

## CASE REPORT



# Head slippage following displacement of a Mayfield head clamp leading to a unique complication of laryngeal edema in an intubated patient: case report

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## Abstract

**Introduction:** The Mayfield head clamp (MHC) is a three-pin skull clamp that allows excellent cranial stabilization during head and neck surgery and is the most frequently used head clamp in neurosurgery. In many cases, surgery is performed with complete reliance on the safety of the MHC. However, potentially serious or life-threatening complications, such as scalp lacerations, depressed skull fractures, venous emboli, or extradural hematoma can rarely occur.

We describe a case in which the MHC displaced downwards due to sudden loss of grip during postoperative removal with a brief review of the literature.

**Case report:** The patient was a 60-year-old male who was scheduled to undergo tumor resection of a recurrent bilateral parasagittal parafalcine meningioma via a bicoronal approach. While removing the MHC, the lower screw stabilizing the arm of the MHC system displaced downwards (when force was applied from both directions) leading to an extension of flexed neck along with jerking of the cervical spine despite hand stabilization of the head in an intubated patient with slight upward displacement of a tightly fixed endotracheal tube.

**Conclusion:** We emphasize the importance of properly managing and maintaining instruments to prevent fatal injury.

**Keywords:** Mayfield head clamp; neurosurgery; complication; laryngeal injury

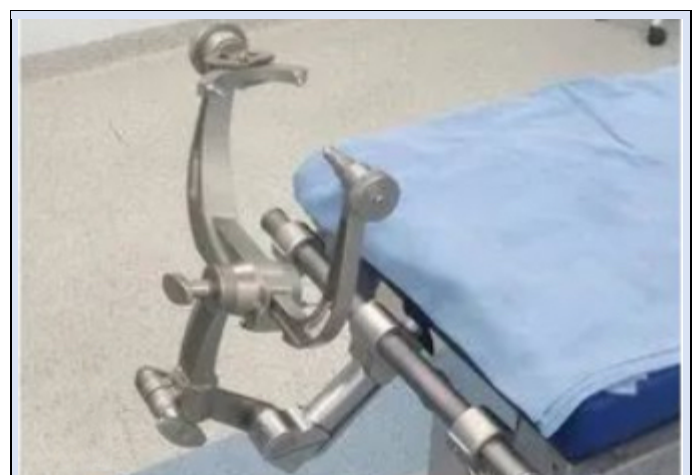
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## Introduction

The Mayfield head clamp (MHC) (MAYFIELD™, Ohwa Tsusho Co., Ltd., Tokyo, Japan) and (Ohio Medical Instrument Co., Cincinnati, Ohio) (**Figure 1**) is the most frequently used head clamp system in the field of neurosurgery. In many cases, surgery is performed with complete reliance on the safety of the MHC<sup>1</sup>.

However, we experienced an extremely rare case in which the MHC accidentally displaced downwards due to loss of screw grip of this MHC, leading to displacement of the endotracheal tube (ETT) during postoperative removal.

Upward pulling of an externally fixed cuffed ETT secondary to uncontrolled hyperextension of the head might have resulted in larynx mucosa injury.



**Figure 1.** Mayfield head clamp apparatus.

## Case report

The patient was a 60-year-old male who underwent a scheduled resection of a recurrent bilateral parafalcine meningioma via a bicoronal approach.

While removing the three fixed pins of the MHC, the lower screw stabilizing the arm of the MHC system displaced downwards when force was applied from both directions. Fortunately, the patient remained in a stable position and did not sustain an injury to the head or neck. The patient was extubated following removal of the MHC at the conclusion of surgery.

The patient was admitted to the intensive care unit (ICU) shortly after extubation and weaning of general anesthesia. However, the patient developed hoarseness and stridor after arrival in the ICU. After a detailed assessment by the anesthesia team, a plan for reintubation via endotracheal tube with subsequent flexible bronchoscopy was pursued.

During reintubation, marked laryngeal edema was noted with a slight contusion over vocal cords (**Figure 2**).



**Figure 2.** Laryngeal edema with vocal cord injury..

The patient was sedated, and 12 hours following reintubation, developed marked submandibular and supraclavicular emphysema more prominent on the right (**Figure 3**).

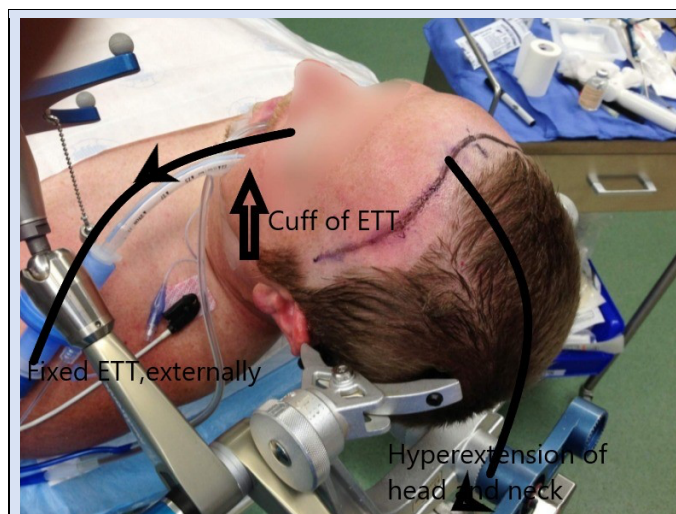


**Figure 3.** Submandibular and supraclavicular emphysema

To decrease swelling, systemic corticosteroid therapy was started along with nebulization. The chest surgery team was consulted. Chest and lung imaging was performed on an emergency basis. No tracheobronchial injury was found. The patient was weaned off the ETT over the course of the next 3 days with subsequent improvement in subcutaneous emphysema. The author experienced an extremely rare case of MHC slippage during removal and emphasizes the importance of properly managing and maintaining the instruments in order to prevent fatal injury.

## Discussion

According to the Ohio Medical Instrument Co., the MHC base unit is of a marine grade and highly suited for use in a saline environment<sup>2,3</sup>. The material specifications call for a shear strength of 27,000 pounds per square inch (psi) and a modulus of elasticity of 10.3 million psi. This material is used for when products are placed under sustained loads without the use of torque wrenches to control load forces. However, as described above, although this material is designed for excellent weight bearing and durability, screw locking and unlocking may be unpredictable due factors such surgical environment, material changes over prolonged usage, and length of surgical procedures. Pressure bearings and slight increase of force may result in exponential response of system, as in our case. MHC may be subject to damaging forces due to overuse, particularly in low- and middle-income countries. Screw fatigue exhaustion often results from overuse coupled with a lack of maintenance services. **Figure 1** presents arrows indicated where the sudden loss of screw grip of the instrument occurred during the attempt to remove the MHC at the conclusion of surgery. **Figure 4** demonstrates a speculated line along which downward displacement of the patient's head occurred due to the weight of the patient's head and the force of gravity. Additionally, the externally fixed ETT was in a relatively insecure position while removing the MHC apparatus and suddenly gave way as the patient's neck pulled on it<sup>4,5</sup>.



**Figure 4.** Possible mechanism of injury. ETT - endotracheal tube.

Laryngeal injury was likely due to the normal larynx on preoperative assessment with no documented complications reported by the anesthesia team due to cuff inflation and the lack of subcutaneous emphysema preoperatively. Upon extubation, the patient developed immediate respiratory distress, which ultimately required intubation. Laryngeal edema and a small hematoma were visualized. A total of 12 hours after reintubation, the patient developed subcutaneous emphysema. In the light of witnessing screw grip of the MHC, we searched for and found additional articles reporting ETT displacement related larynx mucosal injuries<sup>6</sup>.

During surgery, neurosurgeons rely completely on the safety of the MHC. Without it, the patient's head would not be stabilized. Since this apparatus can cause fatal injury if it breaks during neck or brain surgery, surgeons must fix three MHC pins accurately and with proper pressure<sup>7</sup>. Moreover, surgeons repeatedly confirm immobilization of the connection parts prior to surgery and intraoperatively. It is very important to examine the apparatus thoroughly before each use to prevent unnecessary complications.

The MHC that slipped and displaced was the more commonly used of the two MHCs owned by the hospital. The author had been assisting in surgeries using this MHC for the past 3 years in approximately 500 surgeries.

Only the pins are subjected to sterilization, and the remainder of the device is cleaned but not sterilized. The MHC was always stored in a designated place determined by the operating theater staff.

When the clamp was removed, a downward force was applied, leading to a loss of neck flexion with sudden loss of control due to loosening of lower arm screw. The cervical spine jerked despite head stabilization, leading to an upward displacement of the ETT. The underlying mechanism was probably fatigue related displacement of the screw after slippage.

In a previous report, Taira et al. reported a case in which the MHC broke<sup>3</sup>. The patient's head fell suddenly to the level of the surgeon's knee when operating on a cerebral aneurysm under a microscope, and with povidone-iodine solution was found inside. Chovanes sent a letter to Taira et al. highlighting the importance of carefully inspecting the MHC before every operation as he found signs of imminent break upon reading their paper and inspecting the equipment, he used<sup>1</sup>.

Another case reported by Lee et al. described an accidental breakage of the MHC acute angle arm while installing this system for immobilization of the head and neck<sup>7</sup>.

The three clinical cases of MHC breakage, including our case, are summarized in **Table 1**.

**Table 1.** Summary of reported Mayfield head clamp malfunctions.

| Author, Year           | Age/Sex | Procedure             | Event time                      | Problem site           | Use period             | Broken part replacement      | Result           |
|------------------------|---------|-----------------------|---------------------------------|------------------------|------------------------|------------------------------|------------------|
| Taira & Tanikawa, 1992 | 68/F    | Aneurysm clipping     | During operation                | Arm joint broken       | 8 years (>1200 uses)   | Unknown                      | Uneventful       |
| Lee et al., 2009       | 58/F    | Cervical laminoplasty | During preoperative preparation | Acute angle arm broken | 10 years (>1000 times) | Other head clamp replacement | Uneventful       |
| Fatima, 2023           | 60/M    | Meningioma resection  | During removal                  | Lower screw displaced  | 3 years (>500 uses)    | N/A                          | Laryngeal injury |

The cases in question occurred most likely due to the fatigue of the equipment. However, the majority of complications occurring in relation to the use of MHC are due skull fractures with or without epidural hematoma, occurring due to the limitless force applied when applying the MHC<sup>8</sup>.

Thiys and Menovsky suggested that the skull clamp application requires proper attention to several details and provided a checklist to be used. They also emphasized the role of supervision of an experienced neurosurgeon and the application of the MHC on synthetic or cadaver skulls as an easy and efficient way to practice and understand proper pinning for different cranial approaches<sup>8</sup>.

Surgeons and nurses must carefully handle all tools used during surgery to prevent tool-related problems. Damaged and malfunctioning tools should not be used and can lead to surgical failure and intra- and postoperative complications. Safety is of utmost importance when using position fixation instruments<sup>2</sup>. Thus, following operating instructions provided by the manufacturer must be followed during surgery.

The first step in preventing fatal injury is to apply and remove the instrument in the correct position with protection from impact and physical damage. Screws should be regularly checked to detect fatigue failure of the MHC. Also, all cleaning and sterilization procedures should be performed in accordance with the operating instructions provided by the manufacturer.

The surgeon should examine the apparatus thoroughly before each use. Finally, instruments should be subjected to regularly scheduled maintenance by the manufacturer through a separate contract when purchasing the MHC. However, most buyers ignore this aspect in an effort to reduce costs.

## Conclusions

Proper management and maintenance of all instruments, and especially those severely relied upon is of utmost importance to prevent potential injury.

## Disclosures

**Conflict of Interest:** All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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