Postoperative Visual Impairment after Spinal Fusion Surgery

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OBJECTIVE: The aim of this prospective study was to detect risk factors for visual impairment or changes in vision following spinal fusion surgery. METHODS: A total of 68 patients aged 18 – 65 years, scheduled for posterior spinal fusion surgery, were included. Ophthalmic examinations were performed by an ophthalmologist on the day before surgery and repeated after the second postoperative day, within the first postoperative week. Patient characteristics were compared according to two clinical outcomes following surgery: worsening of vision during the pre- and postoperative interval (group 1) and no change in pre- and postoperative examinations (group 2). RESULTS: The mean age of patients with postoperative visual changes was significantly higher than that for patients without postoperative visual changes. Total number of female patients and use of intraoperative ephedrine to treat hypotensive episodes were significantly higher in group 1 than in group 2 patients. CONCLUSION: Older age, female gender and intraoperative hypotensive episodes are potential risk factors for postoperative visual impairment in patients who have undergone spinal fusion surgery.

KEY WORDS: SPINAL FUSION SURGERY; COMPLICATIONS; POSTOPERATIVE VISUAL LOSS

Introduction
There has been a substantial increase in the number of patients undergoing spinal fusion surgery.1 Postoperative visual loss (POVL) is a rare but devastating complication of spinal fusion surgery, and the incidence of POVL or visual impairment is also increasing.2 In a multicentre study published in 2012, the authors suggested that the incidence of postoperative visual loss after spinal surgery ranged between 0.03% and 0.2%, based on data held on national databases.3 Visual impairment can occur in one or both of the patient’s eyes during the postoperative period, and POVL (as documented in the clinic) may not represent total blindness. The signs of visual impairment in these patients range from blurred vision to irreversible, complete, visual loss.

The mechanism of POVL is unclear, although its pathology may involve the visual circuit anywhere between the cornea and the occipital lobe. Permanent damage is frequently observed in the optic nerve, and the mechanism of damage appears to be related to ischaemia in this anatomical region.2,3 Visual impairment may occur after cardiovascular, spinal fusion, reconstructive and other types of surgery.2,4

The present prospective study evaluated...
the incidence and aetiology of visual loss/impairment or visual changes after instrumented spinal fusion surgery.

**Patients and methods**

**STUDY POPULATION**

Patients aged 18 – 65 years of age with American Society of Anesthesiology (ASA) physiological status I – III, who were scheduled for elective spinal fusion surgery at Ege University Hospital, Izmir, Turkey, between November 2010 and June 2011, were enrolled sequentially into this study. Preoperative ophthalmic examinations were performed by an ophthalmologist (F.A.). Patients who had preoperative ophthalmologic problems (such as glaucoma or cataract) were excluded from the study. Demographic information, together with each patient’s height, weight, body mass index (BMI), biochemical and complete blood count values, coexisting diseases (diabetes mellitus, hypertension, hyperlipidaemia, atherosclerosis), premedication, and alcohol and/or smoking habits were recorded preoperatively by another investigator (Ö.K.).

Ethical approval was obtained from the Institutional Review Board of Ege University (decision no. 10-9.1/7 of the Ethical Committee session held 5 November 2010), and patients provided written informed consent before participating in the study.

**PRE- AND POSTOPERATIVE ASSESSMENTS**

During surgery, patients were placed in a neutral prone position on the operating table parallel to the floor. Haematocrit levels were checked by analysing blood samples at least once intraoperatively. Surgical procedure (posterior segmental instrumentation, total number of spinal segments involved, laminectomy or discectomy), duration of surgery, intraoperative haemodynamic parameters, total blood loss, total amount of transfused blood products and lowest level of haematocrit observed during surgery were also recorded. Intravenous ephedrine was administered intermittently as required, when the patient’s mean arterial pressure (MAP) was < 60 mmHg and systolic arterial pressure was < 90 mmHg; its use was recorded. Total duration of surgery was also recorded.

To characterize the extent of visual impairment, an experienced ophthalmologist (F.A.) evaluated patients’ eyes based on four criteria: visual acuity; pupil diameter–pupil light reflex; anterior chamber; posterior chamber. Visual acuity was measured using a standard eye chart; ophthalmic and fundoscopic examinations were undertaken to assess any pathology in pupil reactivity, opacification or whitening of the ischaemic retina, or narrowing of retinal arterioles. Visual assessments were carried out the day before surgery and repeated after the second postoperative day (but within the first postoperative week). Changes in pupil diameter–pupil light reflex and anterior or posterior chamber, together with 10 – 20% changes in visual acuity, were considered to indicate postoperative visual impairment. Additionally, on a daily basis, patients were asked if they were experiencing any visual problems; they were also asked to contact the investigators after hospital discharge if visual problems developed.

Patients were divided into two groups on the basis of postoperative visual outcome: group 1 consisted of patients with a worsening of vision between the pre- and postoperative ophthalmic examinations; group 2 consisted of patients with no change in vision between examinations. Demographic and clinical characteristics
were analysed and compared between the groups.

As steroids are used to treat perineural oedema in patients undergoing spinal surgery,5 steroid administration was assessed as a secondary parameter.

**STATISTICAL ANALYSES**

Data were analysed using the SPSS® statistical package, version 15.0 (SPSS Inc, Chicago, IL, USA) for Windows®. For comparative analyses of between-group results, Student’s t-test, Mann–Whitney U-test and the χ²-test (or Fisher’s exact test) were used for demographic data, duration of surgery, MAP, heart rate, temperature, oxygen saturation, intraoperative haematocrit values, ephedrine and/or steroid use, and total number of spinal segments operated on during surgery. Values were expressed as mean ± SD. A P-value < 0.05 was considered to be statistically significant.

**Results**

In total, 68 patients were enrolled and 52 completed this prospective study; 16 patients were excluded because of ophthalmological pathologies such as glaucoma and cataract. Following spinal fusion surgery, none of the patients had visual loss, but visual changes were noted during visual examination in 11 of 52 patients (21.2%). These patients were assigned to group 1; nine had a 10 – 20% decrease in visual acuity, a preoperative macular aneurysm became haemorrhagic in one patient, and an odd foveal reflex was observed postoperatively during examination of the posterior chamber in one patient. No significant differences between the two groups were observed in terms of height, weight, BMI or total duration of surgery (Table 1). There were no significant between-group differences related to the type of surgical procedure used (i.e., posterior segmental instrumentation, laminectomy or discectomy).

Compared with patients in group 2, mean age and total number of female patients were both significantly higher in group 1 (P < 0.001 and P = 0.035, respectively; Table 1). Intraoperative MAP was significantly lower in group 1 compared with group 2 after 3 h (P = 0.022) and 4 h (P = 0.013) of surgery (Fig. 1).

The number of patients with coexisting diseases and the total dose of ephedrine administered to treat hypotensive episodes were significantly higher in group 1 compared with group 2 (P = 0.034 and P = 0.006 respectively; Table 2). There was no significant between-group difference with regard to smoking habit, steroid use, number of spinal segments operated on (all shown in

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**Table 1:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group 1, n = 11</th>
<th>Group 2, n = 41</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>58.72 ± 4.54ᵃ</td>
<td>45.02 ± 11.80</td>
</tr>
<tr>
<td>Gender, males/females</td>
<td>1/10ᵃ</td>
<td>19/22</td>
</tr>
<tr>
<td>Height, cm</td>
<td>161.36 ± 8.91</td>
<td>166.17 ± 11.26</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>76.81 ± 9.21</td>
<td>76.51 ± 15.05</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>29.67 ± 4.38</td>
<td>27.77 ± 5.15</td>
</tr>
<tr>
<td>Duration of surgery, h</td>
<td>3.63 ± 0.92</td>
<td>3.00 ± 1.16</td>
</tr>
</tbody>
</table>

Data presented as mean ± SD.

ᵃP < 0.05 versus group 2; χ²-test or Fisher’s exact test.
Table 2), or total blood loss, haemoglobin/haematocrit levels and total amount of transfused red blood cell units (data not shown).

Discussion

Postoperative visual loss is a rare and dreaded complication that can occur following nonocular surgery in any position.
Publications on POVL are often case reports or retrospective case–control studies. The incidence of POVL has been suggested to be between 0.03% and 0.2% but the actual percentage affected by this complication remains undetermined. In 2003, the ASA Postoperative Visual Loss Registry reported that 67% of postoperative visual impairment cases were operated on in the prone position. More recently, the Postoperative Visual Loss Study Group demonstrated an absolute risk of ischaemic optic neuropathy (ION) per 10,000 procedures of 0.08 – 48.11, and reported that obesity and male gender were associated with an increased risk of developing ION after major spinal surgery in the prone position.

There are conflicting reports about the effect of gender on POVL. Kalyani et al. found that 82% of patients who experienced visual impairment after cardiac surgery were male, although this was probably explained by the fact that the majority of patients who undergo cardiac surgery are men. In contrast, the majority of patients with visual impairment in the present study were women. This difference could be due to the fact that the total number of female patients scheduled for spinal fusion surgery at our institution was greater than the number of male patients.

In the present study, the mean age of patients with postoperative visual impairment was significantly higher than that of patients with no postoperative visual changes. This may indicate that older age is a risk factor for postoperative visual impairment, following spinal fusion surgery. According to the literature, the increasing incidence of comorbidities and coexisting disease with older age and a low tolerance to blood loss in the elderly may have been responsible for the increased risk of visual impairment. Similar to our findings, other research has reported higher incidences of nonarteritic posterior ischaemic optic neuropathy (NA-PION) or posterior ischaemic optic neuropathy (PION) – both of which may cause visual impairment – in middle-aged and older patients. The mean ages of patients with surgically related NA-PION, arteritic PION or PION were reported as 61.5 years, 73.4 years and 77.3 years, respectively.

In addition, older age and coexisting disease may impair the autoregulation of systemic arterial pressure. Intraoperative total ephedrine use in the present study was higher in patients with postoperative visual impairment, which may have been due to the hypotensive episodes observed. Hypotension has been reported as an important risk factor for POVL. The largest study to investigate the aetiology of postoperative ION after spinal fusion surgery, however, suggested that hypotensive episodes and anaemia severity were similar in patients with or without postoperative ION, although it is important to note that this was a retrospective study. Due to the lack of records on POVL, the target blood pressure remains to be determined.

A close relationship between PION and systemic diseases (such as hypertension, diabetes mellitus, ischaemic heart disease, cerebrovascular disease, carotid artery disease and other peripheral vascular diseases) and migraine headache has been demonstrated. Nonarteritic anterior ION is a primarily hypotensive disorder. It should be considered that impaired autoregulation of blood pressure, as well as sudden and prolonged hypotensive periods induced by general anaesthesia, are common in patients with diabetes. The most frequent coexisting systemic disorders in the present study were hypertension, hyperlipidaemia and diabetes mellitus. Most published studies on POVL have reported
similar results. The relatively short duration of surgery and the lack of any noteworthy intraoperative blood loss may, however, have represented advantages unique to the patient population in the present study, which may explain why visual impairment rather than POVL was observed. Thus, coexisting disease alone may not be a potential risk factor but could be critical when combined with other factors.

The duration of surgery is one of the most important factors related to postoperative visual impairment. A number of studies have indicated that a prolonged duration of surgery increases the incidence of postoperative visual impairment, as reviewed by Roth. One study reported that the mean duration of surgery was 450 min in 93 patients who developed postoperative visual impairment following spinal fusion surgery in the prone position. Analysis of the ASA Postoperative Visual Loss Registry indicated that 89% of ION cases observed after spinal surgery involved posterior fusion or instrumentation on more than one level (thoracic, lumbar or sacral vertebrae), and 39% of these patients had undergone a second surgical procedure. In the same study, the mean duration of anaesthesia was 9.8 h (range 3.9 – 14 h); in 94% of the cases anaesthesia duration exceeded 6 h. In addition, the mean period of time spent in the prone position was 7.7 h. Prolonged duration of surgery may increase the incidence of postoperative visual impairment as a result of prolonged optic nerve ischaemia. The average duration of surgery in the present study was 3 h and there was no significant between-group difference in duration: the longest operation lasted 5 h. The relatively short duration of surgery in the present study may have resulted in less intraoperative blood loss, intraoperatively stable arterial pressure and a reduced risk of other factors that might affect the optic nerve. There were no significant between-group differences in terms of the lowest intraoperative haematocrit/haemoglobin levels or the volume of red blood cell transfusions. Two retrospective studies investigated the relationship between intraoperative decreases in haemoglobin/haematocrit and ION. In one, no difference was observed between patients who developed ION after spinal surgery and patients without ION with regard to the lowest haematocrit levels. In contrast, the second study demonstrated a weak relationship between haematocrit levels and incidence of postoperative ION in patients who underwent cardiac surgery ($P = 0.047$). These results suggest that massive intraoperative bleeding and a reduced oxygen supply to the optic nerve may cause arteritic ION or PION. Safe haematocrit limits remain to be determined. The combined effects of anaesthesia, hypotension and anaemia on consumption of oxygen by the optic nerve are yet to be investigated.

The present study is unique in this field due to its prospective design: the research required a high degree of organization in order to complete the pre- and postoperative visual examinations during the limited time frame. Instrumented posterior spinal surgery is a major procedure, and during the postoperative period patients are unable to sit or move easily. As a consequence, only a small number of patients were included in the present study. Sixteen patients were excluded due to pathologies such as cataract and glaucoma, which were diagnosed during the preoperative ophthalmic examination. Such undiagnosed pathologies could result in symptoms following surgery, which could present a medicolegal problem for the surgical team. It is also difficult to explain to a patient why POVL has occurred following nonocular
surgery. The mean age of patients whose vision worsened in the present study was 58 years. Thus, the authors feel it is reasonable to consider that patients aged > 55 years may be at higher risk of POVL than younger patients.

In summary, potential risk factors for postoperative visual changes or impairment in patients undergoing spinal fusion surgery include older age (suggest to be > 55 years), female gender, concomitant systemic disease and intraoperative hypotensive episodes.

Patients scheduled for instrumented spinal surgery should be informed of the risk of visual impairment or complete visual loss, and pre- and postoperative ophthalmic examinations should be performed in those who are at heightened risk.

Conflicts of interest
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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References