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Occipitocervical fusion: Fix to C2 or C3?

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ABSTRACT

Objective: The objective of this study was to explore the differences in clinical outcome between short-segment fixation (SSF; occiput-C2) and multi-segment fixation (MSF; occiput-C2, 3).
Methods: From January 2008 to January 2012, patients who underwent surgery for instability at the occipitocervical junction were included in the study. Two different groups of surgeons using two different management options completed the surgeries. One group performed SSF, whereas the other group performed MSF. A total of 53 patients met the criteria (33 SSF, 20 MSF). Mean follow-up was 33.9 months (range, 12–62 months). Fusion was demonstrated by plain radiographs and computed tomography imaging. Neurological status, pillow neck pain, operative time, blood loss during operation, and perioperative complications were compared between the SSF and MSF groups.
Results: The fusion rate was 97% in the SSF group and 100% in MSF the group. There was no statistically significant difference in the fusion rate between the two groups ($P > 0.05$). One patient (3%) in the SSF group and two patients (10%) in the MSF group experienced perioperative complications. Of the 25 patients who had neurological symptoms, 22 (88%) showed improvement after the operation in the SSF group and 14 (87.5%) of 16 showed improvement in MSF group. In addition, patients who suffered from pillow neck pain achieved varying degrees of improvement after the operation.
Conclusion: SSF may be the better choice for treating occipitocervical instability when no subaxial instability is present. Overall, modern instrumentation can provide the stability needed for successful clinical fusion.

1. Introduction

The occipitocervical junction is an important structure that connects the skull and cervical spine. It consists of the base of the skull or occiput and the atlas and axis vertebrae. The osseous complexes along with the integral ligamentous structure are subject to forces in eight planes. Approximately half of all cervical flexion-extension motion comes from the occiput to C1 and half of all cervical rotation depends on C1–C2 [1]. Other than the flexion and extension, the other movements that occur at the junction include bilateral lateral bending, bilateral rotation, distraction, and axial loading. Occipitocervical instability can result from various conditions including trauma, rheumatoid arthritis and other inflammatory arthropathies, congenital malformations, neoplasms, and degeneration. Instability of this region may lead to serious complications such as spinal cord and nerve root compression, respiratory distress, paresis and paralysis, or even sudden death [2–4]. Forester was the first person to perform the occipitocervical reconstruction using a fibular strut graft in 1927. Since then, fixation techniques have improved rapidly and developments have been made in surgical technique, implants and instrumentation. Today a variety of fixation implants and instruments are available including wire/rod, screw/rod, hook/rod, screw/plate, and screw rod/plate. All of these surgical techniques can provide stability for bone graft fusion [5–13]. Previously, fixation with wire-based techniques often required extended fusion segments and significantly prolonged postoperative immobilization due to insufficient construct stability. The standard technique involved extending the fusion segment to C3 or even lower. Despite the addition of an external fixation device such as a halo-vest after the operation, a high rate of non-union (more than 20% fusion failure) has been reported [14]. The ideal instrumentation will resist deforming forces in all planes especially in view of the significant

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lever arm that is created by the suboccipital bone and the cervical spine that meet each other at an acute angle of 50°.

Many previous biomechanical studies have suggested that occipitocervical instrumentation can terminate at C2, with or without the inclusion of the atlas [15,16]. Some surgeons also fix to C2 when treating occipitocervical instability. However, this may be inadequate and predispose patients to subaxial instability [17–19]. Therefore, constructs extended to include the subaxial spine are also used clinically when addressing problems at the occipitocervical junction [8,9,20]. No clear explanation is given as to which patients are treated with instrumentation only to the C2 versus C3 or lower cervical vertebra. Krauss et al. suggested that given the inconsistent ability to place optimal screws into C2, they prefer using the fairly consistent anatomy of C3 to anchor the construct [21]. Overall, there is a lack of clinical evidence regarding the levels that should be instrumented and fused. In contrast, there are many clinical studies concerning occipitocervical fixation, but most of them reported different fusion segments together. To the best of our knowledge, no clinical article comparing short-segment fixation (SSF) and multi-segment fixation (MSF) has been published in the English literature. In our study, we divided patients into two groups by the number of fixed segments. The aim of this study was to explore any differences in the fusion rates and complications between occiput-C2 fixation and occiput-C3 fixation in occipitocervical fixation.

2. Materials and methods

2.1. Patients

From January 2008 to January 2012, patients who suffered instability at the occipitocervical junction received treatment in our hospital were included in the study. Surgeons from two groups with different opinions completed the surgery; one group chose SSF (occiput-C2) and the other group preferred to MSF (occiput-C2, 3). Inclusion criteria of this retrospective study design included: (i) at least 12 months of follow-up records available; (ii) fixation segments were occiput-C2 with or without C3, the C2 fixation was done with pedicle screws, and C3 fixation was done with lateral mass screws; (iii) the instrumentation was screw rod/plate, and any case involving subaxial instability or severe osteoporosis as determined on radiographs was excluded. Fifty-eight patients met the study criteria with a minimum of 12 months of follow-up data, and five (8.6%) were subsequently lost to follow-up for various reasons and were not included in the analysis. Of these, three (8.3%) patients were in the SSF group and two (9.1%) were in the MSF group, with no statistically significant difference in the number of patients lost to follow-up between the two groups.

All patients had varying degrees of occipitocervical instability or atlantoaxial dislocation, spinal cord injury symptoms, or pain. Each patient also suffered symptoms that warranted surgical intervention. Data collected preoperatively and both immediately after operation and at follow-ups included general demographics, operative details, fusion status, perioperative complications, length of follow-up, American Spine Injury Association (ASIA) grade, and Visual Analog Scale (VAS) pain scores. In this study, patients who had subaxial instability were excluded to reduce possible influencing factors. Implants were from different manufacturers: Medtronic Sofamor Danek in 35 cases and Synthes in 18 cases.

2.2. Evaluation index and statistical methods

Follow-up evaluation was completed 3, 6, and 12 months after surgery and then once per year thereafter. Graft fusion and the stability of the internal instrumentation were observed by plain radiography and computed tomography imaging, and continuous traversing trabeculae indicated that bone fusion was achieved. X-ray and CT scans were obtained for all cases during the follow-up period, and a single blinded observer evaluated these images to evaluate fusion. Neurological status was assessed using the ASIA classification for preoperative and postoperative evaluation. Pillow neck pain was assessed using VAS scores. Perioperative complications included neurological injury, vascular injury, cerebrospinal fluid (CSF) leak, and infection.

The demographic characteristics of the two groups were compared using independent t tests to compare mean values, and the χ^2 test was used to compare proportional data. There were no statistically significant differences between the two groups in demographic characteristics (Table 1). Improvements in neurological status, operative time, blood loss during operation, and perioperative complication rates were compared between the two groups. VAS scores reported preoperatively, 3 months postoperation, and at last follow-up were compared using t tests between the different time points and between the two groups. SPSS 17.0 software was used for data entry and analysis, and a P value < 0.05 was considered statistically significant.

Table 1
General information of 53 patients and results of evaluation indexes.

	SSF group	MSF group	P
Lost to follow-up	3	2	$P > 0.05$
Mean age (years)	41.9	44.2	$P > 0.05$
Sex			$P > 0.05$
Male	20	12	
Female	13	8	
Fusion rate	97%	100%	$P > 0.05$
Perioperative complication rate	3%	10%	$P > 0.05$
Operation time (min)	174.7 ± 45.5	208.3 ± 51.5	$P < 0.05$
Blood loss (ml)	434.8 ± 197.0	529 ± 235.3	$P > 0.05$
VAS score			
Number	13	9	
1. Preoperative	4.4 ± 1.4	4.3 ± 1.6	$P > 0.05$
2. 3 months post-operation	2.2 ± 0.9	2.3 ± 1.0	$P > 0.05$
3. Last follow-up	2.1 ± 0.8	2.0 ± 0.8	$P > 0.05$
	1 and 2, $P < 0.05$	1 and 2, $P < 0.05$	
	1 and 2, $P < 0.05$	1 and 2, $P < 0.05$	
	2 and 3, $P > 0.05$	2 and 3, $P > 0.05$	

SSF, short-segment fixation; MSF, multi-segment fixation.

2.3. Operative procedures and postoperative care

All surgeries were done with patients in prone position under general anesthesia. A midline incision was made with subperiosteal exposure of the occiput and cervical spine. X-ray imaging was used to establish the correct cervical alignment. We used autologous bone grafts harvested from the posterior iliac crest in all cases. Decompression was performed in 22 (66.7%) patients in the SSF group and in 13 (65%) patients in the MSF group. There was no statistically significant difference in the decompression rate between the two groups. After the operation, patients were instructed to wear a rigid cervical collar for 3 months. Postoperative care was the same in both groups.

3. Results

Among the 53 patients included in this study, the mean length of follow-up was 33.9 months (range, 12–62 months). There were 33 patients in the SSF group, which consisted of 20 males and 13 females with an average age of 41.9 years (range, 15–72 years), and 20 patients in the MSF group, which consisted of 12 males and 8 females with an average age of 44.2 years (range, 16–66 years).