End Plate Heat Injury after Percutaneous Laser Disc Decompression (PLDD) in the Lumbar Spine: MR imaging and Pathological Correlation

Kosaka, Riya\textsuperscript{1}; Kobayashi, Shigeru\textsuperscript{2}; Yonezawa, Takumi\textsuperscript{3}

Orthopedic Surgery, Hirakata City Hospital, Osaka\textsuperscript{1}
Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui, Fukui\textsuperscript{2}
Orthopedic Surgery, Osaka Medical College, Takatsuki, Osaka\textsuperscript{3}, Japan.
Percutaneous LASER Disc Decompression; PLDD

- Minimum invasive alternative to open surgery for contained type disc herniation
- Vaporization on the center of the disc with LASER energy, thereby diminishing intradiscal pressure
- Reported success rate, 70-75%

Aseptic bone necrosis (ABN) adjacent to the disc after PLDD has been reported as one of complications, however, most of them are illustrated as a case report and the true incidence of ABN is unknown.
Objective

to identify the incidence of bone marrow lesions after PLDD at outside institution and to identify the risk factors for postoperative bone marrow lesions.
# Subjects

Consecutive 72 patients, 72 discs who received PLDD for symptomatic herniation of lumbar or cervical disc

<table>
<thead>
<tr>
<th>sex</th>
<th>M 48 / F 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>age at surgery</td>
<td>29.6 (14~62) yrs.old</td>
</tr>
<tr>
<td>disc level</td>
<td>C4/5: 1</td>
</tr>
<tr>
<td></td>
<td>C5/6: 9</td>
</tr>
<tr>
<td></td>
<td>C6/7: 4</td>
</tr>
<tr>
<td></td>
<td>L4/5: 33</td>
</tr>
<tr>
<td></td>
<td>L5/6: 3</td>
</tr>
</tbody>
</table>
|           | L5/S1: 22     | cases
Methods

Analysis of pre and postoperative MRI for vertebral damages

Qualitative assessment for the T1/T2 pattern of signal

Type I  decreased signal on T1 / increased on T2
Type II  high on T1 / iso or high on T2
Type III low on both T1 and T2

Quantitative assessment for the extent of signal change

stage 1 restricted to subchondral bone
stage 2 inside 1/3 of vertebral height
stage 3 exceeding 1/3 of vertebral height

Signa™ unit, 1.5 tesla superconductive magnet spin echo method, T1- and T2-weighted
Results

72 discs scheduled for PLDD

preceeding Modic’s changes in 6 discs (8.3%)

PLDD

66 pts. with no marrow damage

postop. occurrence and/or enlargement of signal changes in 6 pts. (8.3%)

spontaneous regression of signal abnormality in 4/6 pts. until 38 mos. postoperatively

true bone necrosis in 2 pts. (2.8%)
Laboratory examination, no evidence of infection before and after treatment

**Marrow Lesions (ML) and Clinical Symptom**
- immediate postop. JOA score: N.S.
- JOA score at final F/U: N.S.

**Comparison of Demographic Data**
between Patients w/ and w/o Marrow Lesions

<table>
<thead>
<tr>
<th></th>
<th>N.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td></td>
</tr>
<tr>
<td>gender</td>
<td></td>
</tr>
<tr>
<td>disc level</td>
<td></td>
</tr>
<tr>
<td>choice of LASER (Nd:YAG vs. Ho:YAG)</td>
<td>N.S.</td>
</tr>
<tr>
<td>total applied energy</td>
<td></td>
</tr>
<tr>
<td>preceding Modic's change</td>
<td>p &lt; 0.0005</td>
</tr>
</tbody>
</table>
34/F, who received Nd:YAG-PLDD for L5/S1 LDH

Preop.                        2 weeks Postop.

1 month Postop.               3 months Postop.
Pathological findings of surgical specimens

A. Inflammatory cell infiltration around the carbides was seen in the nucleus pulposus (NP).
B. Thermal degeneration was seen in the annulus fibrosus (AF) and endplate (EP). Some carbides were seen in the necrotic tissue of the end plate. Immunohistochemical examination (C: CD 45, D: CD 68) showed the presence of numerous T cells (C) and macrophages (D) around the carbides, along with newly formed blood vessels.
Discussion

Reported Incidence of Bone Necrosis after PLDD

<table>
<thead>
<tr>
<th>Study</th>
<th>Incidence (Num/Total)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casper GD, 1995</td>
<td>13 / 223 pts.</td>
<td>5.8%</td>
</tr>
<tr>
<td>Tonami H, 1999</td>
<td>4 / 182 pts.</td>
<td>2.2%</td>
</tr>
<tr>
<td>Cvitanic OA, 2000</td>
<td>41 / 109 pts.</td>
<td>37.6%</td>
</tr>
</tbody>
</table>

Pathogenesis: catheter placement, high-dose energy, disc height narrowing, type of LASER, etc.

Similar MRI changes consistent with osteonecrosis were reported in IDET; intradiscal therapy with radiofrequency (Djurasovic M, 2002, Scholl BM, 2003)

Possible Cause: catheter placement focal disruption of the endplate (Scholl BM, 2003)
MR imaging showed changes in the intensity of the endplate and pathological examination revealed extensive necrosis of cartilage and bone.

Preoperative presence of marrow changes, indicating preceding disc degeneration, was identified as a significant predictor for postop. marrow damage.

In the discs with highly degenerated endplates, subchondral bone might tend to be damaged, probably because thinned and focally disrupted chondral endplate cannot work as a barrier for heat spreading.

Preceding Modic’s change may be a sign for vulnerability of the disc yielding to heat, and may prove to be a relative contra-indication for PLDD.
Conclusions

1. A retrospective analysis of pre- and postoperative MRIs in 72 patients receiving PLDD revealed postoperative signal abnormalities on MRI were observed in 8.3% of patients, however, the true incidence of bone necrosis was 2.8%.

2. For avoiding endplate and bone marrow damage, it is crucial to exclude patients with preceding signal changes on MRI from the candidates of PLDD.

Disclosure Information:
None of the authors has any potential conflict of interest.