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TECHNICAL NOTES

A novel method for safe and accurate placement of the rocker pins of head immobilization devices utilizing a digital caliber phantom: technical note

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Abstract

Background Immobilization of the head and skull by head immobilization devices (HIDs) is a common practice in neurosurgery. A variety of complications and morbidities are associated with pinning the skull during application of HIDs.

Objective Our aim is to describe a new technique that avoids repeated puncturing of the head and skull during application of HIDs and hence avoiding the potential complications resulting from multiple re-adjustments.

Methods We used a pre-adjusted digital millimetric caliber (DMC) as a phantom for the two rocker pins of the HID to mimic and simulate the process of skull pinning. Localization and preparation of the accurate skull pinning sites are safely guided by the pinning phantom.

Results The technique was applied in different neurosurgical approaches. The pinning phantom was utilized to accurately locate the suitable pinning sites. Contrary to the common practice, there was no need for repeated head and skull puncturing. Minimal manipulations of the head and neck are exerted in this approach as compared with the usual techniques. The head of the patient is allowed to be kept safe on the operating table until the final one-time confident skull pinning by the sterilized skull clamp pins.

Conclusion The process of scalp and skull pinning of HIDs is technically demanding. The DMC utilized as a pinning phantom is a useful technique which provides safe and confident application of the skull rocker pins of HIDs allowing the neurosurgeon to avoid multiple puncturing of scalp and skull and minimizing manipulations of the head and cervical spine.

Keywords Head immobilization devices · Skull clamp · Mayfield holder · Skull pinning · Head clamp

Introduction

Immobilization of the head and skull by head immobilization devices (HIDs) is a common practice in neurosurgery. A wide variety of cranial and spinal surgeries require head immobilization as a necessary step of these procedures [1–4].

There are many types of HIDs available in the market. One of the most commonly used types nowadays is the one based on skull pinning for obtaining rigid immobilization [4–6].

These devices usually require pinning the skull with three to four pins; either two rocker pins on opposite sides or two rocker pins on one side and a single pin on the opposite side of the skull.

A variety of complications and morbidities are associated with skull pinning during the application of HIDs [2–13].

Despite the relatively scarce reports of complications of HIDs, the Food and Drug Administration (FDA) in February 2016 declared in a safety communication that more than 1000 incidences were reported to result in more than 700 injuries. This denotes that it is an under-reported problem which needs light to be shed upon [14].

There are no clear guidelines for skull pinning techniques. It is a matter of transferred experiences. Moreover, even in the most skilled hands, the targeted location of where to insert the skull pins is frequently re-adjusted during application of HIDs [4, 6, 15–18].

Our aim is to describe a new technique that enables the neurosurgeon to avoid repeated head and skull puncturing and unnecessary cervical spine manipulations and hence avoiding the potential complications resulting from multiple re-adjustments. This provides an accurate, confident, and safe skull pinning.

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Methods and technique

The authors utilized a digital millimetric caliber (DMC) provided with two pin-like feet indicators which simulate the two rocker pins of the HID. The DMC is provided with a millimetric digital display screen. The distance between the 2 feet indicators of the DMC is accurately pre-adjusted to match the exact distance between the two rocker pins of the HID utilized by the neurosurgeon, hence constituting an exact pinning phantom for the rocker pins (Fig. 1).

The technique was applied in different neurosurgical approaches including those in prone position to allow pinning the skull only once with the sterilized pins of the HID while providing accuracy and safety.

The patient is positioned supine under anesthesia. After induction of anesthesia, the pre-adjusted skull rocker pins phantom is utilized to estimate the appropriate skull pinning sites considering relevant factors such as the intended surgical approach, HID orientation, head tilt, cervical spine, thin bones, craniometric points, and pre-existing shunt buttons, connectors, and tubings.

Upon determination of the safest and suitable skull pinning sites (Fig. 2a), the scalp is marked over these sites by a permanent marker followed by a minimal shaving. Local anesthesia or scalp block is then applied by the neuro-anesthetist in the chosen scalp pinning sites. Until this step, the head of the patient is still safely placed over the operating table.

Finally, the patient is partially moved out of the edges of the operating table and the head is safely held by the assistant thus allowing the surgeon to confidently apply the sterilized skull clamp once in the pre-marked scalp pinning sites (Fig. 2b). The opposite single pin is then placed accordingly.

For surgical approaches requiring prone position, planning of estimated pinning sites is performed while the patient is still in supine position with the head still safe on the operating table in simulated neck flexion.

This technique helps the neurosurgeon apply the sterilized pins of the HID only once, thus avoiding the potential complications of repeated pinning. The DMC phantom was found especially useful in pediatric patients and in approaches requiring prone position.

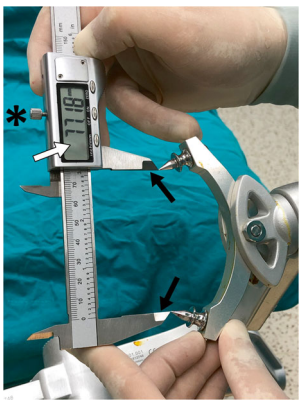

Fig. 1 The digital caliber is adjusted to the exact distance between the rocker pins and secured permanently by the locking screw of the caliber. White arrow indicates the digital millimetric display screen. Black arrows indicate the two pin-like feet of the caliber. The asterisk denotes the locking screw

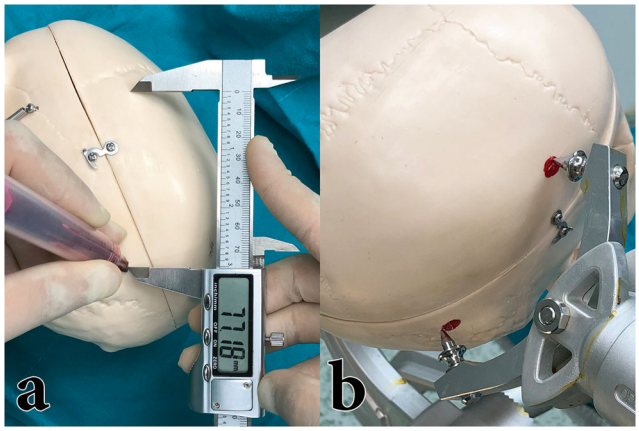

Fig. 2 The digital caliber phantom is used to estimate the appropriate skull pinning sites on a skull model. **a** The pinning sites are marked by permanent marker. **b** The rocker pins of HID are confidently applied to the pre-determined pinning sites

Discussion

There are no evidence-based guidelines or consensus on the application of HIDs or skull pinning [15–18].

Many reports described serious morbidities associated with skull pinning such as epidural bleeding, pneumocephaly, skull fractures, air embolism, hardware breakage, and asystole. [2–13].

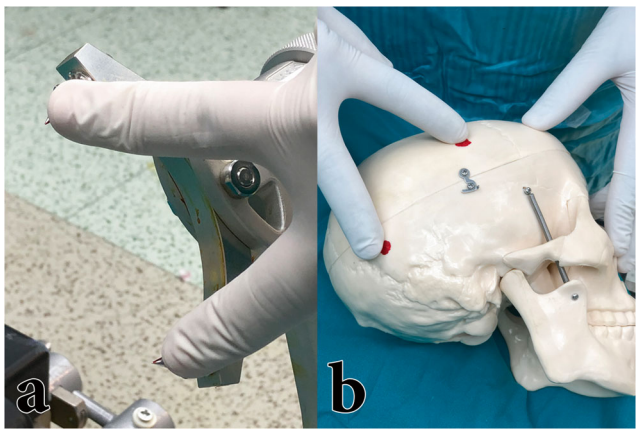

Fig. 3 The "victory sign" technique. **a** The distance between the tips of middle and index fingers of the victory sign of the neurosurgeon is nearly equivalent to the distance between the two rocker pins of the HID. **b** The tips of the surgeon's victory sign are used to pre-determine the estimated pinning sites

Many factors are to be considered during choosing the pinning sites for HIDs. These include the orientation of the HID, surgical approach intended, gravity forces, and relevant craniometric points. Also, previous craniotomy flaps, burr-holes, shunt devices, tubings, and thin skull bones should be respected [18–20].

Not infrequently, the neurosurgeon initially pins the skull in inappropriate pinning sites to subsequently discover the necessity of readjusting the location of one or more of the pins. This results in multiple punctures of the scalp and the skull with subsequent potentially serious hazards for the patient.

To avoid faults related to inappropriate pinning sites, we utilized a pre-adjusted digital pinning phantom to enable pre-hand determination of appropriate scalp and skull pinning sites with head and cervical spine safely positioned on the operating table. This avoids repeated punctures of the scalp and skull and avoids prolonged handling and manipulation of the head and neck outside the edges of the operating table.

Another merit of the DMC is its applicability to any type of HID rocker pins because the 2 ft-like pins of the DMC are adjustable in a millimetric fashion thus aiding exact simulation of the shape and distance between the two rocker pins.

The concept of utilizing a phantom of a medical device or a part of a medical device is not unprecedented in the history of operative neurosurgery. For example, the grid phantom is a part of the routine setup of some intraoperative MRI machines. We recently described "the victory sign" technique in order to help estimate the proper skull pinning sites (Fig. 3). But due to inherent anthropometric variations related to this technique, we developed the pinning phantom to overcome these variations [18].

Conclusion

The process of scalp and skull pinning of head immobilizing devices is technically demanding. The digital millimetric caliber utilized as a pinning phantom is a useful technique which provides safe and confident application of the skull rocker pins of HIDs allowing the neurosurgeon to avoid multiple puncturing of scalp and skull and minimizing manipulation of the head and cervical spine.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest in personal, financial, institutional or industry affiliations in any of the drugs, materials, or devices described in this article. The authors have no conflicts that may affect ethical adherence.

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