Surgical Outcome of Occipitocervical Fixation for Craniocervical Instability

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ABSTRACT

Background: The occipitocervical junction is a unique area between the cranium and the upper cervical spine. Treating pathologies of this region require a good knowledge and understanding of the anatomy, biomechanics of this region and nature of the disease.

Objective: To evaluate the efficacy of Occipitocervical Fixation (OCF) in patients with craniocervical instability in two tertiary care hospitals.

Material and Methods: This study was conducted at Combined Military Hospital Rawalpindi and Hayatabad Medical Complex, Peshawar from April 2005 to December 2016. All patients with craniocervical instability were included in our study, and those having occipital bone fractures or previously operated patients with same technique were excluded from the study. All patients were compared using lateral static and dynamic X-ray taken before the operation, after the operation, and during last follow-up. The Nurick score was used to assess neurological function pre and postoperatively. The surgical outcome evaluation also included development of complications in the postoperative phase or in follow up period. The demographic details of the patients, clinical features, radiographic findings (pre and postoperative) and clinical outcome using Nurick myelopathy grading system were noted and entered into a structured proforma. All data were entered into a SPSS Version 18 and analyzed. The results were presented in tables and pictures.

Results: A total of 49 cases with craniocervical instability underwent OCF. The mean age of the patients was 40.5 ±1.2 SD years. There were 31 male patients and 18 female patients. Majority of patients showed improvements in myelopathic symptoms after the operation. The mean preoperative Nurick score was 3.0. At the end of follow-up after surgery, the mean Nurick score was 2.1. There were total 7(14.28%) cases having complications, in which 4 (8.16%) patients had wound infection, 2 (4.08%) patients implants failure and 1(2.04%) had vertebral artery injury. However no postoperative neurological deficit was observed.

Conclusions: Occipitocervical fixation is a reasonable option to have spinal stability, achieve bone fusion and to get neurological improvement. The procedure can be complicated by certain conditions but these can safely be handled in experience hands.

Keywords: Craniocervical instability, Occipitocervical fusion, Nurick grading system.

INTRODUCTION

The occipitocervical junction Instability is well known neurosurgical condition in which there may be severe sub occipital pain or neurological symptoms and signs due to compression of the spinal cord or medulla oblongata leading to progressive functional disability¹. Surgical approach to this region is challenging due to complex bony and soft tissue anatomy. Craniocervical region instability may be congenital, traumatic, infective, degenerative or due to malignancy involving the upper cervical spine².

The craniocervical junction is extremely mobile due to the complex articulation between the occipital condyles and the atlanto-axial joints. The range of motion i.e 50% of the cervical flexion/extension, and cervical rotation, are created from the craniocervical junction. The rounded anatomical architecture of occipital condyles is responsible for sagittal movement (flexion-extension). The atlanto-axial joint complex is responsible mainly for rotatory movement. These joints are further strengthened by various ligaments³,⁴.

The aim of surgical intervention is to restore spinal alignment, decompress neural tissue and to achieve bony fusion. Various surgical procedures are in the armamentarium of spine surgeons to treat this pathology as until this date no uniformity exist in treating this pathology. One best way to treat this condition is occipitocervical fusion (OCF) in which bony fusion and instrumental fixation both are done. The purpose of OCF is to give stability to occipitocervical junction, reduce displacement, correct the deformity and do decompress neural structures. Instrumental fixation gives immediate mechanical stability, improve bony fusion rate, decrease the postoperative external immobilization requirements and rehabilitation time is also shortened¹.
Various techniques of OCF such as screw-rod, occipitocervical hook and wiring etc. are currently available, and they all have shown to have high fusion rates (89-100%)\(^3\). Screw-rod fixation allows for strong biomechanical fixation and giving immediate stability after surgery.\(^2\,\,^4\).

However like any surgical procedure certain complications may also occur during OCF which include vertebral artery injury, dural tear causing cerebrospinal fluid (CSF) leakage, and wound infection, injury to neural tissue, implants failure and failure of bony fusion\(^9\).

**MATERIAL AND METHODS**

**Study Design & Setting:**
We retrospectively reviewed a series of consecutive patients having craniocervical instability in neurosurgery department Hayatabad Medical Complex Peshawar and Spine department Combined Military Hospital Rawalpindi from April 2005 to 31 December 2016.

**Inclusion & Exclusion Criteria:**
All patients having craniocervical instability who underwent occipital cervical fusion using rod and screw construct were included in our study. Patients having occipital bone fractures or previously operated patients with same technique were excluded from this study. Lateral static and dynamic x rays were taken in all patients before the operation, after the operation and during last follow-up. Patient was followed at two weeks in outpatient department for wound complications followed further at 6, 10 week and 6 month for bony fusion and implant failure.

**Data collection and analysis:**
Patient's demographic data was recorded. Detailed clinical examination was performed. Underlying disease process causing instability was noted. Nurick grading system was used to assess neurological function pre and postoperatively (Table 1). All data were entered into a SPSS Version 18 and analyzed. The results were presented in tables and pictures.

**Surgical & Clinical Management:**
The surgery was performed with the patients' in prone position. A midline incision was given in all patients, from external occipital protubera to the desirable cervical area. After adequate exposure of the sub occipital and posterior cervical areas, occipital screws and plate and either C2 pedicle screws or C3, 4, 5 lateral mass screws were placed. Rod fixation was then preformed. Decompression was done as per need.
The patients were observed for any postoperative complications in early and late follow up period.

**Table 1. Nurick Grading System**

| Grade | Description                                      |
|-------|--------------------------------------------------|
| 0     | Root symptoms only or normal                     |
| 1     | Signs of cord compression; normal gait           |
| 2     | Gait difficulties but fully employed             |
| 3     | Gait difficulties prevent employment, walks unassisted |
| 4     | Unable to walk without assistance                |
| 5     | Wheelchair or bedbound                           |

**RESULTS**

A total of 49 cases with craniocervical instability underwent OCF. The mean age of the patients was 40.5 ± 1.2 SD years. Age distribution is shown in figure 2 and gender distribution in figure 3.

There were 31 male patients and 18 female patients with male to female ratio of 1.72 to 1.

The commonest cause of craniocervical instability was trauma which was present in 34 patients (69.39%) followed by degenerative spine disease 5 patients (10.2%). Rheumatoid Athris, Basilar invaginations, tumors, os odontoidum and tuberculosis are other causes noticed in the present study. Pic no 3,4,5,6 are some of the indications and table no 2 show the various etiologies of craniocervical patients being studied here.
Majority of patients showed improvements in myelopathy symptoms after the operation i.e. n=43(87.75%). The mean preoperative Nurick score was 3.0. At the end of follow-up (6 months) after surgery, the mean Nurick score was 2.1. Neck pain was relieved in 45 (91.83%) patients after bony fusion. Various clinical presentations are given in the table no 2.

### Table No.3: Clinical Presentation

| S. No | Presentation                  | No  | Percentage |
|-------|-------------------------------|-----|------------|
| 1     | Preoperative Neck pain        | 42  | 85.7%      |
| 2     | Cranial nerve deficits        | 10  | 20.4%      |
| 3     | Motor problems                |     |            |
|       | Unstable gait                 | 40  | 81.6%      |
|       | Cranial nerve deficits        | 10  | 20.4%      |
|       | Shoulder drop                 | 4   | 8.2%       |
|       | Sphincters                    | 3   | 6.1%       |
| 4     | Parasthesias                  | 16  | 32.65%     |

### Surgical complications:
Various complications occurred in 7(14.28%) cases, 4 (8.16%) patients had wound infection, 2 (4.08%) patients suffered implants failure and 1(2.04%) had vertebral artery injury. However no postoperative neurological deficit was observed.pic no 7 and 8 are showing some of the complications.
DISCUSSION

Foerster in 1927 was the first person who reported OCF. He used nasal bone as graft. A great deal of modification took place since then in term of implants use and graft source\(^\text{10}\).

Various etiological factors cause craniocervical instability through various mechanisms. Os odontoideum results in the formation of a separate bone structure due to abnormal fusion between the odontoid process of the second cervical vertebra and the body. In the absence of a united odontoid process, the atlanto axial movements appear to be supported only by ligaments, resulting in atlantoaxial instability\(^\text{11}\). According to some authors, in minimally symptomatic or asymptomatic patients with Os odontoideum without C1-2 instability, good treatment outcomes can be obtained using conservative management without surgical treatment\(^\text{12,15}\). Rheumatoid arthritis of the cervical spine leads to a spectrum of joint erosions and deformity resulting in spinal instability\(^\text{16,19}\). Atlanto-occipital dislocation is another indication for OCF because it can lead to death without treatment\(^\text{1,20}\).

Craniovertebral tuberculosis may lead to Atlanto axial dislocation or bone destruction and granulation which may require anterior decompression and posterior fusion\(^\text{21,22}\). Occipitocervical fixation has been done in all our study population with or without decompression. Improvement in the myelopathy symptoms can be seen in most of the patients enrolled in the study population. Majority of patients show improvement in myelopathy symptoms after the operation i.e. \(n=43\) (87.75\%). The mean preoperative Nurick score is 3.0. At the end of follow-up after surgery, the mean Nurick score is 2.1. Neck pain subsided in 45 (91.83\%) patients after bony fusion in our study. Choi SH\(^\text{8}\) reported in his research improvements in myelopathy symptoms in 68.8\% (11/16) of the subjects using the Nurick score, and sensory symptoms was reduced by 78-95\% in patients who showed bone fusion\(^\text{4,6,23}\).

This surgical procedure to produce bony fusion and to achieve good functional outcome can be complicated by infection (superficial and deep), dural tear, CSF leakage, screw failure, vascular injury and failure to relieve patient symptoms\(^\text{3,4,6}\). Wound infection in posterior spinal surgery has been relatively more common than anterior cervical surgery. In the present study 4 (8.16\%) patients suffered wound infection. We treated all these patients conservatively and no revision was required in any of these cases. We noticed that three out of these 4 patients were previously operated for the same instability in a different way but due to failure of treatment, we reoperated them. But the scared skin in occipital region has been a weak protection against infection.

A study by Choi SH\(^\text{8}\) reported 13.3\% (2/16) infection in their study. In some other studies wound infection was 11\% (1/9) and 3.8\% (1/26)\(^\text{23}\). In both these studies, they treated infection with antibiotics without the removal of implants.
We see implants failure in two 2 (4.08%) patients. This was probably due to scanty amount of graft placement. In literature review we observe implants failure in various frequencies e.g. it was 7% (1/16) in one study4 and 4.2% (1/24)3 in another study. Choi SH2 reported screw failure in 12.5% (2/16) of the subjects and screw loosening in 6.3% (1/16). Thickness of screw purchase has got significant role in occipital screw pull out strength. Likewise pull out strength of a bicortical screw purchase is 50% more than unicortical screw purchase25.

Vertebral artery injury while passing C2 pedicle screw or C1C2 trans articular screw fixation is well recognised complication and various authors have reported various ranges. In our study 1(2.04%) patient had vertebral artery injury which we came across while dissection around CV2. We controlled it with pressure and did not proceed with pedicle screw on this side. Subsequent angiogram revealed no issue with vertebral artery anatomy. The incidence of vertebral artery injury was 6.3% in Choi SH2 report which is slightly higher than our incidence but their study population as compared to ours is less. True incidence requires larger studies with big cohorts. We did not find any persistent CSF leak after surgery in our study though literature has quoted it in range of 25-28% 1, 3 in some studies.

Theoretically atlantoaxial fixation provides greater freedom regarding range of motion by preserving the occipital condyles and C1 joint with resultant less disability. Our study did not show any significant difference in range of motion after OCF25.

The craniocervical instability is a treatable surgical entity but the best type of surgery largely depends on the instability type, the status of posterior cervical elements, the amount of decompression, general condition of the patient, anatomical variation and the surgeon's experience with particular approach.

Our study is having a limited number of patients and to arrive at best surgical treatment large studies are needed to recommend any specific surgical approach for any specific disorder of craniocervical junction causing instability and neurological complications.

CONCLUSION
Occipitocervical fusion is a reasonable option to have stability, achieve bony fusion, and decompress neural tissues and to achieve a good functional outcome. Most of the complications can be managed safely in experience hands.

DECLARATION
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper. The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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AUTHOR’S CONTRIBUTION
The following authors fulfill authorship criteria as per ICMJE guidelines:

Rehman RU, Qureshi MA: Idea conception, drafting the work, final approval, agreed to be accountable for all the work.

Khalique AB, Afzal MW: Design of the work, data acquisition, critical revision, final approval, agreed to be accountable for all the work.

Talha M, Ismail SJ: Data analysis, drafting of the work, final approval, agreed to be accountable for all the work.

Ihsanullah: Data interpretation, critical revision, final approval, agreed to be accountable for all the work.