Cervical spondylosis is a progressive disorder of the aging spine that results predominantly from degeneration of the intervertebral discs and vertebrae. The formation of “bone spurs” or osteophytes may cause symptomatic compression of the spinal cord and/or nerve roots. Surgical intervention is indicated when patients experience neurological deficits or intractable pain, and dorsal approaches offer direct visualization of the compressed spinal cord and/or nerve roots. A foraminotomy involves widening the foramen and indirectly decompressing the nerve roots; this type of procedure is often accompanied by a partial laminotomy and medial facetectomy.

Posterior cervical foraminotomy (PCF) was first described by Scoville in 1946. Although it is considered to be a safe procedure with a low complication rate, radiculopathy symptoms may recur, in some cases necessitating reoperation. Many studies have provided data on outcomes after PCF. In this article, we report the incidence and timing of symptom recurrence after unilateral posterior cervical foraminotomy (PCF).

Object. The authors conducted a study to investigate the rate and timing of reoperation due to symptom recurrence after unilateral posterior cervical foraminotomy (PCF).

Methods. The authors retrospectively reviewed demographic, surgical, and clinical data from 151 patients who underwent unilateral PCF at their institution with an average follow-up of 4.15 years. The main outcome variables were reoperation rate, time to reoperation, and short- and long-term radiculopathy improvement rates. Kaplan-Meier analyses were conducted to assess risk of reoperation and recurrence of radiculopathy over time.

Results. After index PCF in 151 patients, the overall reoperation rate was 9.9% (15 patients). The average time until reoperation was 2.4 years, and the average last follow-up examination was 4.15 years after the first surgery. Patients who presented with preoperative neck pain in addition to radiculopathy had a higher risk for reoperation and a shorter time to reoperation. The majority of patients who underwent a reoperation had an anterior cervical discectomy and fusion (80%). A smaller number of patients had reoperation that included a repeat PCF (6.7%) or laminectomy with posterior cervical fusion (13.3%). The rate of same-level reoperation (6.6%, 10 patients) was significantly higher (p = 0.05) when compared with adjacent-segment (1.3%, 2 patients) or distant-segment (1.9%, 3 patients) reoperation. At last follow-up, the overall rate of improvement in radiculopathy was 85%, with the majority of patients (91.4%) experiencing resolution as early as 1 month after index surgery. Following the subgroup that experienced initial symptom improvement, 16.1% of these patients experienced radiculopathy recurrence an average of 7.3 years after the initial operation. While the reoperation rate for the overall cohort in this series was 9.9%, patients with follow-up periods longer than 2 years had a reoperation rate of 18.3%. Moreover, patients with more than 10 years of follow-up had a reoperation rate of 24.3%.

Conclusions. PCF is a procedure performed to address nerve root compression in the cervical spine. The authors evaluated 151 patients who underwent unilateral PCF and found a reoperation rate of 9.9% at an average of 2.4 years after the initial surgery (6.6% at same level, 3.3% elsewhere). The reoperation rates reached 18.3% and 24.3% in patients with follow-up periods longer than 2 and 10 years, respectively. The authors’ analysis revealed that patients with no preoperative neck pain had the lowest rates of revision surgery after PCF.
of reoperation after PCF and identify perioperative variables associated with a higher reoperation rate.

Methods

Patient Collection

The study was approved by the Johns Hopkins Institutional Review Board. We retrospectively reviewed all PCFs for cervical degenerative disease performed by full-time neurosurgeons at our institution between January 1990 and January 2013. Our source population included 225 patients who underwent PCF, and we excluded 6 cases with fewer than 3 months of follow-up. Of the 219 patients with follow-up of at least 3 months, we excluded 68 patients who underwent bilateral PCFs. Nondegenerative cases, anterior cervical operations, posterior fusions (instrumented and noninstrumented), and cases that involved foraminotomy and simultaneous laminectomy were also excluded. Thus, our study population was made up of 151 patients who underwent unilateral PCF with at least 3 months of follow-up. Patient data, including demographic information, presenting symptoms, operative results, and complications, were compiled in a retrospective database. Our main outcome variables were rate of reoperation, time to reoperation, and progression of radiculopathy.

Statistical Analysis

The patient population was described with summary statistics. We used the Kaplan-Meier method to assess the time to reoperation for patients who underwent PCF, and the log-rank (Mantel-Cox) test was used to estimate the p value. Cox proportional hazard ratios were used for our multivariate analysis; we included only variables that were found to have a p value < 0.2 and used a forward-model building approach. A p value ≤ 0.05 was considered statistically significant. Principal component analysis was used to assess the variables that created the greatest variability in our data set. We calculated the Pearson correlation matrix among preoperative status, operative variables, and postoperative outcome to infer any relationship among the variables. All statistical analyses were performed using Statistica software (StatSoft Inc.).

Results

A total of 261 PCFs were performed in 151 patients. Among the 151 patients, the mean age was 56 ± 13.6 years, and 70.8% (n = 107) were male (Table 1). The average number of spinal levels decompressed was 1.7 ± 1, and the most frequent levels were C5–6 (31%) and C6–7 (35.6%) (Fig. 1, Table 2). The majority of the patients were treated for either spondylosis (51.6%) or disc herniation (37.1%), and the PCF was followed by removal of the osteophyte (7.3%) or disc-osteophyte complex (4%). The preoperative diagnosis was not a predictor of reoperation based on a regression analysis (p = 0.62). The intra- and perioperative characteristics of the patients are described in Table 2.

Reoperation Rates

In an average follow-up period of 4.15 years, the overall reoperation rate was 9.9% (Table 3, Fig. 2 upper). Kaplan-Meier analysis revealed the rates of reoperation to be 9%, 14.3%, and 24.3% at 1, 5, and 10 years, respectively. The level of reoperation was also analyzed. Of 151 patients, 10 patients (6.6%) required reoperation due to same-level disease (Fig. 2 lower), and 2 patients (1.3%) required reoperation due to adjacent-level disease (Fig. 2 upper).
Outcomes after posterior cervical foraminotomy

required reoperation due to adjacent-segment disease. This rate was significantly lower when compared with the same-level rate as assessed with a log-rank test (p = 0.05). Lastly, 3 patients (1.9%) required reoperation at nonadjacent segments.

We calculated the Pearson correlation matrix for our preoperative, demographic, and surgical variables in relationship to the time to reoperation. An inverse relation was noticed for patients who presented with neck pain (r = −0.141). This parameter was statistically significant with regard to the time to reoperation (p < 0.05). This indicates that patients who presented with preoperative neck pain required a reoperation sooner than patients without neck pain.

Radiculopathy Recurrence

The improvement rate of radiculopathy at the 1-month follow-up was 91.4% in our cohort. At an average last follow-up 4.15 years after treatment, 85% of patients experienced radiculopathy improvement. We separately analyzed data for 68 patients from our cohort who had more than 2 years of follow-up. The overall reoperation rate in this group was 16.4%. Short-term outcome (at 1-month follow-up) revealed symptomatic improvement in 91.4% of patients. Following the subgroup of patients who experienced an initial improvement of symptoms, 16.1% had recurrence of their radiculopathy an average of 7.3 years after the initial operation.

Multivariate Analysis of Reoperation Rate

We sought to analyze variables that might confer a higher risk for reoperation by performing multivariate analysis and only including patients who underwent reoperation at the index level. All preoperative and operative variables with a p < 0.2 in univariate analysis were included in the model. We found that patients who presented with radiculopathy and preoperative neck pain had a 2.9-fold greater risk of requiring a reoperation after PCF compared with patients who presented with radiculopathy alone (p = 0.03).

Discussion

Posterior cervical foraminotomy has been well de-
In this series, a majority of patients who underwent PCF experienced initial symptom improvement, at least in the short term. In patients with more than 2 years of follow-up, symptom relief reached 84% at the time of last follow-up. The overall rate of reoperation for the total cohort was 9.9%. Davis reported a 6% reoperation rate in a study of 170 patients; all of the cases involved reoperation to address pathology at the same level due to symptom recurrence. Wang et al. recently reported a 5% reoperation rate at the index level in a cohort of 178 patients treated with PCF. Similarly, in the present study, 10 (6.6%) of 151 patients required reoperation due to same-segment disease, comparable to rates reported in other studies. Interestingly, the rates of reoperation due to adjacent-segment disease versus distant-segment disease were not significantly different (p = 0.99), which may be an argument in favor of the natural history of spondylosis.

Patients with symptom recurrence after PCF underwent repeat surgery an average of 2.4 years after the index surgery. A Kaplan-Meier analysis showed that 24 patients who did not experience radiculopathy recurrence 10 years after the initial PCF would not have any recurrence for the rest of their follow-up time (10–22 years from the initial operation).

When analyzing preoperative symptoms and correlating them with postoperative outcomes, we found that patients with preoperative neck pain were more likely to require earlier reoperation. In addition, the multivariate analysis of the pre- and intraoperative variables showed that preoperative neck pain was correlated with an increased risk of revision surgery. In this study, patients who presented with radiculopathy and neck pain had a higher incidence of reoperation and required reoperation earlier than patients who presented with radiculopathy alone. In our institutional experience, these results have a particularly strong impact on young adults or athletes who opt out of a cervical decompression and fusion in favor of a less invasive foraminotomy. The operation is intended to preserve the cervical range of motion in these active patients. Within the general population, patients may be advised that PCF is a safe procedure associated with favorable outcomes. Patients who have neck pain in addition to radiculopathy may be consulted regarding their elevated risk of reoperation.

Both PCF and anterior cervical discectomy and fusion (ACDF) represent surgical options to treat cervical radiculopathy. Certain cervical pathologies may benefit more from ACDF (e.g., central-lateral disc herniation, bilateral foraminal stenosis, osteophyte anterior to the nerve root, or facet hypertrophy). On the other hand, patients who wish to maintain cervical range of motion may be good candidates for PCF. Moreover, patients who are poor surgical candidates or who are at increased risk for nonunion (e.g., those receiving chronic corticosteroid treatment or those who smoke) may have improved results with PCF.

Limitations

Although we presented statistically and clinically significant data on patients undergoing PCF, our retrospective study has inherent limitations. Retrospective cohort studies are limited to a single outcome while measuring multiple exposures. Future prospective studies are best suited to thoroughly analyze outcomes following PCF.

Conclusions

Posterior cervical foraminotomy is a procedure that addresses foraminal nerve root compression. In this series, patients who underwent PCF had an overall 9.9% reoperation rate with an average time to reoperation of 2.4 years after the index operation. The rate of reoperation at the index segment was 6.6%, which was statistically significantly higher than reoperation at adjacent or distant segments (p = 0.05). Patients with preoperative neck pain had a higher risk for reoperation and a shorter time to reoperation. At the average last follow-up of 4.15 years, the overall rate of improvement in radiculopathy was 85%, with the majority of patients (91.4%) experiencing resolution as early as 1 month after the index surgery. Following the subgroup of patients who experienced initial symptom improvement, 16.1% had recurrence of their radiculopathy an average of 7.3 years after the initial operation. While the reoperation rate was 9.9% for the overall cohort in this series, patients who had more than 2 years of follow-up had a reoperation rate of 16.4%. Moreover, patients who had more than 10 years of follow-up had a reoperation rate of 24.3%. According to the results of this series, the majority of patients experience symptomatic improvement of radiculopathy after PCF; therefore, patients may be advised that PCF is a safe operation with favorable outcomes. Patients who have neck pain in addition to radiculopathy may be consulted regarding their elevated risk of reoperation.

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