not stated | |
| 3) Selection of Controls | |
| a) community controls * | X |
| b) hospital controls | |
| c) no description | |
| 4) Definition of Controls | |
| a) no history of prior lumbar surgery * | X |
| b) no description of source | |
| **Comparability** | |
| 1) Comparability of cases and controls on the basis of the design or analysis | |
| a) study controls for post lumbar surgery syndrome * | X |
| b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.) | |
| **Exposure** | |
| 1) Ascertainment of exposure | |
| a) secure record (eg surgical records) * | X |
| b) structured interview where blind to case/control status * | |
| c) interview not blinded to case/control status | |
| d) written self report or medical record only | |
| e) no description | |
| 2) Same method of ascertainment for cases and controls | |
| a) yes * | X |
| b) no | |
| 3) Non-Response rate | |
| a) same rate for both groups * | X |
| b) non respondents described | |
| c) rate different and no designation | |
| SCORE | 8/12 |

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.

Adapted and modified from Wells GA, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis. www.ohri.ca/programs/clinical_epidemiology/oxford.asp (145).

Table 11. *Methodological quality assessment of cohort studies utilizing Newcastle-Ottawa quality assessment scale.*

| | Manchikanti et al (200) | Manchikanti et al (201) | Di Donato et al (182) | Kim et al (203) |
|---|---|---|---|---|
| **Selection** | | | | |
| 1) Representativeness of the exposed cohort | | | | |
| a) truly representative of the average pt with low back pain in the community * | X | X | X | X |
| b) somewhat representative of the average pain patients in the community * | | | | |
| c) selected group of users e.g. nurses, volunteers | | | | |
| d) no description of the derivation of the cohort | | | | |
| 2) Selection of the non exposed cohort | | | | |
| a) drawn from the same community as the exposed cohort * | X | NA | NA | NA |
| b) drawn from a different source | | | | |
| c) no description of the derivation of the non exposed cohort | | | | |
| 3) Ascertainment of exposure | | | | |
| a) secure record (eg surgical records) * | X | X | X | X |
| b) structured interview * | | | | |
| c) written self report | | | | |
| d) no description | | | | |
| 4) Demonstration that outcome of interest was not present at start of study | | | | |
| a) yes * | X | X | X | X |
| b) no | | | | |
| **Comparability** | | | | |
| 1) Comparability of cohorts on the basis of the design or analysis | | | | |
| a) study controls for post lumbar laminectomy syndrome* | X | X | X | X |
| b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.) | | | | |
| **Outcome (Exposure)** | | | | |
| 1) Assessment of outcome | | | | |
| a) independent blind assessment * | | | X | |
| b) record linkage * | X | X | | |
| c) self report | | | | |
| d) no description | | | | X |
| 2) Was follow-up long enough for outcomes to occur | | | | |
| a) yes (select an adequate follow up period for outcome of interest) * | X | X | X | X |
| b) no | | | | |
| 3) Adequacy of follow up of cohorts | | | | |
| a) complete follow up - all subjects accounted for * | X | X | | X |
| b) subjects lost to follow up unlikely to introduce bias - small number lost - > ____ % (select an adequate %) follow up, or description provided of those lost) * | | | | |
| c) follow up rate < 70% (select an adequate %) and no description of those lost | | | | |
| d) no statement | | | X | |
| SCORE | 8/12 | 7/12 | 7/12 | 7/12 |

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Adapted and modified from Wells GA, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis. www.ohri.ca/programs/clinical_epidemiology/oxford.asp (145).

Table 12. *Characteristics of randomized controlled trials and observational studies of percutaneous endoscopic adhesiolysis studies meeting inclusion criteria.*

| Reference, Year | Number of Patients Selection Criteria | Control/ Comparator | Outcome Measures | Time of Measurements | Results | Strengths | Weaknesses | Methodological Quality Assessment |
|---|---|---|---|---|---|---|---|---|
| Manchikanti et al, 2005 (199) | 83 patients with low back and lower extremity pain of at least 2 years duration, facet disease ruled out, who failed conservative therapy. 73% of active control group and 84% of treated group had failed lumbar surgery syndrome. Patients had failed conservative therapy, including fluoroscopically guided epidural injections and percutaneous adhesiolysis. | Epiduroscopy to target area, with less than 100 cc of saline infusion followed, after mechanical adhesiolysis, with 1% lidocaine and steroid/ epiduroscope advanced to S3 followed by 10 cc of 1% lidocaine and steroid | VAS, ODI, work status, range of motion, P-3 | 1, 3, 6, 12 months | 90% of epiduroscopy group had > 50% relief at 1 month, 80% did at 3 months, 56% did at 6 months, and 48% at 12 months. 33% of active control had >50% relief at 1 month and none did thereafter. | Pragmatic randomized controlled trial that showed effectiveness of endoscopic adhesiolysis in patients who did not respond to percutaneous adhesiolysis. | Study included primarily post lumbar surgery syndrome patients, but was not exclusively this diagnosis. Study did not evaluate effectiveness of repeating procedure.<br><br>A high percentage of patients were unblinded. | 11/12 |
| Di Donato et al, 2010 (182) | 350 patients with low back pain of at least 6 months duration due to post lumbar surgery syndrome, spondylolisthesis, stenosis, or disc herniation who had failed conservative therapy and refused fusion | Endoscopic adhesiolysis with mean 110 ml of saline with hyaluronidase followed by 8 ml of ozone and 50 mg of Cipro Floxin. All patients wore an orthopedic corset for 2 weeks after the procedure. | VAS (0 - 2, 3 – 5, and > 5), ODI | 1 week, 3, 6, 12, 36, 48, and 60 months | At 3 months, 94% of patients had an ODI of <40% and 90% of patients had VAS < 5. At 12 months, 82% had an ODI < 40% and 74% had significant pain relief. High levels of pain relief and functional benefit persisted at more distant time periods. | Only study to follow patients for 5 years. Evaluated use of ozone instead of local anesthetic and steroid. | All patients had a pre-procedure VAS of > 5. A successful outcome was a VAS of < 5. It is not possible to tell how many patients had a 50% reduction or a 3 point reduction in VAS. An ODI of < 40% was considered a success. 60% of patients had an ODI equal to or less than 40% at the start of the study, so it is not possible to assess functional improvement. Percentage of patients with post lumbar surgery syndrome is not provided. | 7/12 |
| Manchikanti et al, 1999 (200) | 120 post lumbar surgery patients. Facet and sacroiliac joint pain was excluded. | 60 patients with percutaneous adhesiolysis; 60 patients with endoscopic adhesiolysis | > 50% pain relief; number of procedures | 1, 3, 6, 12 months | At one month, 72% of percutaneous and 97% of endoscopic patients had > 50% relief. At 3 months, it was 10% and 52%. After the second procedure, 22% of the percutaneous group had > 50% relief, whereas 75% of the endoscopic group did. Percutaneous adhesiolysis is more cost-effective than endoscopic adhesiolysis. | All patients were post lumbar surgery patients. Direct comparison between percutaneous and endoscopic adhesiolysis. | Retrospective evaluation<br><br>Limited outcome parameters | 8/12 |

VAS = visual analog scale; P-3 = Pain Patient Profile; ODI = Oswestry Disability Index; RMDQ = Roland Morris Disability Questionnaire

Table 12 (cont.). *Characteristics of randomized controlled trials and observational studies of percutaneous endoscopic adhesiolysis studies meeting inclusion criteria.*

| Reference, Year | Number of Patients Selection Criteria | Control/ Comparator | Outcome Measures | Time of Measurements | Results | Strengths | Weaknesses | Methodological Quality Assessment |
|---|---|---|---|---|---|---|---|---|
| Manchikanti et al, 2000 (201) | 85 patients with low back and leg pain that did not respond to epidural or facet injections or to percutaneous adhesiolysis.<br>Duration of pain was < 4 years in 21% of patients and > 4 years in 79%.<br>86% had prior lumbar surgery syndrome. | Endoscopic adhesiolysis with between 10 and 110 cc of saline and 5 - 60 cc of radio-opaque dye, followed by local anesthetic and steroid<br>Average of 1.3 procedures/ patient. | > 50% pain relief, number of endoscopies performed | At least 12 months | 94% had > 50% relief at 2 months and 52% at 6 months. 21% had significant relief at 12 months. | Evaluated patients who had failed to respond to epidural or facet injections and to percutaneous adhesiolysis.<br>86% of patients had post lumbar surgery syndrome. | Only VAS was evaluated.<br><br>Retrospective study.<br><br>No active comparator | 7/12 |
| Murai et al, 2007 (202) | 183 patients enrolled at 15 centers. Low back pain and sciatica not responsive to conservative therapy including epidural, facet, and sacroiliac injections.<br>37 patients had post lumbar surgery syndrome. 87 patients had not been operated on. | Endoscopic adhesiolysis followed by local anesthetic and steroid | Japanese Orthopedic Association (JOA) scores; Japanese version of RMDQ; VAS for leg and low back, leg numbness and dissatisfaction with activities of daily living | 1 and 3 months | Both groups improved significantly at 1 and 3 months. The non-operated group had significantly lower scores at 1 and 3 months than did the operated group.<br>Both groups had 50% reduction in VAS at both time periods. | Compared response in post lumbar surgery syndrome and non-operated patients | The duration of follow up was only 3 months.<br>Duration of pain prior to intervention was not provided.<br>32% of patients dropped out.<br>Data was collected by patients filling out a survey rather than by seeing patients. | 8/12 |
| Kim et al, 2011 (203) | 98 out of 109 patients with chronic low back pain and radiculopathy who had failed conservative therapy, including epidural steroid injections were followed for ≥ 6 months. 20 underwent epiduroscopic adhesiolysis (1 had post lumbar surgery syndrome, 1 had disc extrusion, 18 had spinal stenosis).<br>78 had laser endoscopy (8 had post lumbar surgery syndrome, 42 had spinal stenosis, and 25 had lumbar disc protrusion, 3 idiopathic). | Laser epiduroscopy versus epiduroscopic adhesiolysis | VAS for back and leg pain; RMDQ; MacNab criteria | 1 month and minimum of 6 months' follow-up.<br><br>90% of enrolled patients completed the study. | For endoscopy patients, VAS went from 8.5 to 4.6 at 1 month, but increased back to 6.1 at last observation.<br>For laser endoscopy patient, the VAS went from 7.6 to 4.9 at 1 month and at last observation, was 3.6 | Compared endoscopy to laser endoscopy.<br><br>Large number of patients.<br><br>Laser endoscopy patients showed persistent relief, whereas endoscopic adhesiolysis patients had return of symptoms. | No active control group.<br><br>Relatively few patients had post lumbar surgery syndrome | 7/12 |

VAS = visual analog scale; P-3 = Pain Patient Profile; ODI = Oswestry Disability Index; RMDQ = Roland Morris Disability Questionnaire

Table 13. *Results of randomized and observational studies on the effectiveness of endoscopic adhesiolysis in treating low back and/or leg pain due to post lumbar surgery syndrome.*

| Study | Study Characteristics | Methodological Quality Scoring | Participants | Pain relief and Function | Results | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | Short term < 12 mos. | Long-term relief ≥ 12 mos. | |
| Manchikanti et al (199) | RA, AC | 11/12 | 86 patients<br><br>50 patients had endoscopic adhesiolysis; 33 had endoscopic caudal steroid injection.<br><br>73% of active control group and 84% of treated group had failed lumbar surgery syndrome. | 90% of epiduroscopy group had > 50% relief at 1 month, 80% did at 3 months, 56% did at 6 months, and 48% at 12 months.<br><br>33% of active control had > 50% relief at 1 month and none did thereafter. | P | P | High quality study showing evidence of effectiveness |
| Manchikanti et al (200) | RE | 8/12 | 60 patients with percutaneous adhesiolysis; 60 patients with endoscopic adhesiolysis<br><br>100% had post lumbar surgery syndrome. | At 6 months, after a second procedure, 75% of the endoscopic group had > 50% relief, while only 22% of the percutaneous group did.<br><br>However, looking at both groups regardless of the number of procedures done, 40% of endoscopic patients had > 50% relief, whereas 72% of percutaneous group did. The percutaneous group had about twice as many procedures as the endoscopic. | P | N | High quality observational study showing short-term evidence of effectiveness |
| Manchikanti et al (201) | RE | 7/12 | 85 patients receiving endoscopic adhesiolysis<br><br>86% had post lumbar surgery syndrome.<br><br>27 patients had 2 procedures | 94% had >50% relief at 2 months and 52% at 6 months. 21% had significant relief at 12 months. | P | N | Moderate quality study showing short-term evidence of effectiveness |
| Kim et al (203) | P, AC | 7/12 | 109<br><br>20 had endoscopic adhesiolysis; 78 had laser endoscopy.<br><br>9% had post lumbar surgery syndrome. | Endoscopic adhesiolysis patients had significant, > 50%, relief at one month, but pain relief was decreasing at last follow-up. Laser endoscopy group had persistent significant relief at last follow-up. | P | N | Moderate quality study showing short-term evidence of effectiveness, limited by low percentage of patients with post lumbar surgery syndrome. |

RA = randomized; AC = active-control; P = prospective; RE = retrospective; P = positive; N = negative

ies (201,203), using the USPSTF criteria, the evidence is fair that endoscopic adhesiolysis is effective for both short-term (< 12 months) and long-term (≥ 12 months) in the treatment of chronic low back and/or leg pain due to post lumbar surgery syndrome.

## 3.0 Complications

Spinal endoscopic adhesiolysis is generally a well tolerated procedure, with minimal and transient complications, including localized pain and self-limited irritation of the nerve root (1,44,110,111,114,162,173,175,188-190,204-220). Spinal endoscopy has, however, also been associated with significant complications, most significantly blindness associated with excessive epidural hydrostatic pressure associated with the administration of high volumes of fluid, greater than 100 ml during the procedure, or a bolus of fluid. The mechanism of blindness is believed to be sudden or excessive subarachnoid pressure leading to either decreased retinal perfusion or macular hemorrhage. Amirikia et al (215) described a case of bilateral retinal hemorrhage and blindness in an 80-year old with macular degeneration. The volume injected was not noted, but the irrigation is described as lasting 5 minutes. They recommend decreasing flow and volume. Retinal hemorrhage was also been reported after saline infusion used to treat post lumbar puncture headache (216). Tabandeh (217) reported a case of hemorrhage after epiduroscopy, but no details of saline use were provided. Gill and Heavner (176) reviewed blindness after epiduroscopy, evaluating 12 cases. About 80% of these cases resolved. They recommended injecting the saline at less than 1 ml/second; this rate is far above the current standard of about 100 ml/60 minutes or about 0.03 ml/second.

Another potential complication of excessive epidural hydrostatic pressure, including that caused by injection into a loculation, is spinal cord or root compression with neural damage.

Other complications potentially associated with epiduroscopy include dural tear, epidural bleeding with potential hematoma formation, and infection.

Dural tears themselves are usually asymptomatic. However, they can result in the access of various medications into the subarachnoid space. Hypertonic saline is known to be neurotoxic and would be expected to cause neural injury if allowed to enter the subarachnoid space. For this reason, the standard protocol when hypertonic saline is used is to wait about 30 minutes after the injection of local anesthetic to ensure that no subarachnoid or subdural block is present. Many practitioners avoid using hypertonic saline during endoscopy in order to remove the risk of the injection of subarachnoid hypertonic saline.

The non-iodinated contrast solution, iotrolan, has been implicated as the cause of encephalopathy and rhabdomyolysis after being unintentionally injected into the subarachnoid space during epiduroscopy (181).

In and of itself, entering the subarachnoid space is not a cause for concern. There is a body of literature focused on the endoscopic examination of the subarachnoid space, called thecaloscopy (168,187,193,218-220). Further, neuroendoscopy, which involves endoscopic examination and laser treatment of the ventricles, has been described (221).

Justiz et al (179) reported a case of neurogenic bladder after endoscopy in a patient with post lumbar surgery syndrome, possibly related to hypertonic saline in the subarachnoid space. Her symptoms persisted until she was provided nitrofurantoin 3 years after the onset. Cessation of the nitrofurantoin caused the retention to recur. She was maintained on long-term nitrofurantoin, with benefit. The authors hypothesized that the nitrofurantoin caused increased nitric oxide levels with subsequent improved bladder function.

Murai et al (202) noted transient leg weakness, but no permanent complications in a prospective study of 183 patients. Heavner and Bosscher (205) noted that the literature documents the safety of epiduroscopy and that the incidence of complications decreases with experience.

Avellanal and Diaz-Reganon (194) reported transient decreased hearing during saline infusion. Heavner et al (178) described 2 cases of intravenous injection of contrast during epiduroscopy.

One issue related to complications is the radiation exposure during the procedure. Komiya et al (180) found that the average time of fluoroscopy use for their epiduroscopies was just less than 10 minutes. This amount of fluoroscopy resulted in an exposure to a humanoid model of 238 mGy. Physician exposure was 0.67 mGy outside the lead apron. Based upon these findings, Komiya et al (180) recommended that physicians limit themselves to 70 epiduroscopy procedures per year. However, Heavner and Bosscher's (177) experience mirrors that of most physicians performing epiduroscopy with less exposure.

Van Boxem et al (114) note that aside from retinal complications, the complications of spinal endoscopy are similar to those associated with percutaneous adhesiolysis.

There have been reports of complications with laser-assisted spinal endoscopy, including motor paralysis resulting from thermal damage to nerve roots (203). Other complications are related to administered drugs – steroids and local anesthetics (85,89,91,111-113,151,222-225).

The experience reported in the literature indicates that the incidence of complications associated with spinal endoscopy is low. The complications reported are generally minimal and self-limited. The most serious complication, retinal side effects, can be minimized or eliminated by attention to technique. This procedure should be considered low risk for serious adverse complications when performed by properly trained practitioners.

## 4.0 Discussion

Endoscopic adhesiolysis is safe and effective in treating post lumbar surgery syndrome patients who have failed other modalities, including percutaneous adhesiolysis. Like many other interventional procedures, it is not curative and requires repeat treatment. Quality studies consistently show that a significant number of patients respond, or that 50% of patients show a significant response. Thus, the procedure can be repeated twice per year.

The exclusion of Dashfield et al's RCT (185) warrants specific discussion. The only discussion of epiduroscopy contained in Chou and Huffman's APS guidelines (77) is based upon Dashfield's report. Dashfield et al, in response to a criticism of their RCT made by Richardson et al (170), made clear that, "Our study was designed to answer the question of whether the site of epidural corticosteroid placement within the epidural space was important in patients with little or no epidural scar tissue. We did not investigate the role of epiduroscopic adhesiolysis in patients with epidural scar tissue" (226). In that the rationale for doing endoscopy is, at a minimum, to break up scarring, Dashfield and Taylor (226) are asking a non-clinically relevant question. Consequently, this study lacks clinical relevance. The NICE re-assessment of endoscopy done in 2009 specifically recognizes this fact and describes Dashfield and Taylor's study (226) as being of limited relevance (117). Extending NICE's analysis (117) to Chou and Huffman's APS guidelines (77), Chou and Huffman's discussion of endoscopic adhesiolysis is of limited relevance.

Cost effectiveness and technical issues with endoscopy have impeded its widespread use. The focal length of the fiberoptic endoscope was set at infinity, making visualization difficult. There was also disagreement amongst practitioners as the identity of the various structures observed. Limitations on what therapeutic maneuvers could be done limited interest in the procedure. Finally, competing and much more widely accepted treatments for post lumbar laminectomy syndrome existed.

With the change of the focal length of the scope from infinity to 6 mm, visualization has markedly improved. Using a different endoscope, Bosscher and Heavner (227) have demonstrated that the epiduroscopy was more reliable than either clinical evaluation or MRI in determining the level of clinically significant spinal pathology in low back or leg pain patients. Epiduroscopy has a potential role as a diagnostic tool (228). Studies are in progress to help clarify what structures are pain generators and to confirm what structures are being visualized. The potential exists for the use of other therapies, including laser ablation and the introduction of ozone. All of these factors have created a resurging interest in endoscopic procedures.

This review is a systematic review of the currently available literature regarding adhesiolysis. While there new literature has become available since the 2009 systematic review (1), much of that literature was excluded either because it was not germane to the current review's focus on post lumbar surgery syndrome or because it did not meet current criteria related to study size. Thus, we continue to have a paucity of literature, particularly that of current, high quality literature documenting the value of endoscopy in its various forms.

The fundamental question concerns the effectiveness of spinal endoscopic adhesiolysis in the treatment of chronic low back and/or lower extremity pain of at least 6 months duration in post-surgical patients nonresponsive to conservative modalities of management and fluoroscopically directed epidural injections. Using USPSTF criteria, the evidence is fair that endoscopic adhesiolysis is effective in treating chronic low back and/or lower extremity pain caused by post lumbar surgery syndrome.

The second question to be addressed is the severity and risk of complications associated with these techniques.

The incidence of complications of spinal endoscopy is low and the complications are generally minimal and self-limited. The most serious complication, retinal side effects, can be minimized or eliminated by attention to technique. This procedure should be considered to be low risk for serious adverse complications.

## 5.0 Conclusion

Endoscopic adhesiolysis is a safe, when performed by trained personnel, and effective procedure in the treatment of post lumbar surgery syndrome. The procedure generated widespread interest in the early part of the first decade of this millennium. Interest in the procedure waned because of technical issues related to the equipment; specifically, problems of visualization related to focal length, difficulty in identifying structures which were visualized, a imitation of therapeutic interventions which could be performed, and the cost and limited applicability of the procedure. These issues are now being addressed, with improved focal length and an enhanced understanding of the structures visualized. Epiduroscopy has been shown to have a unique role in diagnosing the level from which clinically significant low back pain arises. There is considerable interest in new therapies, such as laser ablation of epidural tissues and the injection of ozone into the epidural space. The process of determining the indications for the effectiveness, safety of, and ease of applicability of these endoscopic procedures is a growing, dynamic field of intellectual interest and activity.

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### Conflict of Interest:

Dr. Hayek is a consultant for Boston Scientific.

Dr. Helm is a clinical investigator with Epimed and receives research support from Cephalon/Teva, AstraZeneca, and Purdue Pharma, LP. He has attended an Advisory Group meeting for Actavis.

Dr. Deer is a consultant and research advisor for Bioness, Flowonix, Jazz, Medtronic, Nevro, St. Jude, Spinal Modulation, and Vertos.

Dr. Justiz is a consultant and research advisor for St. Jude Medical and Anulex Technologies.

Dr. Falco is a consultant for St. Jude Medical Inc. and Joimax Inc.

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