Effect of surgical treatment on physical activity and bone resorption in patients with neurogenic intermittent claudication

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Abstract The effect of surgical treatment on physical activity and bone resorption was examined in patients with neurogenic intermittent claudication. Nineteen patients, 50–77 years of age, with neurogenic intermittent claudication (mean, 62 m; range, 20–400 m) caused by degenerative lumbar disease were included in the study. Decompressive laminectomy alone was performed for 7 patients with lumbar spinal stenosis (LSS) and 5 patients with degenerative lumbar spondylolisthesis (DLSL), and decompressive laminectomy, with a Graf stabilization system, was performed for 7 patients with DLSL associated with flexion instability. Clinical symptoms and levels of urinary cross-linked N-telopeptides of type I collagen (NTx) were assessed before and 12 months after surgery. Subjective symptoms, including low back pain, leg pain and/or tingling, and gait disturbance, as well as restriction of activities of daily living were significantly alleviated by the surgical treatment, resulting in an increase in physical activity. Urinary NTx levels were significantly decreased by the surgical treatment, from 63.1 ± 16.9 (mean ± SD) nmol BCE/mmol Cr to 52.1 ± 11.2 nmol BCE/mmol Cr (P < 0.05). These findings suggest that surgical treatment appears to alleviate the clinical symptoms and increase physical activity in patients with LSS or DLSL, potentially resulting in the suppression of bone resorption. Surgical treatment may contribute to the prevention of physical inactivity-induced osteoporosis in elderly patients with neurogenic intermittent claudication caused by degenerative lumbar disease.

Key words Lumbar spinal stenosis · Degenerative lumbar spondylolisthesis · Laminectomy · Graf stabilization system · Neurogenic intermittent claudication

Introduction

Degenerative lumbar disc diseases, such as lumbar spinal stenosis (LSS) and degenerative lumbar spondylolisthesis (DLSL), are common diseases in the elderly. In LSS, symptoms of stenosis are produced by advanced multilevel disc degeneration, leading to hypertrophy of the facet joints, infolding of the ligamentum flavum, descent of the pedicles, and occasional disc herniation. DLSL with an intact neural arch is caused by degenerative osteoarthritis of the facet joints. Anterior slippage of the vertebra in DLSL causes anterior displacement of the vertebral arch, together with hypertrophy of the facet joints and the ligamentum flavum, resulting in segmental spinal stenosis. These diseases not only cause low back pain but also cause pain and/or tingling in the legs and gait disturbance (neurogenic claudication). These symptoms result in a reduction in physical activity. Because physical activity plays an important role in the maintenance of bone health, a reduction in physical activity may increase the risk of osteoporosis in the elderly. Thus, therapy directed at increasing physical activity in patients with degenerative lumbar disease may be an important component of a bone health-care plan.

Prostaglandin (PG) E₁ administration has been recognized as a useful treatment for degenerative lumbar disc disease with cauda equina compression, because PG E₁ can enhance blood flow in the cauda equina.²⁸ Systemic intravenous administration of PG E₁ has been shown to alleviate the clinical symptoms of degenerative lumbar disc disease.¹⁹ Previously, we reported that the systemic administration of lipo-PG E₁ to patients with LSS with cauda equina compression alleviated their clinical symptoms, resulting in an increase in physical activity.¹³ However, the alleviation of clinical symptoms and the increase in physical activity were too small to affect the levels of a specific bone resorption marker, urinary cross-linked N-telopeptides of type I collagen (NTx). Therefore, we speculated that more effective treatment, i.e., surgical intervention might be needed to markedly increase physical activity and suppress bone resorption. In the present study, we investi-
gated the effect of surgical treatment on clinical symptoms and physical activity in patients with neurogenic intermittent claudication caused by degenerative lumbar disc disease, and then we examined whether the increased physical activity gained by surgical treatment suppressed urinary NTx levels.

### Subjects and methods

#### Subjects

Nineteen patients, 50–77 years of age, with neurogenic claudication caused by LSS or DLSL, were recruited during a 1-year period between October 1998 and September 1999 at a hospital in Shizuoka, Japan. Because of severe symptoms of stenosis, all of the patients were considered to need surgery at the time of recruitment. Seven patients were men and 12, women; 7 had LSS and 12 had DLSL. The patients’ conditions were classified into three types according to symptoms experienced while walking: radicular type, characterized by radicular pain (no patients in this category); cauda equina compression type, characterized by a burning sensation in the legs and the perineal area, and/or urinary disturbance (14 patients [5 LSS and 9 DLSL]); and mixed type, with mixed symptoms (5 patients [2 LSS and 3 DLSL]). Table 1 shows the characteristics of the study subjects. Based on the results of physical and neurological examinations, and plain X-ray images, magnetic resonance images (MRI), myelography, and computed tomographic myelography (CTM) of the lumbar spine, the diagnosis of LSS or DLSL was reconfirmed. In all of the patients with DLSL, anterior slippage was observed at the L4-L5 level, with Meyerding grade 1. Patients with degenerative lumbar scoliosis and patients with peripheral vascular disease or diabetic neuropathy were excluded from the study. None of the patients had received any medication that could affect bone metabolism. Informed consent was obtained from all participants.

#### Surgery and management after surgery

For patients with LSS or DLSL with no associated flexion instability (determined as described below), laminectomy alone was performed. When lateral stenosis was present, the medial part of the facet joint was resected and the intervertebral foramens were completely curetted to release the nerve root compression. Facetectomy was minimized, and was limited to less than the medial one-third of the joints. Sufficient dural and/or nerve root decompression was achieved. For patients with DLSL associated with flexion instability, laminectomy, with a Graf stabilization system, was performed. Pedicle screws were inserted according to the approach of Weinstein et al.27 Then, sufficient dural and/or nerve root decompression by laminectomy, with facetectomy and/or foramenotomy, if necessary, was performed as described above. Ligamentoplasty was achieved by the application of Graf bands. The size of the band to be used was determined with a tensor. A force measurement of 5dN was equated to a particular band length, and then the band was inserted over the heads of the pedicle screws, leading the segment to a new extended position.

All patients had bed rest for just 1 week after the surgery, and then were allowed to walk with a hard orthosis. The orthosis was removed 3 months after the surgery unless any problems were found. After the removal of the orthosis, return to normal daily activities was gradually permitted.

#### Clinical evaluation

Clinical evaluation was done before and 12 months after the surgery, according to the score rating system of the Japanese Orthopaedic Association (JOA score; Table 2).16 The full JOA score consists of 29 points, based on three subjective symptoms (9 points), three clinical signs (6 points), seven activities of daily living (14 points), and three levels of urinary bladder function (−6 points). The improvement rate was calculated by the following equation: improvement rate = (final JOA score − initial JOA score)/(29 − initial JOA score) × 100. The evaluation results were classified into four categories according to the improvement rate in the JOA score: more than 75.0%, excellent; 50.0%–75.0%, good; 25.0%–49.9%, fair; and 0.0–24.9%, or less, poor.

#### Radiographic evaluation

Plain radiographs in the anteroposterior, flexion-extension or neutral position on standing lateral views...