NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of
Laser lumbar discectomy

Introduction
This overview has been prepared to assist members of IPAC advise on the safety and efficacy of an interventional procedure previously reviewed by SERNIP. It is based on a rapid survey of published literature, review of the procedure by specialist advisors and review of the content of the SERNIP file. It should not be regarded as a definitive assessment of the procedure.

Procedure name
Discectomy can be replaced by discotomy (or diskotomy), disc decompression, nucleotomy and nucleolysis
The word percutaneous and automated may also be included in the title
In certain circumstances the word endoscopic may also be used to indicate in situ visualisation.

Title combinations include:
- Percutaneous laser lumbar discectomy
- Percutaneous laser nucleotomy
- Percutaneous laser nucleolysis
- Percutaneous laser disc decompression
- Percutaneous endoscopic laser discectomy
- Automated laser discectomy
- Laser-assisted disc decompression (except where assisted refers to the additional use of arthroscopic instrumentation)

Choy\textsuperscript{12} uses the name ‘percutaneous laser nucleolysis’ instead of ‘percutaneous laser disc decompression’, because “what is being accomplished is not discectomy; only 0.7 – 1.0mm of disc material is vaporized”.

Specialty society
British Orthopaedic Association

Executive summary
Laser lumbar discectomy is one of several minimally invasive disc procedures used for treating non-sequestered herniated lumbar discs. A search of the literature located 30 studies, of which 5 were selected for this review. A list of excluded studies is provided. The
selected studies used a variety of methods to establish the success of the procedure, varying from freedom from pain, patient satisfaction, clinical measurements (straight leg raise etc), or no subsequent surgery. There was no mortality and morbidity rates were below 5% (excluding transient postoperative dysesthesia).

A brief appraisal of all the available literature suggests that surgical failures are frequently due to the presence of free fragments, which suggests that selection criteria for patients should be carefully considered. In addition, most articles on laser discectomy were published around 1995 to 1996. Very little of additional use has been published since this time.

**Indication(s)**

Low back pain is a common and expensive cause of chronic disability. While most people recover within 8 to 10 weeks, those who do not recover, account for most of the health care and social costs for spinal disorders. About 1% undergo surgery, yet surgical and other interventions “account for up to 30% of health care costs for spinal disorders, the scientific evidence for most of these procedures is unclear.”

Herniated (or prolapsed) lumbar discs are a common cause of backache and sciatica. The herniation is a result of a protrusion of the nucleus pulposus through the tear in the surrounding annulus fibrosus. The annulus fibrosus may rupture completely resulting in an extruded disc or may remain intact but stretched resulting in a contained disc prolapse. This may then compress one or more nerve roots, resulting in pain, numbness or weakness in the leg.

Surgery is considered when there is nerve compression or persistent symptoms that are unresponsive to conservative treatment. Clinical indications can include unilateral radicular symptoms with leg and back pain, positive straight leg raise test, other signs of root dysfunction, and failure to improve after a certain amount (more than 6 weeks) of conservative treatment. Laser lumbar discectomy can be performed when the prolapse is contained.

**Summary of procedure**

Laser lumbar discectomy works by vapourising part of a prolapsed disc and can be performed where the prolapse is contained. It forms part of a medley of minimally invasive surgical techniques, as well as open repair procedures such as open lumbar discectomy or laminectomy.

A probe is inserted into the disc through a small incision in the patient's back. The needle is inserted through the annulus and into the nucleus pulposus. Laser energy is delivered through the probe and used to vapourise part of the nucleus pulposus. Several types of laser are available, each with differences in absorption, energy requirements, and rate of application. The procedure is performed under local and/or neuroleptic anaesthetic, and using radiographic imaging.

The major proposed advantages of laser lumbar discectomy relate to its minimal invasiveness, with procedures being performed as day surgery cases under local anaesthesia. Detractors have reported high rates of subsequent open surgery.
Literature review
A systematic search of MEDLINE, PREMEDLINE, EMBASE, Current Contents, PubMed, Cochrane Library and Science Citation Index using Boolean search terms was conducted, from the inception of the databases until October 2002. The York Centre for Reviews and Dissemination, Clinicaltrials.gov, National Research Register, SIGLE, Grey Literature Reports, relevant online journals and the Internet were also searched in October 2002. Searches were conducted without language restriction.

Articles were obtained on the basis of the abstract containing safety and efficacy data on laser discectomy in the form of randomised controlled trials (RCTs), other controlled or comparative studies, case series and case reports.

Studies were selected where a laser was the only intended method of repair. Articles described as laser-assisted repair were excluded if arthroscopic instrumentation had also been used. Studies using cadavers were also excluded. Tabulated studies are given in the reference list with reasons for inclusion stated. Studies for which data were not tabulated are listed in the annex following the reference list.

List of studies found
Total number of studies found: 29
- Randomised controlled trials 2
- Systematic reviews 2
- Non-randomised comparative studies (English) 2
- Non-randomised comparative studies (German) 1
- Case series 20
- Case reports 2

RCTs in progress
Two studies of laser lumbar discectomy were located in the National Research Register database. Attempts were made to obtain further information, but both contact people were on leave.

- A randomised prospective study comparing laser disc decompression & steroid injection in alleviating radicular pain secondary to prolapsed lumbar pain. 1/10/95 – 1/10/97, Prospective randomised patient blind parallel group study, 70 patients.

- Effectiveness of laser discectomy on lumbar disc protrusion. 1/4/97 – 31/12/99 (no further description)
Summary of key efficacy and safety findings
See following tables.

Abbreviations:
- APD: automated percutaneous discectomy
- APLD: automated percutaneous lumbar discectomy
- CN: chemonucleolysis
- KTP: potassium-titanyl-phosphate
- LD: laser discectomy
- MRI: magnetic resonance imaging
- Nd:YAG: neodymium:yttrium-aluminium-garnet
- RSD: reflex sympathetic dystrophy
- SLR: straight leg raise
<table>
<thead>
<tr>
<th>Authors, date, location, number of patients, length of follow-up, selection criteria</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Appraisal/Comments</th>
</tr>
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<tbody>
<tr>
<td><strong>Randomised controlled trials</strong>&lt;br&gt;Livesey 1999¹, UK&lt;br&gt;13 KTP laser discectomy, 16 epidural steroid injections; no date specified.&lt;br&gt;Follow up: 1 – 26 weeks.&lt;br&gt;Selection criteria: contained disc prolapse, moderate pain, positive tension signs, otherwise normal neurology and disc narrowed by not more than 50% on X-ray</td>
<td>Both groups improved based on a variety of outcome measures (modified MacNab, angle of straight leg raise and Oswestry low back pain disability score). No significant difference detected in improvement between 2 groups.</td>
<td>Not mentioned</td>
<td>Potential for bias: no description of method of randomisation. “Patients blindly assessed before and after surgery”. Uncertain if patients and assessors were blinded. Brevity of abstract leaves many questions unanswered.&lt;br&gt;Outcome measures: MacNab is well validated, but status of modified MacNab is unknown. Status of Oswestry scoring system is not stated.&lt;br&gt;Comments: Results from conference abstract. Hospital discontinued laser procedure based on cost following this trial.</td>
</tr>
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</table>
### Non-randomised comparative studies

<table>
<thead>
<tr>
<th>Study details</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Appraisal/Comments</th>
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<tbody>
<tr>
<td>Bosaccco et al. 1996, US</td>
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<tr>
<td>63 patients treated prospectively with KTP laser (LD); 1992-3. Functional results (not complications) compared with 70 (historical) patients with herniated nucleus pulposus treated with open laminectomy/discectomy (dates of these not stated).</td>
<td></td>
<td>1 LD patient (1.6%) required readmission for acute urinary retention and reflex ileus</td>
<td>Potential for bias: prospective study with historical control group. 2 patients lost to follow-up. Outcome measures: Andrews and Lavyne rating scale (reference and details of scale given – validation uncertain).</td>
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<td>Follow up: 61 patients scored from telephone questionnaire and chart review. 20-45 months (mean 31.75)</td>
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<tr>
<td>Selection criteria: single nerve root signs (L4 and L5) and symptoms, positive straight leg raising test and MRI evidence to support clinical findings. No previous surgery, stenosis, sig. disease, evidence of extruded or sequestered disc.</td>
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<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>Historical control</th>
</tr>
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<tbody>
<tr>
<td>Excellent</td>
<td>21/63 (34%)</td>
<td>36/70 (51%)</td>
</tr>
<tr>
<td>Good</td>
<td>19/63 (31%)</td>
<td>24/70 (34%)</td>
</tr>
<tr>
<td>Fair</td>
<td>15/63 (24%)</td>
<td>8/70 (11%)</td>
</tr>
<tr>
<td>Poor</td>
<td>6/63 (10%)</td>
<td>2/70 (3%)</td>
</tr>
</tbody>
</table>

LD group: 17/61 (28%) had complete relief of pain. 40/61 (66%) had partial relief of pain. 44/61 (72%) of patients had excellent or good relief of radicular pain and 33/61 (54%) relief of back pain. 76% of patients not involved in compensation cases had good or excellent results. 36/61 (59%) returned to work by postop. week 4. 14/61 (23%) experienced persistent symptoms. 62/63 (98%) length of stay < 24 hours. (no equivalent measures given for historical control group).
<table>
<thead>
<tr>
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<th>Appraisal/Comments</th>
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</thead>
<tbody>
<tr>
<td><strong>Black 1995</strong>, US</td>
<td>APD and KTP laser allocation abandoned early due to a 5/19 (26%) and 3/12 (25%) failure rate. 4/50 (8%) failure rate for Nd:YAG discectomy. Subsequent follow-up case series study of Nd:YAG (1993-1995) showed 1/55 (1.8%) failure rate at 15 months.</td>
<td>2/50 (4%) Nd:YAG patients experienced aseptic discitis.</td>
<td>Potential for bias: Concurrent comparison. No blinding. No description of method of allocation of patients. Outcome measures: Success was defined as freedom from radicular pain, normal functioning, and medically cleared to return to employment.</td>
</tr>
</tbody>
</table>
**Study details**  |  **Key efficacy findings**  |  **Key safety findings**  |  **Appraisal/Comments**

**Case series**

**Knight and Goswami**  
2002, UK

687 levels in 576 consecutive patients treated with KTP laser; 1992-97

**Follow-up:** minimum 3 years (100% for 1st year, decreasing to 67%).

**Selection criteria:** patients with chronic back pain unresponsive to conservative management, disc bulge, contained disc, radial tears of disc, painful discs proven by spinal probing and discography, stenotic symptoms.

**Exclusions:** stenosis, sequestration, cauda equina, tumors, acute trauma.

<table>
<thead>
<tr>
<th>Year</th>
<th>Result</th>
<th>Back n=348</th>
<th>Buttock n=292</th>
<th>Leg n=310</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 G</td>
<td>210 (60%)</td>
<td>165 (56%)</td>
<td>184 (59%)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>72 (21%)</td>
<td>52 (18%)</td>
<td>58 (19%)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>55 (16%)</td>
<td>67 (23%)</td>
<td>59 (19%)</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>11 (3%)</td>
<td>8 (3%)</td>
<td>9 (3%)</td>
<td></td>
</tr>
<tr>
<td>2 G</td>
<td>192 (55%)</td>
<td>145 (50%)</td>
<td>173 (56%)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>82 (24%)</td>
<td>65 (22%)</td>
<td>63 (20%)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>60 (17%)</td>
<td>71 (24%)</td>
<td>65 (21%)</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>14 (4%)</td>
<td>11 (4%)</td>
<td>9 (3%)</td>
<td></td>
</tr>
<tr>
<td>3 G</td>
<td>181 (52%)</td>
<td>140 (48%)</td>
<td>158 (51%)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>86 (25%)</td>
<td>68 (23%)</td>
<td>67 (22%)</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>71 (20%)</td>
<td>73 (25%)</td>
<td>75 (24%)</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>10 (3%)</td>
<td>11 (4%)</td>
<td>10 (3%)</td>
<td></td>
</tr>
</tbody>
</table>

G=good/excellent; S=satisfactory; P=poor; W=worse

Further disc prolapse at same level in 2% of patients.

17% of patients required endoscopic laser foraminoplasty for foraminal and lateral recess decompression.

4 patients (1%) had aseptic discitis with increased pain and muscular spasm.

**Potential for bias:** originally consecutive selection of patients, but substantial losses to follow-up.

**Outcome measures and their validity:** Oswestry Disability Index, Visual Analogue Pain Index, Patient Target Achievement Score and Patient Satisfaction Scores (validation uncertain). Took >50 on Oswestry as excellent and >20 as satisfactory response.

**Comments:** patients with demonstrated tears were included. 23% of patients had previous open disc decompression and fusions.
<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Case series</strong></td>
<td><strong>Ohnmeiss et al. 1994</strong>, US</td>
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<td>Follow up on 164/204 patients extracted from records for KTP laser disc decompression; before 1994</td>
<td>41 patients met all selection criteria (group 1); of these 29/41 (71%) had a “successful result”</td>
<td>Out of 164 patients: 1 confirmed (0.6%), 1 possible case (0.6%) of reflex sympathetic dystrophy (RSD)</td>
<td>Potential for bias: Follow up only available for the 204 patients extracted from records.</td>
</tr>
<tr>
<td><strong>Follow-up:</strong> min 1 year, by mail.</td>
<td>42 patients did not meet all selection criteria (group 2); of these 12/42 (29%) had a “successful result”, significantly less than group meeting selection criteria (P&lt;0.005; binomial comparison of groups 1 and 2).</td>
<td>12 cases (7.3%) of postoperative dysesthesia, 5 resolved.</td>
<td>Outcome measures and their validity: Successful outcome defined as “no subsequent lumbar surgery, patient felt that LD had helped, and if patient was working before symptom onset, was able to work at time of follow up (not validated)”</td>
</tr>
<tr>
<td><strong>Selection criteria:</strong> Group 1 (met all selection criteria) ie leg pain, physical exam finding (motor, sensory, reflex deficit and/or SLR); discographic confirmation of contained disc herniation; no stenosis or spondylolisthesis. Group 2 (did not meet selection criteria) ie no deficits identified by physical exam, presence of stenosis or spondylolisthesis, extruded disc fragment or leakage of discographic contrast from disc (discography performed), multiple prior lumbar surgeries. Group 3 (could not be assigned to either of first 2 groups) ie discography not performed, incomplete physical exam recorded. Group 4 - role of discography: additional subgroup of patients meeting all criteria of group 1 but either discography was not performed (n=38) or extravasation of contrast was noted (n=7).</td>
<td>Remaining 81 patients could not be assigned to either group (group 3), 45 (56%) had a “successful result”. Significantly better than among patients in group 2 (P&lt;0.025; binomial comparison)</td>
<td>During instrument insertion in 3 patients (1.8%), instrument came in contact with nerve, and in another the instrument tip bent.</td>
<td>Other comments: Aim of study was to put patients into groups according to whether they met specific selection criteria for procedure, and to review this against the success of procedure.</td>
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<td></td>
<td>Patients in group 1 had significantly greater success than those in group 3 (0.05&lt;P&lt;0.06). Of 164 patients, 39 (23.8%) had second procedures due to no improvement or worsening of symptoms</td>
<td>In 5 patients (3%) procedure was stopped periodically due to heat build up.</td>
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<td>Success rate better in those meeting selection criteria.</td>
<td>Among reoperated group: 1 RSD (0.6%), 4 (2.4%) postop dysesthesias, 1 (0.6%) post-op. neurological deficit, 2 (1.2%) stenosis, 1 (0.6%) far lateral disc herniation, 3 (1.8%) recurrent disc herniation, 3 (1.8%) extruded disc fragments.</td>
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<td>Role of discography (group 4): 20/45 (44.4%) had successful outcome. Significantly less than for patients meeting all criteria but including the discogram (70.7% vs 44.4%, P&lt;0.035).</td>
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</table>
Specialist advisor's opinion / advisors’ opinions

Specialist Advice was sought from the British Orthopaedic Association

One Specialist Advisor described this procedure as definitely novel and performed in very few specialist centres. Damage to nerve roots, vertebral endplates and neighbouring structures, and disc space infection were listed as potential complications. The same Advisor thought that most spinal surgeons believe the procedure is ineffective and mentions one (unnamed) UK trial that showed poor efficacy. The equipment is described as expensive and requires x-ray imaging and/or percutaneous arthroscopy.

Issues for consideration by IPAC

Choy introduced the procedure Nd:YAG laser discectomy in 1986 and has been its main and most influential proponent. He has published many papers, but these were excluded from this report on the basis of that they contribute little to the evaluation of safety and efficacy.

A brief appraisal of all the available literature suggests that surgical failures are frequently due to the presence of free fragments, which suggests that selection criteria for patients should be carefully considered. In addition, most articles on laser discectomy were published around 1995 to 1996. Very little of additional use has been published since this time.

References


   - Only RCT available in English. Although information taken from conference abstract and minimal data, results were of pragmatic use to hospital.


   - Historically controlled study. Useful pain information.


   - Concurrent comparison. Mixture of laser types.


   - Recent case series, clear efficacy data.

Laser discectomy

- **Aim of case series was to review success against selection criteria. Good safety information included.**

**ANNEX: Studies that met the inclusion criteria but which were not tabulated.**


Nerubay J, Caspi I, Levinkopf M. Percutaneous carbon dioxide laser nucleolysis with 2- to 5- year followup. Clinical orthopaedics and related research. 1997; 337:45-48

Plancarte R, Calvillo O. Complex regional pain syndrom type 2 (causalgia) after automated laser disectomy: a case report. Spine. 1997;22(4);459-461


