Occipitocervical fusion

see Occipitocervical junction

Overview, Indications, Techniques, and Considerations

Introduction Occipitocervical fusion (OCF) is a surgical procedure performed to stabilize the junction between the occiput (base of the skull) and the upper cervical spine (C1-C2 and sometimes extending to lower cervical levels). It is typically indicated for instability due to trauma, congenital abnormalities, tumors, infections, or degenerative diseases affecting the craniovertebral junction.

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Indications 1. **Trauma**: Atlanto-occipital dislocation, Jefferson fractures (C1 burst fractures), Hangman fractures (C2 traumatic spondylolisthesis). 2. **Congenital Malformations**: Chiari malformation with basilar invagination, Klippel-Feil syndrome, os odontoideum. 3. **Inflammatory and Degenerative Diseases**: Rheumatoid arthritis (atlantoaxial instability), basilar invagination. 4. **Neoplastic Conditions**: Tumors affecting the craniocervical junction, metastatic lesions. 5. **Infections**: Tuberculosis, osteomyelitis, or septic conditions leading to instability. 6. **Post-Surgical or Iatrogenic Causes**: Previous decompressive surgeries requiring stabilization.

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Surgical Techniques ##### **1. Preoperative Planning** - **Imaging**: CT scan (bone

anatomy, screw trajectory), MRI (cord compression, soft tissue involvement), dynamic X-rays (instability assessment). - **Neuromonitoring**: Intraoperative SSEPs (somatosensory evoked potentials) and MEPs (motor evoked potentials) to minimize neural injury. - **Hardware Selection**: Occipital plates, rods, screws in the occiput, C1 lateral mass screws, C2 pedicle screws, C3-C4 extensions if needed.

2. Patient Positioning - **Prone position** on a radiolucent table. - **Head fixation** using Mayfield head holder or Halo vest (if instability is severe).

3. Surgical Approach - **Midline posterior approach** with dissection to expose the occiput, C1, and C2. - **Careful preservation of vertebral artery** during exposure of C1-C2. - **Occipital plate fixation** anchored with screws to the skull base. - **C1 lateral mass and C2 pedicle screws** are inserted. - **Rod placement and locking** to achieve rigid fixation. - **Bone grafting** (autograft, allograft, or BMP) to promote fusion.

4. Postoperative Considerations - **Immobilization**: Hard cervical collar or Halo vest for added stability. - **Complication Monitoring**: Neurological deficits, wound infection, vertebral artery injury, dysphagia. - **Long-term Follow-up**: Fusion assessment via radiographs or CT scan.

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Complications 1. **Neurological Injury**: Spinal cord or nerve root compression. 2. **Vertebral Artery Injury**: Risk during C1-C2 screw placement. 3. **Hardware Failure**: Loosening or breakage. 4. **Nonunion or Pseudarthrosis**: Incomplete fusion requiring revision. 5. **Dysphagia and Speech Difficulties**: Due to rigid fixation reducing neck mobility. 6. **Infection**: Postoperative wound complications.

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Conclusion Occipito-cervical fusion is a life-saving and function-preserving procedure for patients with craniocervical instability. Proper patient selection, meticulous surgical planning, and adherence to biomechanical principles are essential for a successful outcome. Advances in instrumentation and neuromonitoring have significantly improved surgical safety and patient prognosis.

Would you like me to refine this further for a specific purpose, such as a presentation or research paper?

Systems

Ascent

Avalon

Baumer

Centurion

ELLIPSE

Lineum

Quartex

S4 Cervical system Posterior Occipital Cervical Thoracic Fixation System

Synthes Occipito-Cervical Fusion System

Virage

Stoffel M, Behr M, Ringel F, Stuer C, Meyer B. Posterior instrumentation of the cervical spine with a versatile modular fixation system. Zentralbl Neurochir. 2007 May;68(2):50-8. doi: 10.1055/s-2007-980171. PMID: 17614084.

Fagerström T, Hedlund R. Cotrel Dubousset instrumentation in occipito-cervico-thoracic fusion. Eur Spine J. 2002 Aug;11(4):364-74. doi: 10.1007/s00586-002-0392-z. Epub 2002 Apr 27. PMID: 12193999; PMCID: PMC3610479.

History

Foerster firstly proposed the occipitocervical fusion with free vascularized fibular grafting in 1927 [1].

After then, many different kinds of posterior occipitocervical fusion and fixation techniques have been reported. Occipitocervical bone grafting with additional sublaminar wiring may be more stable than single bone grafting. However, the patient still need bed rest for 12 weeks. Spinal cord injury and rotational instability often occurred in those patients [2].

Ransford described a novel technique in 1986. An anatomically contoured steel loop was secured to the occiput via small burr holes and to the vertebrae by sublaminar wiring. It afforded a rigid stabilization. The patient could mobilise with a cervical collar or cervicodorsal brace only [3].

In early 1990s, occipitocervical plate had been applied, and then screw-rod system. In 2000, universal vertebral pedicle screw has been widely used. The posterior occipitocervical fixation could provide more stable fixation, which is relatively easier to perform and less risky [4] [5].

Indications

Occipitocervical fusion can be necessary in case of cranio-cervical junction instability resulting from trauma, rheumatoid arthritis, tumors and congenital anomalies of the craniocervical junction. Accurate imaging studies and proper patient selection are the keys to a successful outcome. Occipitocervical fusion procedures can be performed with low morbidity. A comprehensive knowledge of the anatomy of the occipital-cervical junction is imperative. A wide variety of stabilization techniques and instrumentation systems are currently available, each of which has its own advantages and disadvantages

Types

Occipitocervical fusion in pediatric patient.

Technique

Posterior Instrumentation for Occipitocervical Fusion Technique.

Complications

Occipitocervical fusion Complications.

Case series

2016

The study population consisted of 20 boys and 20 girls, with a mean age of 7.3 years. Trauma (45% [n = 18]) was the most common cause of instability, followed by congenital etiologies (37.5% [n = 15]). The condyle-C1 interval had a diagnostic sensitivity of 100% for atlantooccipital dislocation. The median number of fixated segments was 5 (occiput-C4). Structural bone grafts were used in all patients. Postsurgical neurological improvement was seen in 88.2% (15/17) of patients with chronic myelopathy and in 25% (1/4) of patients with acute myelopathy. Preoperatively, 42.5% (17/40) of patients were neurologically intact and remained unchanged at last follow-up, 42.5% (17/40) had neurological improvement, 12.5% (5/40) remained unchanged, and 2.5% (1/40) deteriorated. All patients had successful fusion at 1-year follow-up. The complication rate was 7.5% (3/40), including 1 case of vertebral artery injury.

Occipitocervical fixation is safe in children and provides immediate immobilization, with excellent survival and arthrodesis rates. Of the radiographic tools evaluated, the condyle-C1 interval was the most predictive of atlantooccipital dislocation [6)].

2010

799 adult patients who underwent posterior occipitocervical fusion were analyzed for radiographic and clinical outcomes including fusion rate, time to fusion, neurological outcomes, and the rate of adverse events.

No articles stronger than Class IV were identified in the literature. Among the patients identified within the cited articles, the use of posterior screw/rod instrumentation constructs were associated with a lower rate of postoperative adverse events (33.33%) ($p < 0.0001$), lower rates of instrumentation failure (7.89%) ($p < 0.0001$), and improved neurological outcomes (81.58%) ($p < 0.0001$) when compared with posterior wiring/rod, screw/plate, and onlay in situ bone grafting techniques.

The surgical technique associated with the highest fusion rate was posterior wiring and rods (95.9%) ($p = 0.0484$), which also demonstrated the shortest fusion time ($p < 0.0064$). Screw/rod techniques also had a high fusion rate, fusing in 93.02% of cases. When comparing outcomes of surgical techniques depending on the disease status, inflammatory diseases had the lowest rate of instrumentation failure (0%) and the highest rate of neurological improvement (90.91%) following the use of screw/rod techniques.

Occipitocervical fusion performed for the treatment of tumors by using screw/rod techniques had the lowest fusion rate (57.14%) ($p = 0.0089$). Traumatic causes of occipitocervical instability had the highest percentage of pain improvement with the use of screw/plates (100% improvement) ($p < 0.0001$).

Based on the existing literature, techniques that use screw/rod constructs in occipitocervical fusion are associated with very favorable outcomes in all categories assessed for all disease processes. For patients requiring occipitocervical arthrodesis for the treatment of inflammatory diseases, screw/rod constructs are associated with the most favorable outcomes, while posterior wiring and onlay in situ bone grafting is associated with the least favorable outcomes. Occipitocervical arthrodesis performed for the diagnosis of tumor is associated with the lowest rate of successful arthrodesis using screw/rod techniques, while posterior wiring and rods have the highest rate of arthrodesis. The nonspecified disease group had the lowest rate of surgical adverse events and the highest rate of neurological improvement [7)].

Case reports

Occipitocervical fusion case reports.

1)
Foerster O: Die Leitungsbahnen des Schmerzgefühls und die chirurgische Behandlung der Schmerzzustände. 1927, Berlin: Urban & Schwarzenburg

2)
Garrido BJ, Sasso RC: Occipitocervical fusion. Orthop Clin North Am. 2012, 43 (1): 1-9. 10.1016/j.ocl.2011.08.009.

3)
Ransford AO, Crockard HA, Pozo JL, Thomas NP, Nelson IW: Craniocervical instability treated by contoured loop fixation. J Bone Joint Surg Br. 1986, 68: 173-177.

4)
Lee YP, Robertson C, Mahar A, Kuper M, Lee DS, Regev GJ, Garfin SR: Biomechanical evaluation of transfacet screw fixation for stabilization of multilevel cervical corpectomies. J Spinal Disord Tech. 2011, 24 (4): 258-263. 10.1097/BSD.0b013e3181eebb26.

5)
Choi SH, Lee SG, Park CW, Kim WK, Yoo CJ, Son S: Surgical outcomes and complications after occipito-cervical fusion using the screw-rod system in craniocervical instability. J Kor Neurosurg Soc. 2013, 53 (4): 223-227. 10.3340/jkns.2013.53.4.223.

6)
Martinez-Del-Campo E, Turner JD, Rangel-Castilla L, Soriano-Baron H, Kalb S, Theodore N. Pediatric occipitocervical fixation: radiographic criteria, surgical technique, and clinical outcomes based on experience of a single surgeon. J Neurosurg Pediatr. 2016 Oct;18(4):452-462. PubMed PMID: 27286444.

7)
Winegar CD, Lawrence JP, Friel BC, Fernandez C, Hong J, Maltenfort M, Anderson PA, Vaccaro AR. A systematic review of occipital cervical fusion: techniques and outcomes. J Neurosurg Spine. 2010 Jul;13(1):5-16. doi: 10.3171/2010.3.SPINE08143. Review. PubMed PMID: 20594011.