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# Surgical Outcomes of Spine Disorders in Patients with Parkinson's Disease

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**Purpose:** Patients with Parkinson's disease also commonly have movement disorders, osteoporosis, and other comorbidities. These patients are more likely to have complications after spinal surgery. The aim of the present study is to show the relation ship between complications of spinal surgery and Parkinson's disease.
**Methods:** A computerized search using diagnostic and procedural codes identified 13 patients with Parkinson's disease who underwent spinal surgery between January 1998 and December 2010. Their medical records and imaging studies were reviewed and recent updatesfor all patients were done by telephone interview.
**Results:** Retrospectively, 13 consecutive patients were reviewed. The mean age was 63.8 (range 44~87) years old and the mean durationof Parkinson's disease was 7.6 (range 1~22) years at the time of the index procedure. The mean T score of the lumbar spine on Dual-energy X-ray absorptiometry (DEXA) scan bone mineral density (BMD) was -2.5 (range -1.0~ -5.1). These patients had nine lumbar lesions, two thoracic lesions, one cervical lesion, and one thoracolumbar lesion. Nine patients required no more surgical treatment for lesions which had been previously operated on (index level). However, four patients (30.8%) needed at least one more operation related to their index procedure; segmental degeneration on the adjacent levels in two, retropulsion of an intervertebral cage with screw loosening in one, and pedicle fracture in one.
**Conclusion:** It has been reported that patients with Parkinson's disease have high complication rates in spinal surgery. Spine surgeons should be aware of the risk of complications and need to conduct careful follow-up after the surgery.

**Key Words**: Parkinson's disease · Lumbar surgery · Osteoporosis · Complication

## INTRODUCTION

Parkinson's disease is a chronic, degenerative, progressive neurological disease characterized by a loss of self-sufficiency, tremor, muscular rigidity, impaired reflexes and bradykinesia, an increased risk offalls and a high incidence of fractures and including affecting speech[2,20]. The incidence of Parkinson's disease increases abruptly from 17.4 in 100,000 person-years for those in their fifties to 93.1 in 100,000 person-years for those in their seventies[4]. In Korea, it is reported that the prevalence of Parkinson disease is 374 in 100,000 person- years for those over 18 years of age and 1,470 in 100,000 person-years for those over 60 years of age[12]. It is reported that the lifetime risk of Parkinson disease is 1.5%[3,4]. Patients with Parkinson disease commonly present with impairment of dexterity. Onset is slow and gradual, but as the disease progresses, patients shows typical, well-known symptoms, including muscular rigidity, resting tremor, shuffling gait, slow voluntary movement, stooped posture and expressionless faces.

These patients have a poor bone quality and severe neuromuscular disorders[1]. Patients with Parkinson's disease may also present with postural deformities. Several factors including axial rigidity, poor trunk coordination, orthostatic hypotension, and difficulty integrating various sources of sensory input may contribute to postural deformities[18]. Coordination-difficulty results in inactivity and chair-bound status, which often exacerbate these problems. Because of these clinical symptoms, when patients with Parkinson's disease have spine disor-

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**Table 1**. Parkinson's disease: diagnostic and therapeutic criteria[22]

| | |
|---|---|
| Stage 0 | No signs of Parkinson's disease |
| Stage I | Unilateral signs with no impairments for everyday activities |
| Stage II | Signs predominating on one side, with some impairment |
| Stage III | Bilateral signs with some postural instability, patient self-sufficient |
| Stage IV | Severely disabled but can walk; some loss of self-sufficiency |
| Stage V | Patient confined to a wheelchair or bed, not self-sufficient |

**Table 2.** Four criteria for successful outcome (Kirkaldy-Willis Criteria)[11]

| | |
|---|---|
| Excellent | Return to normal work with little or no complaint |
| Good | Return to normal work with some restriction |
| Fair | Reduced working capacity |
| Poor | Unable to return to work |

**Table 3.** Patient's summarized demographics

| Patient demographics | | |
|---|---|---|
| | Average | Range |
| Age at index procedure (years) | 63 | 44~87 |
| Duration of Parkinson's disease (years) | 7.6 | 1~22 |
| Follow up period (months) | 57.5 | 21~127 |
| Gender | 6 men | 7 women |
| DEXA scan BMD (T-score) | -2.5 | -1.0~-5.1 |

ders, we might assume them to show poor outcomes after the surgery in comparison with their age-matched control group without Parkinson's disease. However, there have been very few reports addressing these issues.

The purpose of this study is to evaluate surgical outcomes for our patients with Parkinson's disease who underwent spinal surgery and reviewed risk factors related to surgical outcome so that we can clinically anticipate complications in these patients.

## MATERIALS AND METHODS

We identified patients with Parkinson's disease who had undergone a spinal operation such as decompression and/or fusion procedures between January 1998 and December 2010. Patients' medical records and imaging studies were reviewed andthe patients were interviewed by telephone to determine whether they had experienced any further spine-related difficulties.

Patient data were reviewed, including pre- and postoperative visual analog scale (VAS) score, the duration and stage of Parkinson's disease, smoking history, bone densitometry and index/subsequent procedures. The Hoehn and Yahr scale was used to stage Parkinson's disease (Table 1), the surgical outcome was measured using the Kirkaldy-Willis criteria (Table 2) and the VAS score was used to estimate pain relief.

## RESULTS

Thirteen consecutive patients with Parkinson's disease who had undergone spinal surgery were enrolled in this study; their data is summarized in Table 1. The mean age at the time of the index procedure was 63.8 years old. There were six men and seven women. The mean duration of Parkinson's disease was 7.6 years at the time of the index procedure. Six patients had one or more co-morbidities in addition to Parkinson's disease. There were five patients with hypertension, four patients with diabetes mellitus, two with coronary artery obstructive disease, one with chronic renal failure, one with a hemorrhagic renal cyst and one with a history of lung cancer. The patient with lung cancer had undergone resection of the upper lobe of the right lung six years before his index operation. Two patients were smokers. None of the patients had any other active disease at the time of presentation in this study. The mean T score of the lumbar spine on Dual-energy X-ray absorptiometry (DEXA) scan Her bone mineral density (BMD) was -2.5 (range: -1.0~-5.1). The index procedure was performed in the lumbar spine in nine patients, the thoracic spine in two patients, thoracolumbar spine in one patient, and the cervical spine in one patient. Two died of causes unrelated to their spinal surgery. The mean follow-up duration after the index procedure was 57.5 months (range: 21~127). Table 3 summarizes the surgical results related with the nature of Parkinson's. Nine patients required no additional surgery at their index level after the index procedure. Among these nine patients, one patient underwent on a cervical open-door laminoplasty at the level of C3-4-5-6 for cervical spinal stenosis. Another four patients underwent on a decompressive lumbar laminectomy and discectomy, and another four underwent on a decompression and instrumented posterior spinal fusion for lumbar stenosis or spondylolisthesis. These patients's VAS score was decreased after the index procedure in different degrees.

On the other hand, four patients (30.8%) underwent at least one additional operation related to their index procedures; segmental degeneration at the adjacent levels in two, retropulsion of an intervertebral cage with screw loosening in one, pedicle fracture in one. Three of these patients underwent one additional procedure, but the remaining patient needed five additional operations, including deep brain stimulation (DBS) for Parkinson's disease. Among these four patients, two patients had adjacent segmental degeneration each

**Table 4.** Patient's summarized finding

| Patient No | Gender | Age (yr) | Duration of PD | DEXA scan BMD (T-score) | H-Y grade | Initial procedure (s) | Complication (s) | Subsequent procedure (s) | Preop VAS | Postop VAS | Surgical Outcome (KW criteria) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 67 | 17 | -5.1 | 4 | PVP L1 | - Progressive L1 compression with cancal encroachment<br>- L1 pedicle wall fracture<br>- Screw loosening<br>- Wound infection<br>- Uncontrolled tremor | - Decompression and screw fixation T12-L2<br>- Reinstrumentation with crosslink apply<br>- L1 corpectomy and instrumentation T12-L2<br>- DBS | 6 | 4 | Poor |
| 2 | M | 80 | 7 | -2.5 | 3 | P+PS L4/5 | Adjacent segment degeneration | P+PS L3/4-L5 | 7 | 3 | Fair |
| 3 | F | 57 | 20 | -1.0 | 4 | P+PS L3/4/5 | Adjacent segment degeneration | P+PS L3/4/5-S1 | 7 | 3 | Good |
| 4 | F | 59 | 3 | -2.3 | 2 | P+PS L5/S1 | Cage retropulsion<br>Screw loosening | P+PS L5/S1 | 8 | 0 | Excellent |
| 5 | M | 81 | 10 | -1.5 | 4 | Decom. Lami. L4/5 | | | 7 | 4 | Fair |
| 6 | F | 72 | 14 | -2 | 2 | HL L4, MD L4/5 Rt | | | 6 | 3 | Fair |
| 7 | M | 65 | 5 | -3 | 3 | P+PS L4/5 | | | 6 | 3 | Fair |
| 8 | F | 54 | 11 | -3.7 | 2 | P+PS L4/5 | | | 6 | 4 | Fair |
| 9 | M | 90 | 16 | -3.2 | 2 | HL L4, MD L4/5 Rt | | | 5 | 3 | Fair |
| 10 | M | 78 | 5 | -2.0 | 2 | C-laminoplasty C3-4-5-6 | | | 4 | 3 | Poor |
| 11 | M | 63 | 28 | -3.6 | 2 | P+PS L4/5 | | | 5 | 3 | Fair |
| 12 | F | 53 | 16 | -1.0 | 2 | TL L4 | | | 6 | 1 | Good |
| 13 | F | 70 | 10 | -2.3 | 3 | P+PS L1/2/3/4/5 | | | 5 | 4 | Poor |

abbreviations used in this table: PVP=percutaneous vertebroplasty; P+PS=Posterior lumbar interbody fusion and pedicle screw fixation; HL=hemilaminectomy; TL=total laminectomy; Decom.Lami.=decompressive laminectomy; MD=microdiscectomy; KW criteria=Kirkaldy-willis criteria

upper and lower segment that was revised by screw extension. One patient underwent on an index level revision due to inserted cage retropulsion with screw loosening. The last patient underwent on a screw re-insertion to the broken pedicle because of uncontrolled severe hyperkinesia after the index procedure; in total, five operations were performed. Two patients underwent on re-operation for segmental degeneration at adjacent levels. One patient who had undergone decompression and fusion at the level of L4/5 six years prior suffered from lower back and right thigh pain for several months. Adjacent segment degeneration above the index level was found and a second operation was performed with bilateral L3 screw fixation and rod extension. The other patient underwent fusion for lumbar stenosis at the level of L3/4/5, but the L5/S1 lumbar disc was protruding and unstable four months after the surgery. This patient needed additional screw fixation for the level of L5/S1. One other patient showed retropulsion of the intervertebral cage with screw loosening two months after fusion L5/S1 for lumbar stenosis. This patient needed one more surgical procedure with screw fixation. One other patient who needed additional surgical procedure initially underwent percutaneous vertebroplasty for L1 compression fracture. However, after the procedure, the spinal cord was compressed by a progressive ongoing compression fracture. Three further operations were performed with instrumentation due to progressive instability and fusion failure.

Almost all the patients experienced pain relief after the operation, presenting with a lower VAS score. The surgical outcomes, when measured by the Kirkaldy-Willis criteria were; excellent in one patient, good in two, fair in seven, and poor in three.

## ILLUSTRATIVE CASES

### 1. Case 1 (patient 4)

A 59-year-old female presented with pain in the left buttock and posterior thigh with VAS 8 due to lumbar stenosis on L5/S1. She had a four-year history of Parkinson's disease, which was moderately controlled with medication. Her major symptom was tremor and she was medicated with the carbidopa-levodopa combination drug (SINEMET®) and ropinirole dopamine agonist (REQUIP®). Under medical treatment, her Parkinson's severity status was Hoehn and Yahr stage II.She was a non-smoker and had been on medication for hypertension and diabetes mellitus for ten years. Her BMD value using DEXA showed -2.3 T-scores in the lumbar spine.

Fig. 1. CT images showed the retropulsed cage with a halo surrounding the loosened cage (A) and a left pedicle fracture with a loosened screw (B)

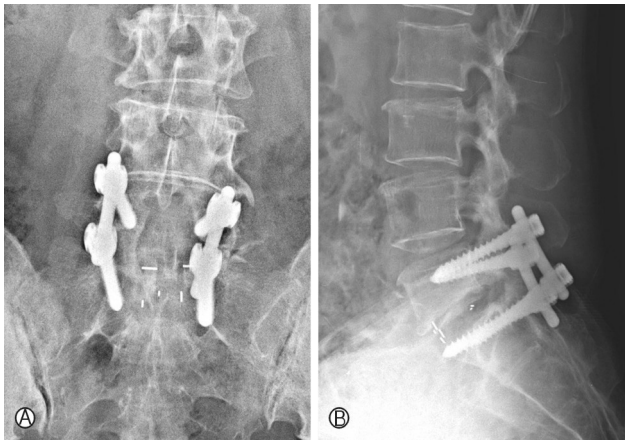

Fig. 2. Plain AP & lateral X-ray two weeks after the revision operation showed L5-S1 pedicle screw implanted in the lumbar spine with the newly inserted bilateral cage (A, B).

With spinal stenosis L5/S1 as the initial diagnosis, and failing conservative treatment, she underwent an index unilateral posterior lumbar interbody fusion with single cage and left unilateral pedicle screw fixation on same level. After the surgery, she experienced pain relief, but still needed medication for pain control. Two months after the surgery, severe pain developed again on her left buttock and thigh with VAS 8. Lumbar spine X-ray and computed tomography (CT) showed that the single cage that had been inserted into the L5/S1 intervertebral space had retropulsed with fracture of the left pedicle of L5 and screw loosening (Fig. 1). We removed the previous cage and inserted new bilateral cages, and pedicle screw fixation was done on L5/S1. We used longer screws on S1 according to the bicortical fixation method (Fig. 2). The patient was followed up for three months after the surgery and showed no pain, with VAS 0. She had no more back or leg pain. On follow-up image, she had no evidence of nonunion or progression of deformity and was functioning well. She has since maintained this level of function, requiring no further intervention.

## 2. Case 2 (Patient 1)

A 67-year-old female who had a twelve-month history of Parkinson's disease showed severe dystonia and tremor at the timeof presentation and without medication, she was unable to control her intended movements. She had stage II-III of Parkinson's disease with medication, but her symptoms deteriorated to stage IV when her medication wore off. BMD values using DEXA showed T-scores of -5.1 in the lumbar spine, -4.3 in the femoral neck, and -4.0 in the Ward's triangle. She was a non-smoker.

Fig. 3. Preoperative magnetic resonance T1-weighted sagittal image demonstrated L1 compression fracture with signal hypointensity (A). Percutaneous vertebroplasty was performed on the L1 compressed body showed in the Plain X-ray Lateral image (B).

She was suffering from mid-back pain and motion tenderness in her upper back for two weeks. Under the initial diagnosis of L1 compression fracture, she underwent percutaneous vertebroplasty (Fig. 3). After the initial procedure, the direct tenderness on upper back was relieved. However, two weeks after the procedure, the L1 compression fracture was progressed, leading to serious compression of the spinal cord. She underwent decompressive laminectomy on T12 and transpedicular screw fixation at the level of T12-L1-L2 (Fig. 4). By this time, her Parkinson's disease was poorly controlled on medication. Two days after her initial fusion surgery, the L1 right pedicle wall was broken and the proximal pedicle

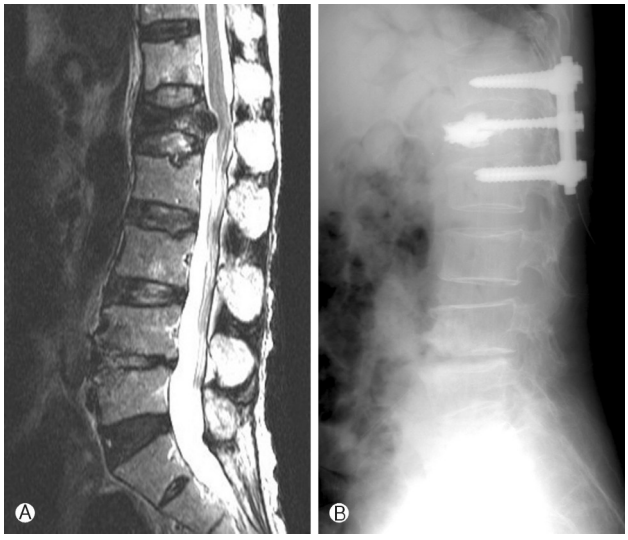

Fig. 4. T2-weighted MRI showed cord compression by progressive compression fracture (A). Plain X-ray lateral image demonstrated decompressed and screw-fixed thoracolumbar spine (B).

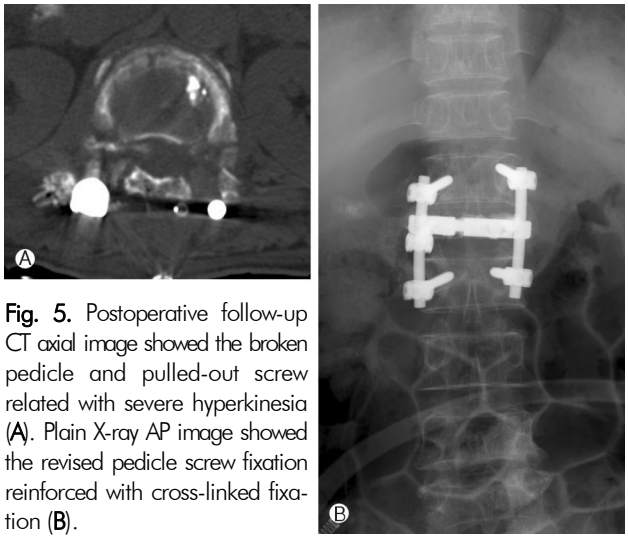

Fig. 5. Postoperative follow-up CT axial image showed the broken pedicle and pulled-out screw related with severe hyperkinesia (A). Plain X-ray AP image showed the revised pedicle screw fixation reinforced with cross-linked fixation (B).

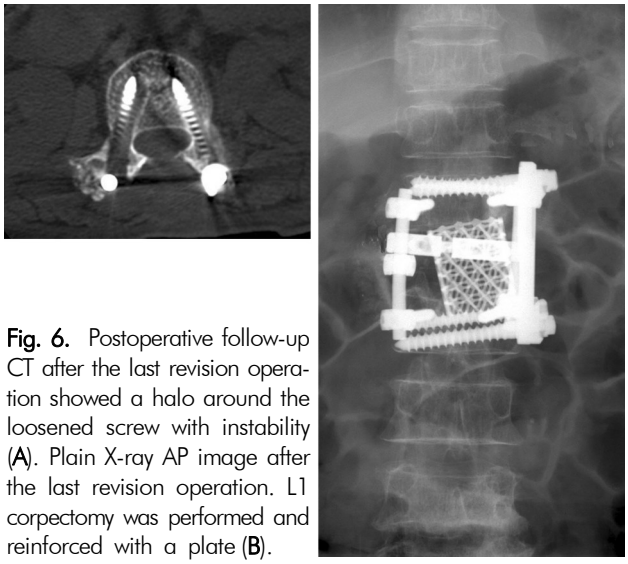

Fig. 6. Postoperative follow-up CT after the last revision operation showed a halo around the loosened screw with instability (A). Plain X-ray AP image after the last revision operation. L1 corpectomy was performed and reinforced with a plate (B).

screw was pulled out, which may have been related to her severe hyperkinesia. She underwent re-instrumentation with fixation of screws with a bigger diameter and cross-linking of two rods for firmness (Fig. 5). Nevertheless, after the last re-operation, her involuntary severe hyperkinesia continued, and could not be controlled by medication. Two weeks after the fusion surgery, she underwent insertion of a DBS on the bilateral subthalamic nuclei. Two weeks after the DBS, mild dyskinesia persisted and a previously inserted screw had loosened. Considering her continuous dyskinesia, firmer fixation was necessary for successful fusion. We performed total corpectomy of the L1 body and replaced it with a pyramesh artificial alloy with reinforcement plate fixation (Fig. 6). Two months later, an infection developed on the surgical wound for the right side electrolead insertion of DBS. The right side lead was removed and patient needed long-term antibiotics. At her follow-up appointment 133 months after the last operation, she had no evidence of infection or nonunion and still needed medication for control the Parkinson's disease.

## DISCUSSION

Patients with Parkinson's disease have been reported have a higher risk of surgical complications because of a combination of serious neuromuscular disorders and poor bone quality, which means they may have to undergo repeated surgeries. In this point of view, we reviewed surgical outcomes of our patients with Parkinson's disease who underwent spinal surgery to evaluate risk factors that related to reoperation. A total of 13 patients who were diagnosed with Parkinson's disease underwent spinal surgery at our hospital. 4 (30.8%) out of these 13 had complications after the index procedure and underwent repeated operations. For comparison, Nasser et al. reported the incidence of complications in spinal surgery in the general population tobe 16.4% (13067 in 79471 patients) after reviewing 105 papers regarding the issue[14]. Pain was relieved after the operation in all the patients, but 10 patients were unable to return to their ordinary work and their successful outcomes on the basis of Kirkaldy-Willis Criteria were poor or fair. Common characteristics of these patients were old ages, low BMD, high H-Y grade and small difference between preoperative and postoperative VAS score than other patients group (Table 4). But because of the small number of

patients, statistical significance was minimal, so that continuous study will be necessary. As a result, on the basis of these outcomes, we anticipate that patients with Parkinson's disease will have a higher rate of complications in comparison with-other groups due to several risk factors and we will discuss about these risk factors quoting other reported papers.

Although there have been very few reports about spinal disease in patients with Parkinson's disease, there is evidence that these patients suffer from spinal problems of a different nature and severity than their age-matched control groups without Parkinson's disease[6,9,15,16]. For example, scoliosis is more common in patients with Parkinson's disease than in the general elderly population, with a reported incidence ranging from 43% to 90%[5,7,8]. The paraspinal musculature of patients with Parkinson's disease has irregular distribution of involuted muscle fibers, and much more connective tissue than their age-matched controls, according to a study by Lacroche et al[13]. Paraspinal musculature in these patients is also atrophied on MRI and computed tomography. Progressive deformities have been seen in many of patients with Parkinson's disease. In addition, this chronic movement disorder almost certainly caused a high rate of instrumentation and fusion failure. This type of neuromuscular disease tends to aggravate post-operative complications. Besides the neuromuscular degenerative disorder, patients with Parkinson's disease frequently suffer from poor bone quality and related complications[10,15,16,21].

According to the World Health Organization criteria, relatively young patients with Parkinson's disease have lower BMD (osteopenia or osteoporosis), and relatively old patients with Parkinson's disease have decreased bone mineral stock at baseline[16]. In our study, the mean BMD of the four patients who had underwent revised operation after their index procedure was -2.7, and the mean BMD of all 13 of the patients who underwent surgery was -2.5 (range -1.0~-5.1). Wood et al[21] reported on the prevalence of osteoporosis in Parkinson's disease. The results of this cohort study showed that over three quarters of all the subjects had abnormal bone density (osteopenia 34%, osteoporosis 42%) and that over 90% of the women had osteoporosis or osteopenia. Also, T-scores on DEXA scan BMD are lower in the spine than in the hip for this group of Parkinson's disease patients. Osteopenia or osteoporosis have already been reported in other studies and may be associated with decreased axial mobility in Parkinson's disease[6]. Sato et al[16], reported a one-year study about hip fractures and related risk factors of 106 patients with Parkinson's disease including 64 women. The mean age of the patients included was 71.9 years old (65-85 years). During this period of study, only femoral neck fractures were recorded. These were experienced by 18 patients (16 women and two men). In Sato's study, several patients had data that classified as having low BMI, low 25-OH-vitamin D (with high PTH), and low BMD; these were suggested to be the strongest risk factors. Sato et al also reported a decrease in sunlight exposure, 25-OH-vitamin D, and BMD, as well as a significant increase in PTH related to movement disorders in both patient groups, as compared to the controls[16]. Lack of sun exposure led to decreased 25-OH vitamin D levels, and may have caused low BMD, but has not been identified as the cause of osteoporosis on the tissue level. However, the results of other previous studies tend to support the theory of a relationship between vitamin D levels and skeletal integrity in Parkinson's disease patients. Another study related to low vitamin D levels in Parkinson's disease patients was conducted by the same group[15]. The patients were divided into two groups according to the disease staging criteria by Hoehn and Yahr (I and II vs. III to V) and also compared to a control-group. Low exposure to sunlight of no more than fifteen minutes in a single week was more common in the group with advanced disease (96%) than in the group with early stage disease.

Gender may be related to higher risk of complications in patients with Parkinson's disease. In the general population, several studies have reported that Parkinson's disease has a male: female ratio of approximately 2:1[19]. Babat et al[1] reported in their spinal surgery cases, that the group of patients with Parkinson's disease had an 11:3 preponderance of women. Also, Taggartet al[17] reported that the BMD decrease was more severe in female than in male Parkinson's disease patients. Postmenopausal women also had poorer bone quality than other normally distributed patients in the Parkinson's disease group[16,20]. Thus, this preponderance is not strange, and could help us anticipate that the risks of spinal surgery are greater for female than for male patients with Parkinson's, and that female patients have a higher likelihood of developing post-operative complications.

Deep brain stimulation (DBS) of the sub-thalamic nucleus (STN) is an effective treatment that can help improve motor function, daily living activities and emotional status in patients with Parkinson's disease[16]. Papers about the relationship between the DBS and spinal surgery in patients with Parkinson's disease are rare. In our study, a single patient underwent DBS for control involuntary hyperkinesia after spinal surgery because of a prior fusion failure. When relating DBS with Parkinson's disease,Upadhyaya et al[18], suggested the following treatment algorithm: when patients indicated for spinal surgery continue to presentwith motor fluctuations despite optimal medical treatment, DBS should be administered before the spinal surgery. In the future,further study related to DBS will help make a prognosis for patients with Parkinson's disease.

## CONCLUSION

Several papers reported the primary mechanism of failure in these patients group to be relentless kyphosis or instability on the operation level or adjacent levels. When accompanied by hardware failure or pulling out of the fixation material, patient condition rapidly deteriorated, with progressive instability. Particularly, almost all of these papers suggest that patients with Parkinson's disease are at high risk for low BMD, which contributes to increasing the frequency of complications. In addition to low BMD, other risk factors that increase the risk complications have been identified: advanced disease, low BMI, limited exposure to sunlight, and low vitamin D intake (with decreased 25-OH-vitamin D levels and secondary hyperparathyroidism).

Parkinson's disease patients often experience unexpected or repeated treatments. Spine surgeons must recognize these risk factors and anticipate complications such as recurrent kyphosis, and must be prepared for the possibility of instrumentation failure. Also, spine surgeons must emphasize the presurgical evaluation of Parkinson's disease nature and deeply cares about perioperative pain control, medication for osteoporosis, and DBS for correction of underlying tremor. Closed careful observation is most important to Parkinson's disease patients.

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