NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of percutaneous intradiscal laser ablation in the lumbar spine

Discs that act like cushions between the bones of the spine can sometimes get damaged and protrude onto nerves, causing back and leg pain, and numbness and weakness in the leg.

In percutaneous intradiscal laser ablation, a needle is inserted through the outer cover of the disc, into its jelly-like centre. A laser is then inserted through the needle to destroy part of the disc, with the aim of shrinking it.

Introduction

The National Institute for Health and Clinical Excellence (NICE) has prepared this overview to help members of the Interventional Procedures Advisory Committee (IPAC) make recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in May 2010.

Procedure name

- Percutaneous intradiscal laser ablation in the lumbar spine
- 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)

Specialty societies

- British Orthopaedic Association
- British Association of Spine Surgeons
- The Society of British Neurological Surgeons
- The Society for Back Pain Research

Description

Indications and current treatment

Symptomatic disc herniation (prolapse) of a lumbar intravertebral disc is a common cause of chronic low back pain and sciatica, both of which can be self-limiting. In disc herniation, the nucleus pulposus (the inner part of the disc) protrudes through a tear on the annulus fibrosus (the outer part). The annulus fibrosus may rupture completely, resulting in an extruded disc, or it may remain intact but stretched, resulting in a contained (bulging) disc prolapse. This may result in compression of one or more spinal nerve roots, causing back or leg pain, with or without leg numbness and weakness. Diagnosis is based on history, clinical examination and imaging studies (typically involving magnetic resonance imaging [MRI]).

The initial management of uncomplicated disc prolapse is usually conservative, and may include rest, analgesic or anti-inflammatory medication, epidural injection and physical therapies. Surgery (discectomy) may be considered when there is persistent nerve compression (presenting with unilateral radicular symptoms or other signs of root dysfunction) or if symptoms do not improve after conservative treatment. However, disc prolapse in the context of cauda equina syndrome (characterised by acute loss of neurological function of the lower limbs and sphincters) is considered a separate condition and is a surgical emergency. A number of different variants of discectomy exist. Microdiscectomy (removal of the disc though a small incision) can be used. In addition, a number of ablative interventional procedures have also been used, including percutaneous intradiscal electrothermal therapy (using an electrode or flexible catheter heated to 90°C to ablate the disc), percutaneous intradiscal radiofrequency thermocoagulation (using an electrode or flexible catheter heated to between 50°C and 80°C to ablate the disc) and percutaneous disc decompression using coblation (using a probe heated to between 40°C and 70°C to ablate the centre of the disc).

What the procedure involves

Percutaneous intradiscal laser ablation (also commonly referred to as percutaneous laser disc decompression [PLDD] in the literature) aims to vaporise part of a prolapsed disc, and can only be performed if the prolapse is

contained (i.e. the disc is bulging but the nucleus pulposus has not extruded through the annulus fibrosus).

The patient is placed in the prone position usually under a local anaesthetic with mild sedation. Under fluoroscopic guidance, a spinal needle is inserted into the patient's back and passed into the disc. The needle is inserted, through the annulus, into the nucleus pulposus and an optical fibre is introduced through the needle. Laser energy is then delivered through the optical fibre to vaporise part of the nucleus pulposus.

Several types of laser are available, each with different absorptions, energy requirements and rates of application.

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to percutaneous intradiscal laser ablation in the lumbar spine. Searches were conducted of the following databases, covering the period from their commencement to 23 June 2009 and updated to 17 May 2010: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches (see appendix C for details of search strategy). Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The following selection criteria (table 1) were applied to the abstracts identified by the literature search. Where selection criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, or a laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising study methodology, unless they reported specific adverse events that were not available in the published literature.
Patient	Patients with lumbar disc herniation.
Intervention/test	Percutaneous intradiscal laser ablation in the lumbar spine.
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the overview

This overview is based on 2530 patients from 3 non-randomised comparative studies[1,2,3], 5 case series[3,4,5,6,7] and 2 case reports[8,9].

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (table 2) have been listed in appendix A.

Table 2 Summary of key efficacy and safety findings on percutaneous intradiscal laser ablation in the lumbar spine

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Tassi GP (2006)[1]

Non-randomised comparative study
Italy
Recruitment period: percutaneous laser disc decompression (PLDD): 2002–2004; microdiscectomy: 1997–2001
Study population: patients with pain due to herniated lumbar disc
n = 1000 (500 vs 500)
Age: PLDD: 49 years (median); microdiscectomy: 47 years (median)
Sex: PLDD: 50.6% (253/500) male; microdiscectomy: 52.2% (261/500) male
Mean duration of symptoms prior to procedure: not reported.
Patient selection criteria: pain due to herniated lumbar disc unresponsive to conservative therapy for 6 weeks. Patients with sequestered disc were excluded. All patients had preoperative MRI and/or CT scan.

Technique: PLDD using Nd:Yag laser (Choy technique) with antibiotics for 12 hours before and after procedure and mild sedation during the procedure vs microdiscectomy (Caspar technique) followed by antibiotics for 3 days.

Follow-up: 2 years (mean)
Conflict of interest/source of funding: not reported</td>
<td>Number of patients analysed: 1000 (500 vs 500)
<u>Success of procedure at 2 years</u> (MacNab criteria)
<table>
<tr><th></th><th>PLDD (n = 500)</th><th>Microdiscectomy (n = 500)</th></tr>
<tr><td>Excellent or good</td><td>83.8% (419/500)</td><td>85.6% (428/500)</td></tr>
<tr><td>No change or poor outcome</td><td>16.2% (81/500)</td><td>14.4% (72/500)</td></tr>
</table>
<u>Neurological symptoms at follow-up</u>
<table>
<tr><th>Symptom</th><th>PLDD</th><th>Microdiscectomy</th></tr>
<tr><td>Foot drop improved or remitted</td><td>67% (4/6)</td><td>50% (4/8)</td></tr>
<tr><td>Sensory deficit improved or remitted</td><td>80% (88/110)</td><td>75% (69/92)</td></tr>
<tr><td>Reflex recovery</td><td>73%(24/33)</td><td>70% (28/40)</td></tr>
<tr><td>Straight leg raising remitted</td><td>91% (422/464)</td><td>88% (418/475)</td></tr>
<tr><td>Impotence recovered</td><td>100% (1/1)</td><td>-</td></tr>
</table>
<u>Re-operation rate for re-herniation or persistent back or leg pain</u>
PLDD group: 3.2% (16/500); microdiscectomy group: 7% (35/500)</td>
<td>PLDD group: 1 patient had fever with back pain 3 days after the procedure. Recovered after 1 week of antibiotics and bed rest (author states 0% complication rate)

Microdiscectomy group:
Overall complication rate: 2.2% (11/500)
Spondylodiscitis: 0.6% (3/500)
Perineural haematoma requiring early new open surgery: 0.4% (2/500)
Neurological radicular deterioration: o.4% (2/500)
Spondylolisthesis requiring vertebral stabilisation: 0.8% (4/500)</td>
<td>Follow-up issues:
100% follow-up.
Study design issues:
29% (145/500) in the PLDD group and 38% (190/500) in the microdiscectomy group had a preoperative electromyogram.
MacNab criteria: ‘excellent’ = pain relieved by over 75% compared with before the procedure and no limited motor function, ‘good’ = pain relieved by 50–75% and improved motor function, ‘no change / passable’ = pain relieved by less than 50% and unimproved dysfunction, ‘poor’ = manifestation of nerve pressed and further treatment required.
Study population issues:
7.8% (39/500) in the PLDD group and 6.2% (31/500) in the microdiscectomy group had previous failed open back surgery.</td>
</tr>
</table>

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Yang J (2005)[2]

Non-randomised comparative study
China
Recruitment period: PLDD: 1998–1999; APLD:1995–1998
Study population: patients with lumbar intervertabral disc prolapse
n = 106 (60 vs 46)
Age: PLDD: 41.8 years (mean); APLD: 40.3 years (mean)
Sex: PLDD: 70% (42/60) male; APLD: 65% (26/40) male
Mean duration of symptoms prior to procedure: PLDD group: 2.5 years; APLD group: 4.3 years.

Patient selection criteria: history of lumbar and leg diseases (not otherwise defined). All patients had a detailed history record, general physical examination and radiographs of lumbar vertebrae. Exclusion criteria: patients with lumbar and leg pain caused by tumour or tuberculosis.

Technique: PLDD (an 8–12 cm incision made in the patient’s back to insert the needle. Fluoroscopy used for visualisation) vs APLD (electric discectomy apparatus used to aspirate the nucleus pulposus for the latter).

Follow-up: not reported
Conflict of interest/source of funding: not reported</td>
<td>Number of patients analysed: 106 (60 vs 46)

<u>Success of procedure</u> (MacNab criteria)
<table>
<tr><th></th><th>PLDD (n = 60)</th><th>APLD (n = 46)</th><th>p value</th></tr>
<tr><td>Excellent</td><td>48.4% (29/60)</td><td>47.8% (22/46)</td><td>>0.05</td></tr>
<tr><td>Good</td><td>33.3% (20/60)</td><td>39.1% (18/46)</td><td>>0.05</td></tr>
<tr><td>Passable</td><td>15.0% (9/60)</td><td>10.9% (5/46)</td><td>-</td></tr>
<tr><td>Poor</td><td>3.3% (2/60)</td><td>2.2% (1/46)</td><td>-</td></tr>
</table>
Authors report that prolapse of the lumbar intervertabral disc recurred or worsened in some patients. Unclear how many and in which group.</td>
<td>PLDD group: no complications

APLD group: 1 patient with infection of intervertebral disc (definition, timing and treatment are not reported in the paper)</td>
<td>Follow-up issues:
• 100% follow-up although it is unclear when follow-up was done.

Study population issues:
• No significant different in distribution of age, sex or course of disease between the 2 groups.</td>
</tr>
</table>

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.

<table>
<tr><th>Study details</th><th>Key efficacy findings</th><th>Key safety findings</th><th>Comments</th></tr>
<tr>
<td>Black J (1995)[3]

Non-randomised comparative study (NRCT) and case series
US
Recruitment period: initial study (NRCT): up to 1993; confirmation study (case series): 1993–1995
Study population: patients with contained disc herniation (disc must be contained by the annulus and/or the dorsilongitudinal ligament) and radicular pain.
n = 81 [104 discs] (50 vs 12 vs 19) initial study (NRCT)
n = 55 [78 discs] (case series)
Age: range 17–66 years (initial study)
Sex: approximately 2:1 male :female ratio (initial study)
Duration of symptoms prior to procedure: majority had persistent symptoms for 1 year.
Patient selection criteria: all patients had received at least 3 months of conservative therapy before the procedure. 80% (44/55) in the confirmation study and 8% (4/50) in the Nd:Yag laser group in the initial study had preoperative discography confirming herniation. 16% (13/81) of patients in the initial study had previous lumbar surgery.

Technique: initial study: PLDD using Nd:Yag laser vs PLDD using KTP laser vs APLD (electric discectomy apparatus used to aspirate the nucleus pulposus). Type of needle and method of visualisation used are not reported.
Case series: PLDD using Nd:Yag laser

Follow-up: 9–58 months (initial study)
Conflict of interest/source of funding: not reported</td>
<td>Initial study (NRCT)
Number of patients analysed: 81 (50 vs 12 vs 19)
<u>Success of procedure</u>
<table>
<tr><th></th><th>PLDD using Nd:Yag laser (n = 50)</th><th>PLDD using KTP laser (n = 12)</th><th>APLD (n = 19)</th></tr>
<tr><td>Good</td><td>92% (46/50)</td><td>75% (9/12)</td><td>74% (14/19)</td></tr>
<tr><td>Failed</td><td>8% (4/50)</td><td>25% (3/12)</td><td>26% (5/19)</td></tr>
</table>
‘Good’ result defined as patients not needing to use narcotics or only occasional analgesia, had no radicular pain or had occasional back pain and were able to resume normal activity.
‘Failure’ defined as daily back pain or daily use of analgesics.

Of those patients in whom the procedure failed, 8 went on to have laminectomy, 2 had PLDD using Nd:Yag laser and 1 had subjective pain syndrome.

Confirmation study (case series)
Number of patients analysed: 55
Failure rate: 1.8% (1/55)</td>
<td>Initial study
PLDD using Nd:Yag laser: 2 patients with aseptic discitis requiring hospitalisation. Both patients responded well to steroids and were discharged within 2–3 days.

PLDD using KTP laser: no complications

APLD group: no complications

Confirmation study complications not reported</td>
<td>In table 2 in original overview by ASERNIP

Follow-up issues:
• 100% follow-up in both studies.

Study design issues:
• No description of method of allocation of patients.
• APLD and KTP laser were abandoned early in the initial study because of 26% and 25% failure rates respectively.

Study population issues:
• Majority of patients in the initial study had persistent symptoms for 1 year prior to the procedure.</td>
</tr>
</table>

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.

Study details	Key efficacy findings	Key safety findings	Comments
Knight M (2002)[4] **Case series** UK Recruitment period: 1992–1997 Study population: patients with chronic back pain from contained disc prolapse. n = **576 (687 discs)** Age: 43 years (mean) Sex: not reported Duration of symptoms prior to procedure: 4.7 years (mean) Patient selection criteria: disc bulge (broad-based), contained disc prolapsed, MRI or clinically suspected tears of the discs, painful discs as proven by spinal probing during discography. All patients had to be unresponsive to conservative management (kinetic muscle balancing physiotherapy) for 3 months. Exclusion criteria: spinal stenosis confirmed by CT or MRI, sequestered discs, cauda equina syndrome and neurological emergencies, associated tumour and acute trauma. 18% (104/576) had previous spinal surgery. Technique: lumbar PLDD and disc ablation using KTP laser. All patients had 6 sessions of physiotherapy over 3 months after the procedure. 22-gauge needle used in the laser procedure. Method of visualisation is unclear. Follow-up: **5.33 years (mean)** Conflict of interest/source of funding: not reported	Number of patients analysed: **576** <u>Response to procedure by year and Oswestry Disability Index</u> (see table below) 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. <u>Visual Analogue Pain Index (VAPI) scores</u> 12% pain free at the end of 3 years 51% had more than 50% reduction in pain scale 8% had deterioration of pain symptoms <u>Patient target achievement score</u>: 56% achieved more than 50% of the preoperative rehabilitation objectives. <u>Patient satisfaction</u>: 61% satisfied with overall outcome	4 patients had aseptic discitis with increased pain and muscular spasm. Treatment and timing of the complication are not reported. No neurological complications observed.	**In table 2 in original overview by ASERNIP** **Follow-up issues**: • 100% at 1 year, 67% (388/576) at last follow-up. **Study design issues:** • Outcome measures : Oswestry Disability Index, Visual Analogue Pain Index, Patient Target Achievement Score and Patient Satisfaction Scores (validation uncertain). • >50 on Oswestry Disability Index is excellent / good and >20 is a satisfactory response.

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

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.

Study details	Key efficacy findings	Key safety findings	Comments
Choy DS (1998)[5] **Case series** US Recruitment period: 1986-1988 Study population: patients with image documented (MRI / CT scan in last 6 months) intervertebral herniated discs and corresponding pain syndromes. n = **518 (752 discs)** Age: 17–92 years (range) Sex: 61% (317/518) male Patient selection criteria: failure of 3 months of conservative therapy. A second concurring opinion of a neurologist, neurosurgeon or orthopedic surgeon. Discs contained or at least contiguous with the parent disc. Patients with sciatic pain for at least 3 months. Exclusion criteria: cancer of the spine, fracture, infection, litigation back disease, myositis, simple back strain, lateral recess syndrome, severe osteoarthritis, marked vacuum phenomena, bone spur impingement on nerve roots, previous surgery with scar tissue nerve entrapment, severe spondylolisthesis or pure bony spinal stenosis. Technique: PLDD using Nd:Yag laser Follow-up: **7 years (mean)** Conflict of interest/source of funding: not reported	Number of patients analysed: **350** Overall success rate (according to MacNab criteria): 75% Success rate past 36 months: 89% (numbers unclear and not reported in the paper) Results for last 350 patients (procedures performed in a private outpatient facility) MacNab criteria / Males (n = 210) / Females (n = 140) Good / Fair / 76% / 86% Poor / 24% (ages 20-80 years) / 18% (all ages) Numbers are not reported in the paper and loss to follow-up is unclear. The procedure failed in all 6 male patients aged 80–92 years. Authors report a recurrence rate of approximately 5%and eventual surgery performed in 6%.	Overall rate: 0.97% (5/518) 2 patients with lumbar disc herniations developed aseptic discitis 3–4 days after the procedure. Both were hospitalised and responded to bed rest and analgesics and were discharged after 3–4 days. 2 patients developed septic discitis (confirmed by MRI and needle puncture culture, which was positive for *Staphylococcus aureus*) 3 days after the procedure. Both responded to brief hospitalisation with parenteral vancomycin continued on an outpatient basis for 6 weeks. One patient developed a retroesophageal abscess which was successfully drained surgically. This patient also required subsequent open discectomy and fusion.	**Follow-up issues**: • 17% (88/518) lost to follow-up at 12 months. **Study design issues:** • The first 168 patients had their procedures done at a teaching hospital, the remaining 350 patients had their procedures performed at a private outpatient clinic. Efficacy data for the initial set of patients is unclear. • Unclear when MacNab criteria were applied to determine success. **Study population issues**: • 96% (497/518) patients had herniated lumbar discs.

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Tonami H (1999)[6] **Case series** Japan Recruitment period: 1995–1997 Study population: patients with lumbar disc herniation confirmed by MRI. n = **182** Age: not reported Sex: not reported Patient selection criteria: preoperative MRI 1–7 days before procedure and postoperative MRI 1–148 days after procedure. Technique: percutaneous laser discectomy (with fluoroscopic guidance) using a holmium:yttrium aluminum garnet laser system. Follow-up: **up to 2 years** Conflict of interest/source of funding: not reported	None reported	Number of patients analysed: **182** 4 patients (2.2%) developed subchondral osteonecrosis of the vertebral body (3 male, 1 female aged 17–45 years). They presented with severe low back pain 8–103 days after the procedure. Diagnosis confirmed by MRI imaging. One of the patients underwent surgical treatment because of continuously severe back pain and at 1-year follow-up most of this patient's pain was relieved. The remaining 3 patients with occasionally severe pain underwent conservative treatment and at 2 years follow-up the pain had diminished.	**Follow-up issues**: • Completeness of follow-up is unclear. **Study design issues:** • Retrospective safety study.

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression.			
Study details	**Key efficacy findings**	**Key safety findings**	**Comments**
Takeno K (2006)[7] **Case series** Japan Recruitment period: 1999–-2004 Study population: patients who required salvage operations for complications after PLDD for lumbar disc herniation. Three patients also had spondylolisthesis. n = **10** Age: 38.5 years (mean) Sex: 80% (8/10) male Patient selection criteria: see above. Technique: Salvage operation (description not provided) where disc herniation and severity of adhesions between herniated masses and nerve roots were graded. (Patients had an initial PLDD using Nd: Yag or holmium Yag laser). Follow-up: **2 years** Conflict of interest/source of funding: not reported	Initial PLDD procedure had no effect on low back pain or sciatica	Number of patients analysed: **10** Symptoms after PLDD procedure: Leg sensory disturbance and/or muscle weakness: 30% (3/10) of patients. CT scans showed intra disc defects induced by PLDD in 3 patients (30%). All 10 patients underwent repeated attempts at conservative treatment. None had any symptomatic improvement. All patients had further 'salvage' procedures: 7 patients underwent microdiscectomy, 1 had microendoscopic discectomy and 2 had posterolateral interbody fusion with pedicle screw. During these operations it was observed that 6 patients had subligamentous extrusion, 3 had transligamentous extrusion and 1 patient had sequestration. Resected disc tissue in 5 patients contained carbonised lesions, and 5 patients had destruction of end plate. The herniated discs of 2 patients were found to be severely cavitated and unstable. In all patients, herniated masses completely compressed and adhered to nerve roots. 5 patients had grade 1 adhesions and 5 patients had grade 2 adhesions. All patients had evidence of heat-induced cell necrosis and carbonisation. 2 years after salvage operation, all patients were free of low back pain and sciatica.	**Follow-up issues**: • 100% follow-up. **Study design issues:** • Retrospective safety study.

Abbreviations used: APLD, automated percutaneous lumbar discectomy; CT, computed tomography; KTP, potassium titanyl phosphate; MRI, magnetic resonance imaging; Nd:YAG, neodymium-doped yttrium aluminium garnet; PLDD, percutaneous laser disc decompression;

Study details	Key safety findings	Comments
Plancarte R (1997)[8] **Case report** US Recruitment period: not reported Study population: patient with herniated intervertebral discs at L4–L5 and L5–S1(assessed clinically and radiographically) n = **1** Age: 39 years Sex: female Technique: automated laser discectomy (small automated probes placed in the herniated intervertebral disc under local anaesthetic and fluoroscopic guidance). Follow-up: **12 months** Conflict of interest/source of funding: not reported	Case report 1: Long-term extreme pain. Automated laser discectomy of L4–L5 was conducted followed by the same procedure on L5–S1. The latter procedure was aborted due to the patient experiencing extreme pain and discomfort. The day after the procedure, the patient complained of paraesthesia of the foot. She presented with significant weakness and inability to dorsiflex the foot. After 4 weeks this symptom subsided but the patient noted a constant burning, prickling pain in the left lower extremity, buttock and foot. Over the next 4–6 weeks the pain became more intense and disabling and the patient was referred to a neurologist and then an orthopaedist. Conservative therapy was tried but did not reduce the pain. Patient referred a Pain Centre and diagnosed with complex regional pain syndrome type 2 (causalgia). Treatment: 2 diagnostic chemical percutaneous sympathectomies (relieved pain for up to 2 weeks) followed by a therapeutic chemical percutaneous sympathectomy using phenol. At 12 months the patient had minimal pain and was on a daily maintenance dose of carbamazepine.	
Jeon S-H (2007)[9] **Case report** Korea Recruitment period: not reported Study population: patient with paramedian disc herniation (L5–S1 level) n = **1** Age: 42 years Sex: female Technique: lumbar discectomy with microsurgical carbon dioxide laser under general anaesthesia Follow-up: **10 days** Conflict of interest/source of funding: none	Case report 2: Perforation of iliac artery. Nearing completion of the discectomy a sudden spurt of arterial blood was noted. The bleeding was stopped with compression, however, the patient had a sudden drop in blood pressure with tachycardia. A laparotomy was performed and a large haematoma was found in the distended retroperitoneal space. Evacuation of the haematoma revealed a 5 mm perforation in the iliac artery. The arteriotomy was repaired and a blood transfusion was required. Pulmonary oedema and paralytic ileus was observed during intensive care. The patient recovered and was discharged after 10 days.	

Efficacy

Success of procedure

A non-randomised comparative study of 1000 patients (500 PLDD vs 500 microdiscectomy) reported 'excellent' or 'good' MacNab criteria results (pain relived by 50% or more and improved motor function) in 84% (419/500) of patients in the PLDD group and 86% (428/500) in the microdiscectomy group at 2-year follow-up[1].

A non-randomised comparative study of 106 patients (60 PLDD vs 46 automated percutaneous lumber discectomy [APLD]) reported 'excellent' MacNab criteria results (pain relived by 75% or more and no limited motor function) in 48% (29/60) of patients in the PLDD group and 48% (22/46) in the APLD group (not significant, follow-up unspecified)[2].

A non-randomised comparative study of 81 patients (50 PLDD using Nd:Yag [neodymium-doped yttrium aluminium garnet] laser vs 12 PLDD using KTP [potassium titanyl phosphate] laser vs 19 APLD) reported a failure rate (defined as daily use of analgesics for back pain following procedure) in 8% (4/50) of patients in the PLDD Nd:Yag laser group, 25% (3/12) in the PLDD KTP laser group and 26% (5/19) in the APLD group (follow-up 9–58 months). A further case series of 55 PLDD Nd:Yag procedures reported a failure rate of 2% (1/55)[3].

A case series of 518 patients reported an overall success rate of 75% (actual numbers not reported)[5].

Reoperation rate

The non-randomised comparative study of 1000 patients reported reoperation rates for herniation or persistent leg or back pain in 3% (16/500) of patients in the PLDD group and 7% (35/500) in the microdiscectomy group at mean 2-year follow-up[1].

Patient satisfaction

A case series of 576 patients reported that 61% patients (actual numbers not reported) were satisfied with the overall outcome of PLDD and ablation using the KTP procedure[4].

Safety

Aseptic discitis

In 2 of the studies described below[3,5]; aseptic discitis was not defined in the papers. In the third study, aseptic discitis was diagnosed when blood investigation and culture, and subsequent biopsy failed to identify an infective pathology[4].

The non-randomised comparative study of 81 patients reported 2 patients with aseptic discitis requiring 2–3 days hospitalisation with steroid treatment in the PLDD Nd:Yag laser group compared with no patients with this complication in the PLDD KTP laser group or the APLD group (follow-up 9–58 months)[3].

Case series of 576 and 518 patients reported 4 patients[4] and 2 patients[5] respectively with aseptic discitis. In first series, the patients had increasing pain and muscular spasms (timing and treatment not reported) and in the second series, both patients developed aseptic discitis 3–4 days after the procedure, were hospitalised for 3–4 days and responded to bed rest and analgesics.

Infection

The non-randomised comparative study of 106 patients reported infection of intervertebral disc (definition, timing and treatment not reported) in 0 patients in the PLDD group and 1 patient in the APLD group[2].

A case series of 518 patients reported 2 patients with septic discitis (confirmed by MRI and needle puncture culture, which was positive for *Staphylococcus aureus*) 3 days after the procedure. Both responded to brief hospitalisation with parenteral vancomycin continued on an outpatient basis for 6 weeks[5].

Necrosis

A case series of 182 patients reported a subchondral osteonecrosis rate (confirmed by MRI) of 2% (4/182). One patient underwent surgical treatment for continuously severe back pain and the pain was resolved at 1-year follow-up. The remaining patients with occasionally severe pain underwent conservative management and their pain had diminished at 2-year follow-up[6].

A case series of 10 patients who required salvage operations after PLDD reported that all patients showed evidence of heat-induced cell necrosis and carbonisation. Herniated masses completely compressed and adhered to nerve roots in all patients following the procedure[7].

Complex regional pain syndrome type 2 (causalgia)

A case report of 1 patient reported a diagnosis of complex regional pain syndrome 8–10 weeks after automated laser discectomy. The patient reported constant burning and prickling pain, and responded to therapeutic chemical percutaneous sympathectomy using phenol. At 12 months the patient had minimal pain and was taking a daily maintenance dose of carbamazepine[8].

Perforation of iliac artery

A case report of 1 patient observed that the iliac artery was perforated during lumbar discectomy with microsurgical carbon dioxide laser under general anaesthesia. Following a sudden spurt of arterial blood and a loss in blood pressure with

tachycardia, a laparotomy was performed and a large haematoma was removed to reveal a 5 mm defect in the internal iliac artery. The arteriotomy was repaired and a blood transfusion was required. The patient recovered and was discharged after 10 days[9].

Validity and generalisability of the studies

- No peer-reviewed randomised controlled trial (RCT) data is available.
- Length of follow-up varied across the studies and the maximum average follow-up was 7 years. No long-term data (>10 years) is available.
- Different lasers were used across the available studies which may have had an effect on the results.
- Evidence is reported from 1995 to 2007, and it is possible that techniques and equipment have changed since this period.

Existing assessments of this procedure

A conference abstract by Livesey published in 2000 describes a UK RCT of 29 patients with sciatica (13 laser discectomy vs 16 epidural steroid injection). This trial was discontinued as there was no difference between the 2 groups in terms of overall success (MacNab criteria), angle of straight leg raise and Oswestry low back pain disability score at a mean follow-up of 40 weeks [10].

The American Society of Interventional Pain Physicians published an Interventional Pain Management (IPM) guideline on the management of chronic spinal pain in 2009. The document includes a recommendation supporting the use of percutaneous lumbar laser disectomy, graded as 1C/strong [11].

Related NICE guidance

Below is a list of NICE guidance related to this procedure. Appendix B gives details of the recommendations made in each piece of guidance listed.

Interventional procedures

- Percutaneous intradiscal electrothermal therapy for low back pain. NICE interventional procedures guidance 319 (2009). Available from www.nice.org.uk/IPG319
- Percutaneous disc decompression using coblation for lower back pain. NICE interventional procedures guidance 173 (2006). Available from www.nice.org.uk/IPG173

- Automated percutaneous mechanical lumbar discectomy. NICE interventional procedures guidance 141 (2005). Available from www.nice.org.uk/IPG141
- Percutaneous intradiscal radiofrequency thermocoagulation for lower back pain. NICE interventional procedures guidance 83 (2004). Available from www.nice.org.uk/IPG83

Specialist Advisers' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College. The advice received is their individual opinion and does not represent the view of the society.

Mr Martin Knight (private sector professional) and Mr Philip Sell (British Association of Spine Surgeons)

- One of the advisers performs this procedure regularly and considers it to be established practice. The other has never performed this procedure and considers it to be novel and of uncertain safety and efficacy. Both agree that fewer than 10% of specialists are engaged in this area of work.

- Comparators are conventional discectomy and microdisectomy.

- Theoretical adverse events include dural tear, heat damage due to incorrect placement of probe, recurrent protrusion of disc, nerve damage, infection, vertebral body collapse, loss of disc height and perineural scarring.

- Adverse events reported in the literature include perforation of the bowel.

- Efficacy outcomes include recurrence rate, reoperation rate, infection rate, VAS leg and back pain score, Oswestry Disability Index and failure to decompress the nerve.

- Training and facilities should include training in a unit focused on minimal invasive spinal surgery with access to a laser, a radiolucent humpbacked table extension, a radiological access jig and an anaesthetist experienced in twilight sedation and analgesia.

- One specialist adviser highlighted the importance of appropriate patient selection. The procedure is valuable for patients with early disc degeneration and those with painful leaking discs or High Intensity Zones on MRI scans.

Patient Commentators' opinions

NICE's Patient and Public Involvement Programme were unable to obtain patient commentary for this procedure.

References

1. Tassi GP. (2006) Comparison of results of 500 microdiscectomies and 500 percutaneous laser disc decompression procedures for lumbar disc herniation. Photomedicine and Laser Surgery 24:694-697.

2. Yang J, Du F, Zhao D-Q et al. (2005) Two different intervention measures in recovery of lumbar function of patients who underwent lumbar discectomy. Chinese Journal of Clinical Rehabilitation 9:268-269.

3. Black WA, Jr. (1995) A neurosurgical perspective on PLDD. [Review] [9 refs]. Journal of Clinical Laser Medicine & Surgery 13:167-171.

4. Knight M and Goswami A. (2002) Lumbar percutaneous KTP532 wavelength laser disc decompression and disc ablation in the management of discogenic pain. Journal of Clinical Laser Medicine and Surgery 20:9-13.

5. Choy DS. (1998) Percutaneous laser disc decompression (PLDD): twelve years' experience with 752 procedures in 518 patients. Journal of Clinical Laser Medicine & Surgery 16:325-331.

6. Tonami H, Kuginuki M, Kuginuki Y et al. (1999) MR imaging of subchondral osteonecrosis of the vertebral body after percutaneous laser diskectomy. AJR American:1383-1386.

7. Takeno K, Kobayashi S, Yonezawa T et al. (2006) Salvage operation for persistent low back pain and sciatica induced by percutaneous laser disc decompression performed at outside institution: correlation of magnetic resonance imaging and intraoperative and pathological findings.[see comment]. Photomedicine and Laser Surgery 24:414-423.

8. Plancarte R and Calvillo O. (1997) Complex regional pain syndrome type 2 (causalgia) after automated laser discectomy: A case report. Spine 22:459-462.

9. Jeon SH, Lee SH, and Choi WC. (1-2-2007) Iliac artery perforation following lumbar discectomy with microsurgical carbon dioxide laser: a report of a rare case and discussion on the treatment. Spine 32:E124-E125.

10. Livesey JP. (2000) Laser discectomy versus lumbar epidural steroid injection: a randomised comparative study of two treatments for sciatica [Abstract]. British Orthopaedic Association: Annual General Corgress In: Journal of Bone and Joint Surgery British Volume 82 Suppl 1:74-

11. Manchikanti L, Boswell MV, Singh V et al. (2009) Comprehensive evidence-based guidelines for interventional techniques in the management of chronic spinal pain. Pain Physician 12:699-802.

Appendix A: Additional papers on percutaneous intradiscal laser ablation in the lumbar spine

The following table outlines the studies that are considered potentially relevant to the overview but were not included in the main data extraction table (table 2). It is by no means an exhaustive list of potentially relevant studies.

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Singh V, Manchikanti L, Benyamin RM et al. (2009) Percutaneous lumbar laser disc decompression: a systematic review of current evidence. Pain Physician 12:573-588.	Review n = 2447 (10 case series) Follow-up (FU) = not reported	Level II-2 evidence indicates that PLD is equivalent to automated percutaneous lumbar disc decompression	Describes each study separately in the text – more useful to present each study in table 2
Goupille P, Mulleman D, Mammou S et al. (2007) Percutaneous laser disc decompression for the treatment of lumbar disc herniation: a review. [Review] [80 refs]. Seminars in Arthritis & Rheumatism 37:20-30.	Review n = 3660 (19 case series) FU = 3–84 months (mean)	Treatment cannot be considered validated for disc herniation-associated radiculopathy resistant to medical treatment	Describes each study individually in text and includes some double counting (Choy patients are repeated from different years) – all relevant studies are presented in table 2
Lee SH, Lee SJ, Park KH et al. (1996) [Comparison of percutaneous manual and endoscopic laser diskectomy with chemonucleolysis and automated nucleotomy]. [German]. Orthopade 25:49-55.	Non-randomised comparative study n = 300 (100 percutaneous manual and endoscopic laser discectomy (PELD) vs 100 chemonucleolysis with chymopapain (CN) vs 100 automated percutaneous laser discectomy (APLD)) FU = 1 year	68% of patients in PELD group, 55% in the CN group and 48% in the APLD group reported the outcome as 'excellent'	Only abstract available in English
Ascher PW (1991) Laser trends in minimally invasive treatment: atherosclerosis, disk herniations. J Clin Laser Med Surg 9:49-57.	Case series n = 292 FU = not reported	One patient reported discitis (method of diagnosis, timing and treatment not reported)	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Chambers RA, Botsford JA, Fanelli E (1995) The PLDD registry. Journal of Clinical Laser Medicine & Surgery 13:215-219.	Case series (registry data) n = 236 FU = 12+ weeks	96% reported good or fair success based on the MacNab criteria. 5.5% (13/236) required further surgical intervention. Complications reported in 4.2% (8/191). 7 cases of new back pain thought to be caused by thermal damage and 1 case of discitis (method of diagnosis, treatment and timing not reported)	Larger studies reported in table 2
Casper GD, Mullins LL, Hartman VL (1995) Laser-assisted disc decompression: a clinical trial of the holmium:YAG laser with side-firing fiber. Journal of Clinical Laser Medicine & Surgery 13:27-32.	Case series n = 223 FU = 1 year	Success rate: 84%	Larger studies reported in table 2
Ohnmeiss DD, Guyer RD, Hochschuler SH et al. (1994) Laser disc decompression: The importance of proper patient selection. Spine 19:2054-2059.	Case series n = 204 FU = 1 year	Success rate was significantly higher in those with discographic confirmation of a contained disc herniation than those with no confirmation or extravasation of contrast was noted (70.7% vs 44.4%, $p < 0.035$). 23.8% (39/164) required further surgical intervention. Complications: 1 confirmed and possible case of reflex sympathetic dystrophy and 12 cases of postoperative dysthesia (5 of which resolved)	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Gronemeyer DH, Buschkamp H, Braun M et al. (2003) Image-guided percutaneous laser disk decompression for herniated lumbar disks: a 4-year follow-up in 200 patients. Journal of Clinical Laser Medicine & Surgery 21:131-138.	Case series n = 200 FU = 4 years (mean)	Back pain eliminated in 73% of patients. 74% patients satisfied with the outcome. One case of discitis reported (method of diagnosis, treatment and timing are not reported)	Larger studies reported in table 2
Schmolke S, Gosse F, Ruhmann O et al. (2000) Age selected outcome in percutaneous laser disc decompression a critical analysis. Neuro-Orthopedics 28:1-10.	Case series n = 180 FU = 39 months (mean)	78% showed reported benefit based on self-assessment of pain and activity	Larger studies reported in table 2
Zhao D-Q, Du F, Yang J et al. (2005) Cohort-controlled study on percutaneous laser decompression in treating lumbar disc herniation. Chinese Journal of Clinical Rehabilitation 9:202-203.	Case series n =173 FU = not reported	Success rate: 96.3% for L4–S1 disc and 100% for L3–4 and L4–5 discs. 82% with excellent or good rating	Larger studies reported in table 2
Gangi A, Dietemann JL, Ide C et al. (1996) Percutaneous laser disk decompression under CT and fluoroscopic guidance: indications, technique, and clinical experience. Radiographics 16:89-96.	Case series n =119 FU = 13 months (mean)	76.5% (91/119) had a good or fair response	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Casper GD, Hartman VL, Mullins LL (1996) Results of a clinical trial of the holmium:YAG laser in disc decompression utilizing a side-firing fiber: a two-year follow-up. Lasers in Surgery & Medicine 19:90-96.	Case series n = 100 FU = 2 years	Success rate: 86.9%	Larger studies reported in table 2
Botsford JA (1994) Radiological considerations: patient selection for percutaneous laser disc decompression. Journal of Clinical Laser Medicine & Surgery 12:255-259.	Case series n = 90 FU = 12–23 months	MacNab criteria improvement occurred in 73.3% patients	Larger studies reported in table 2
Iwatsuki K, Yoshimine T, Awazu K (2007) Percutaneous laser disc decompression for lumbar disc hernia: indications based on Lasegue's Sign. Photomedicine and Laser Surgery 25:40-44.	Case series n = 65 FU = 1 year	PLDD was effective in 80% patients with Lasegue's sign but ineffective for those without the sign	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Bosacco SJ, Bosacco DN, Berman AT et al. (1996) Functional results of percutaneous laser discectomy. American Journal of Orthopedics (Chatham, Nj) 25:825-828.	Case series n = 63 FU = 4 weeks	72% (44/61) achieved relief of radicular pain and 54% (33/61) achieved relief of low back pain. One patient reported acute urinary retention and reflex ileus requiring 5 day hospital admission 1 week after the procedure	Larger studies reported in table 2
Liebler WA. (1995) Percutaneous laser disc nucleotomy. Clinical Orthopaedics & Related Research 58-66.	Case series n = 59 FU = 2 years	72% success rate	Larger studies reported in table 2
Nerubay J, Caspi I, and Levinkopf M. (1997) Percutaneous carbon dioxide laser nucleolysis with 2- to 5-year followup. Clinical Orthopaedics & Related Research 45-48.	Case series n = 50 FU = 2 years 8 months (mean)	74% achieved excellent or good MacNab criteria success. 4 patients reported symptoms and signs of root irritation probably caused by thermal damage. Pain disappeared in 3 of these patients between 1–5 months. One patient remained in permanent pain at follow-up	Larger studies reported in table 2
Gupta AK, Bodhey NK, Jayasree RS et al. (2006) Percutaneous laser disc decompression: clinical experience at SCTIMST and long term follow up. Neurology India 54:164-167.	Case series n = 40 FU = 4.6 years	Immediate pain relief: 80% (32/40) Good/Fair MacNab criteria success in 92% (37/40) Significant pain at puncture site:20% (8/40) Pain during laser treatment: 1 patient Muscular spasm: 1 patient	Larger studies reported in table 2
Davis JK (1992) Early experience with laser disc decompression. A percutaneous method. Journal of the Florida Medical Association 79:37-39.	Case series n = 40 FU = not reported	2 patients required open discectomy and 4 required additional surgery after the procedure	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Agarwal S, Bhagwat AS. (2003) Ho: Yag laser-assisted lumbar disc decompression: a minimally invasive procedure under local anesthesia. Neurology India 51:35-38.	Case series n = 36 FU = not reported	91.5% success rate	Larger studies reported in table 2
Choy DS, Ngeow J (1998) Percutaneous laser disc decompression in spinal stenosis. Journal of Clinical Laser Medicine & Surgery 16:123-125.	Case series n = 35 FU = 30 months	MacNab criteria success: excellent 69%, good 9%, poor 22%	Larger studies reported in table 2
Ishiwata Y, Takada H, Gondo G et al. (2007) Magnetic resonance-guided percutaneous laser disk decompression for lumbar disk herniation--relationship between clinical results and location of needle tip. Surgical Neurology 68:159-163.	Case series n = 32 FU = 6 months	Overall success: 68.8%	Larger studies reported in table 2
McMillan MR, Patterson PA, Parker V (2004) Percutaneous laser disc decompression for the treatment of discogenic lumbar pain and sciatica: a preliminary report with 3-month follow-up in a general pain clinic population. Photomedicine and Laser Surgery 22:434-438.	Case series n= 32 FU= 3+ months	75% (24/32) reported improvement in discogenic back pain at 3 months.	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Black W, Fejos AS, Choy DS. (2004) Percutaneous laser disc decompression in the treatment of discogenic back pain. Photomedicine and Laser Surgery 22:431-433.	Case series n = 32 FU = not reported	MacNab criteria success: Good: 43.75%(14/32) Fair: 43.75% (14/32) Poor: 12.5%(4/32)	Larger studies reported in table 2
Casper GD, Hartman VL, Mullins LL (1996) Laser assisted disc decompression: an alternative treatment modality in the Medicare population. Journal - Oklahoma State Medical Association 89:11-15.	Case series n = 31 (all patients aged 65+ years) FU = 1 year	Success: 80%	Larger studies reported in table 2
Gevargez A, Groenemeyer DW, Czerwinski F (2000) CT-guided percutaneous laser disc decompression with Ceralas D, a diode laser with 980-nm wavelength and 200-microm fiber optics. European Radiology 10:1239-1241.	Case series n = 26 FU = 4 weeks	46% pain free after procedure (scored >85% on visual analogue scale) 31% had relief of leg pain but occasional back pain 15% slight alleviation of radiate pain 8% no pain alleviation	Larger studies reported in table 2
Tonami H, Yokota H, Nakagawa T et al. (1997) Percutaneous laser discectomy: MR findings within the first 24 hours after treatment and their relationship to clinical outcome. Clinical Radiology 52:938-944.	Case series n =26 FU = 1 year	Recovery rate immediately after procedure: 53.1% rising to 64.6% at 1 year.	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Dangaria T (1998) Result of laser-assisted disc ablation after unsuccessful percutaneous disc decompression. Journal of Clinical Laser Medicine & Surgery 16:321-323.	Case series n = 15 FU = 13 months (mean)	No patients had an excellent recovery, 7 patients had a poor recovery, 5 had a fair recovery and 3 patients had a good recovery.	Larger studies reported in table 2
Schatz SW,Talalla A. (1995) Preliminary experience with percutaneous laser disc decompression in the treatment of sciatica. Canadian Journal of Surgery 38:432-436.	Case series n = 14 FU = up to 6 months	64% (9/14) reported total relief of leg pain. 4 patients required subsequent microsurgical discectomy and 1 required decompressive laminectomy.	Larger studies reported in table 2
Mayer HM, Brock M, Berlien HP et al. (1992) Percutaneous endoscopic laser discectomy (PELD). A new surgical technique for non-sequestrated lumbar discs. Acta Neurochirurgica - Supplementum 54:53-58.	Case series n = 6 FU = hospital discharge	Success: Excellent: 2 patients Good: 3 patients Satisfactory: 1 patient	Larger studies reported in table 2
Choy DS (2001) Response of extruded intervertebral herniated discs to percutaneous laser disc decompression. Journal of Clinical Laser Medicine & Surgery 19:15-20.	Case report n = 21 FU = not reported	85.7% (18/21) achieved the top MacNab category with good pain relief	Larger studies reported in table 2
Epstein NE (1994) Nerve root complications of percutaneous laser-assisted diskectomy performed at outside institutions: a technical note. Journal of Spinal Disorders 7:510-512.	Case report N = 2 FU = 4 weeks and 5 months	One patient reported acute foot drop after the procedure that resolved following delayed surgical discectomy. Another patient reported left foot and thigh anesthesia and weakness where he was unable to lift his leg or dorsiflex his foot. This had not changed at 5 months follow-up	Larger studies reported in table 2

Article	Number of patients/follow-up	Direction of conclusions	Reasons for non-inclusion in table 2
Choy DS (1999) Early relief of erectile dysfunction after laser decompression of herniated lumbar disc. Journal of Clinical Laser Medicine & Surgery 17:25-27.	Case report n = 2 FU = 3 years and 1 month	2 cases of erectile dysfunction caused by disc herniation were reversed by PLDD	Larger studies reported in table 2
Slotman GJ, Stein SC. (1995) Laparoscopic laser lumbar diskectomy. Operative technique and case report. Surgical Endoscopy 9:826-829.	Case report n = 1 FU = 2 weeks	Pain relief confirmed immediately after procedure	Larger studies reported in table 2
Stein S, Slotman GJ. (1994) Laser-assisted laparoscopic lumbar diskectomy. New Jersey Medicine 91:175-176.	Case report n = 1 FU = 8 days	Patient reported immediate and complete relief of leg and back pain after the procedure	Larger studies reported in table 2
Farrar MJ, Walker A, Cowling P (1998) Possible salmonella osteomyelitis of spine following laser disc decompression. European Spine Journal 7:509-511.	Case report n = 1 FU = 9 months	Case of chronic discitis and vertebral osteomyelitis caused by *Salmonella typhimurium* 6 months after the procedure (confirmed by blood culture). Infection successfully treated with intravenous ceftriaxone and oral ciprofloxacin. Patient's leg and back pain improved 3 months after treatment	Larger studies reported in table 2
Kobayashi S, Uchida K, Takeno K et al. (2007) A case of nerve root heat injury induced by percutaneous laser disc decompression performed at an outside institution: technical case report. Neurosurgery 60:Suppl-2.	Case report n = 1 FU = 1 month	Salvage surgical procedure required 1 month after PLDD. Carbon spots in the dura matter of the nerve roots was observed indicating that the nerve roots were damaged by excess heat during PLDD	Larger studies reported in table 2

Appendix B: Related NICE guidance for percutaneous intradiscal laser ablation in the lumbar spine

Guidance	Recommendations
Interventional procedures	**Current guidance: Laser lumbar discectomy. NICE interventional procedures guidance 27 (2003).** 1.1 Current evidence on the safety and efficacy of laser lumbar discectomy does not appear adequate to support the use of this procedure without special arrangements for consent and for audit or research. Clinicians wishing to undertake laser lumbar discectomy should inform the clinical governance leads in their Trusts. They should ensure that patients offered it understand the uncertainty about the procedure's safety and efficacy and should provide them with clear written information. Use of the Institute's *Information for the Public* is recommended. Clinicians should ensure that appropriate arrangements are in place for audit or research. Publication of safety and efficacy outcomes will be useful in reducing the current uncertainty. NICE is not undertaking further investigation at present. **Percutaneous intradiscal electrothermal therapy for low back pain. NICE interventional procedures guidance 319 (2009).** 1.1 Current evidence on the safety and efficacy of percutaneous intradiscal electrothermal therapy for low back pain is inconsistent. Therefore this procedure should only be used with special arrangements for clinical governance, consent and audit or research. 1.2 Clinicians wishing to undertake percutaneous intradiscal electrothermal therapy for low back pain should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure that patients and their carers understand the uncertainty about the procedure's safety and efficacy and provide them with clear written information. In addition, the use of NICE's information for patients ('Understanding NICE guidance') is recommended (available from www.nice.org.uk/IPG319publicinfo). • Audit and review clinical outcomes of all patients having percutaneous intradiscal electrothermal therapy for low back pain (see section 3.1). 1.3 NICE encourages further research into percutaneous intradiscal electrothermal therapy for low back pain. Research should describe patient selection, use validated measures of long-term pain relief and quality of life, address the role of the

	procedure in avoiding major surgery, and measure long-term safety outcomes. **Percutaneous disc decompression using coblation for lower back pain. NICE interventional procedures guidance 173 (2006).** 1.1 Current evidence suggests that there are no major safety concerns associated with the use of percutaneous disc decompression using coblation for lower back pain. There is some evidence of short-term efficacy; however, this is not sufficient to support the use of this procedure without special arrangements for consent and for audit or research. 1.2 Clinicians wishing to undertake percutaneous disc decompression using coblation for lower back pain should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. Use of the Institute's *Information for the public* is recommended (available from www.nice.org.uk/IPG173publicinfo). • Audit and review clinical outcomes of all patients having percutaneous disc decompression using coblation for lower back pain. 1.3 Further research will be useful in reducing the current uncertainty, and clinicians are encouraged to collect long-term follow-up data. The Institute may review the procedure upon publication of further evidence. **Automated percutaneous mechanical lumbar discectomy. NICE interventional procedures guidance 141 (2005).** 1.1 Current evidence suggests that there are no major safety concerns associated with automated percutaneous mechanical lumbar discectomy. There is limited evidence of efficacy based on uncontrolled case series of heterogeneous groups of patients, but evidence from small randomised controlled trials shows conflicting results. In view of the uncertainties about the efficacy of the procedure, it should not be used without special arrangements for consent and for audit or research. 1.2 Clinicians wishing to undertake automated percutaneous mechanical lumbar discectomy should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. In addition, use of the Institute's *Information for the public* is recommended.

	• Audit and review clinical outcomes of all patients having automated mechanical percutaneous lumbar discectomy. The Institute may review the procedure upon publication of further evidence. **Percutaneous intradiscal radiofrequency thermocoagulation for lower back pain. NICE interventional procedures guidance 83 (2004).** 1.1 Current evidence on the safety and efficacy of percutaneous intradiscal radiofrequency thermocoagulation for lower back pain does not appear adequate to support the use of this procedure without special arrangements for consent and for audit or research. 1.2 Clinicians wishing to undertake percutaneous intradiscal radiofrequency thermocoagulation for lower back pain should take the following actions. • Inform the clinical governance leads in their Trusts. • Ensure that patients understand the uncertainty about the procedure's efficacy and provide them with clear written information. Use of the Institute's *Information for the Public* is recommended. • Audit and review clinical outcomes of all patients having percutaneous intradiscal radiofrequency thermocoagulation for lower back pain. 1.3 Further research will be useful in reducing the current uncertainty and clinicians are encouraged to collect longer-term follow-up data. The Institute may review the procedure upon publication of further evidence.

Appendix C: Literature search for percutaneous intradiscal laser ablation in the lumbar spine

Websites	Date searched	Title, year and link
NICE ('published' and 'in development' guidance)	23/06/09	**Published** Laser lumbar discectomy IPG27, (2003) Prosthetic intervertebral disc replacement IPG100, (2004) Automated percutaneous mechanical lumbar discectomy IPG141, (2005) Percutaneous endoscopic laser lumbar discectomy IPG300, (2009) **In Progress** Prosthetic intervertebral disc replacement in the lumbar spine, review of IPG100
Notification and specialist advisors papers	N/A	N/A
FDA (MAUDE database)	23/06/09	SIDEFIRE 29 CM LASER NEEDLE (1996)
ASERNIP	23/06/09	Laser discectomy (2003) Percutaneous Endoscopic Laser Discectomy (2000)
ANZHSN	23/06/09	Nothing relevant found
Cochrane reviews (CDSR)	23/06/09	Surgical interventions for lumbar disc prolapse (2007) Low level laser therapy for nonspecific low-back pain (2008) Rehabilitation after lumbar disc surgery (2008)
National Institute for Health Research Clinical Research Network Coordinating Centre (NIHR CRN CC) Portfolio Database	23/06/09	Nothing relevant found
Current Controlled Trials *meta*Register of Controlled Trials - *m*RCT	23/06/09	Nothing relevant found
Clinicaltrials.gov	23/06/09	Nothing relevant found
General internet search	23/06/09	Nothing relevant found

Database	Date searched	Version/files
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	17/05/2010	May 2010
Database of Abstracts of Reviews of Effects – DARE (CRD website)	17/05/2010	n/a
HTA database (CRD website)	17/05/2010	n/a
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	17/05/2010	May 2010
MEDLINE (Ovid)	17/05/2010	1950 to May Week 1 2010
MEDLINE In-Process (Ovid)	17/05/2010	May 14, 2010
EMBASE (Ovid)	17/05/2010	1980 to 2010 Week 19
CINAHL (NLH Search 2.0/EBSCOhost)	17/05/2010	n/a
Zetoc	17/05/2010	n/a

MEDLINE search strategy

The MEDLINE search strategy was adapted for use in the other sources.

1 exp Laser/
2 exp Laser Therapy/
3 1 or 2
4 exp Diskectomy/
5 3 and 4
6 (Laser* adj5 (discectom* or diskectom* or decompress* or dekompress* or nucleotom* or nucleoly* or nucleotim*)).tw.
7 KTP.tw.
8 Holmium.tw.
9 YAG.tw.
10 PLDD.tw.
11 or/5-10
12 exp Intervertebral Disk Displacement/
13 (Intervertebral* adj3 Dis* adj3 (Displace* or Hernia*)).tw.
14 (Dis* adj3 (prolapse* or hernia* or slip* or ruptur* or bulg* or compress* or displace* or protrus* or perforat*)).tw.
15 ((Herniat* or displace*) adj3 (nucle* pulpos* or annul* fibros*)).ti,ab.
16 exp Sciatica/
17 Sciatic*.tw.
18 Discogenic*.tw.
19 Ischia*.tw.
20 Lumboischia*.tw.
21 (Piriformis* adj3 Syndrom*).tw.
22 or/12-21
23 11 and 22

24	Animals/ not Humans/
25	23 not 24