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Technique to minimize paraspinal muscle atrophy after posterior cervical fusion

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ABSTRACT

Objective: Paraspinal muscle atrophy (PMA) after posterior cervical fusion is a known complication that causes considerable morbidity. It has been shown in the lumbar spine that preservation of the posterior ramus of the spinal nerve is important in minimizing paraspinal muscle atrophy. During posterior cervical spine fusions, we modified the exposure of the dorsal cervical spine by exposing only the medial two-thirds of the lateral mass utilizing a low electrocautery setting. In a retrospective analysis, we compared the incidence of paraspinal muscle atrophy using this modified technique with historical cohorts who underwent posterior cervical fusion using the standard technique of exposure of the entire lateral mass.
Materials and methods: All patients who underwent posterior cervical fusion and internal fixation between 1999 and 2007 were included. Patients operated from 1999 to 2003 who underwent the standard exposure of the lateral mass formed Group 1 ($n = 31$). Group 2 ($n = 32$) included patients whose lateral masses were exposed using the modified technique of limiting the exposure only to the medial two-thirds of the lateral mass with the cautery on a low setting. All patients were assessed for PMA at six months after surgery. Atrophy was graded as no atrophy, mild atrophy (minimal midline atrophy), moderate atrophy (muscle lost without palpable hardware) and severe atrophy (hardware palpable). Before initiating the study, no atrophy and mild atrophy were grouped together as a non-significant atrophy and moderate atrophy and severe atrophy were grouped together as significant atrophy.
Results: We found a statistically lower incidence of paraspinal atrophy using this modified exposure of the lateral mass ($p < 0.03$).
Conclusions: This modified technique of cervical spine exposure is associated with lower paraspinal muscle atrophy secondary to the preservation of the innervation of the paraspinal musculature.

1. Introduction

Paraspinal muscular atrophy (PMA) after dorsomedian approach is a common complication of spinal surgery [1]. The causes of these changes include mechanical injury, ischemia, denervation, and disuse secondary to immobilization or bracing. The incidence, possible causes, imaging characteristics and techniques to minimize it have been previously described in regards to the lumbar spine [2–8]. PMA in the lumbar spine has shown to lead to poor clinical outcome with increased postoperative pain, instability and also contributes to failed back syndrome [1]. No study has been performed on any aspect of PMA of the cervical spine. It is extremely important to study these changes independently in the cervical spine in order to reduce its incidence and severity. PMA in the cervical spine could lead to postoperative pain, muscle spasm, instability, swan-neck deformity and cosmetic disfiguration. In order to minimize these complications in the lumbar spine, various modifications have been proposed. Preservation of the posterior ramus of the spinal nerve is one of the most significant way to minimize PMA in the lumbar spine postoperatively [2,9]. In order to preserve the posterior ramus of spinal nerve in the posterior cervical fusion, we modified our technique of the exposure of the lateral mass starting in 2004. In this retrospective study, we compared the incidence of PMA using this novel technique with historical cohorts who were operated before 2004 utilizing a standard exposure.

2. Materials and methods

Institutional Review Board approval was obtained. All the patients who underwent posterior cervical fusion and internal fixation by the senior author (TF) between 1999 and 2007 were evaluated. Medical records were reviewed by one of the authors (JRS) and findings recorded. Occipito-cervical fusions were not included in this study. Posterior cervical fusions extending down to the first or second thoracic vertebral levels were included in this study. All of the patients whose atrophy was not recorded at least

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Fig. 1. Shows severe atrophy with palpable hardware.

6 months after surgery were called for follow-up and evaluated clinically if possible. All the results were recorded and statistical analysis was performed on SPSS 14.0 software (SPSS Inc, Chicago). Operations performed between 1999 and 2003 using the standard exposure formed Group 1 of this study ($n = 31$). Lateral mass fusion and internal fixation was performed by subperiosteal exposure of the entire lateral mass using an electrocautery setting at 35 mA. In the first 10 patients, monaxial screws were inserted in the lateral mass followed by the insertion of a plate. In four of these patients the lateral mass fusion was further supplemented by interspinous process wiring. In the remaining 21 patients, polyaxial screws were placed into lateral mass followed by rod fixation. In the year 2004, the technique of exposure of the lateral mass was modified (see below). Group 2 consisted of all patients who were fused using this modified technique ($n = 32$). Atrophy was assessed by one of the authors (TF or JRS). Atrophy was graded as no atrophy, mild atrophy (minimal midline atrophy), moderate atrophy (muscle lost without palpable hardware) and severe atrophy (hardware palpable) (Figs. 1–3). Before initiating the study, no atrophy and mild atrophy were grouped together as a non-significant atrophy and moderate atrophy and severe atrophy were grouped together as significant atrophy. All the patients were followed up at least at 6 weeks, 3 months, 6 months and most patients were evaluated 1 year or longer. Fusion was assessed by the lack of lucencies around the screws and absence of motion on flexion/extension views on X-rays [10] at the end of at least 6 months.

Fig. 2. Shows moderate atrophy with diffuse muscle loss without palpable hardware.

Fig. 3. Minimal atrophy with only midline muscle atrophy.

3. Surgical technique of minimal exposure of the lateral mass

In Group 2, the lamina and the medial half of the lateral mass, were exposed using a cautery on a low setting (<25 mA). At this point, the lateral border of the lateral mass was felt through the insertion of remaining paraspinal muscles using a Penfield 4 dissector. The exposure of the lateral mass was further extended to expose the medial two-thirds of the lateral mass to the point where superior, inferior and medial landmarks for screw placement could be identified visually. The exposure of the lateral mass was thus limited to the medial two-thirds of the lateral mass. The paraspinous insertions on the lateral one-thirds of the lateral mass were preserved, as were the lateral aspects of facet capsule. Following the exposure, using anatomical landmarks, entry points were made with the awl utilizing the Magerl technique [11]. Pilot holes were drilled unicortically to a preset depth (generally 14–16 mm deep) depending on the size of the lateral mass as measured on the preoperative imaging. Polyaxial screws were inserted, followed by internal fixation in lordosis. A cross-link connecting these rods was generally used in cases where a laminectomy was performed. Before the insertion of the rods, the lateral mass and exposed parts of the facet capsule were decorticated in all patients. Local bone graft was utilized in all patients, frequently supplemented dorsally by demineralized bone matrix. In cases in which no laminectomy was performed, local bone graft obtained from the spinous process and/or demineralized bone matrix was utilized to facilitate the fusion. In patients with risk factors for fusion failure (smoking, noncompliant with follow-up and brace use), bone graft obtained form the posterior iliac crest was also utilized. Bone morphogenetic protein was not used for any of these patients. External bone growth stimulators were also used in high risk patients.

4. Results

There were 31 patients operated upon using the standard technique of exposure between 1999 and 2003 (Group 1). The indication of the surgery in this group of patients has been summarized in Tables 1 and 2. There were 18 males and the mean age of this group was 52 years. Laminectomy was performed in 23 patients. Follow-up was available for 24 patients and the mean follow-up time was 454 days and median follow-up time was 280 days. Of these, significant atrophy was noted in seven of them (29%). All these seven patients had their atrophy established by 6 months.