

### 【論文紹介】

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- ・「Head Fixation Using a Vac-Loc cushion during Neuroendovascular Therapy」  
（Vac-Loc クッションを用いた脳神経血管内治療時における頭部固定の検討）

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# Head Fixation Using a Vac-Lok Cushion during Neuroendovascular Therapy

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**Objective:** Vac-Lok cushions are widely used in the field of radiation therapy to fix a body in place. We introduced this device during neuroendovascular therapy and evaluated its utility in comparison with a conventional device.

**Methods:** We conducted questionnaire surveys regarding post-procedural headache among patients and regarding advantages and disadvantages of the new fixation device among radiation technologists and neurosurgeons. We measured the contact pressures of volunteers' heads to compare stress on the head between the two devices.

**Results:** Contact pressure significantly decreased using the new device. Furthermore, complaints regarding post-procedural headache sharply declined after introducing the new device. The new device also reduces respiratory motion artifacts and allows the head to be positioned at any angle we want.

**Conclusion:** The Vac-Lok cushion is extremely useful for fixing the head in place during neuroendovascular therapy.

**Keywords** ► neuroendovascular surgery, working angle, 3D, Vac-Lok

## Introduction

Recently, endovascular therapy of the head and neck region has been increasingly performed nationwide due to improvements in the angiographic system and various devices. Indications of endovascular therapy have been expanded to lesions that used to be difficult to treat with improvements in the devices, but the procedure has become more complicated, and patients in whom the treatment time is prolonged also appear to be increasing. In a multicenter study conducted in Japan, the mean treatment time was 172.6 min for cerebral aneurysms, 179.2 min for cerebral arteriovenous malformation, 309.2 min for cavernous sinus dural arteriovenous fistulas, 291.1 min for other dural arteriovenous fistulas, and 190 min for all diseases combined. The treatment has been reported to require an average of more than 3 h.<sup>1)</sup>

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At our facility, the angiographic system was updated to SIEMENS Artiszee BA Twin (Siemens, Munich, Germany) in February 2012. Conventionally, the fixation device accompanying the angiographic system (conventional fixation device) was used for head fixation during endovascular therapy under general anesthesia. However, the patients often complained of pain and fatigue around the head after the procedure. In 37 consecutive patients treated with the conventional fixation device, three complained of pain and fatigue around the head after the procedure. While none of the patients developed grade II or severer pressure ulcer after the procedure, a few patients exhibited reddening of the head judged to be grade I pressure ulcer. Also, the head position was adjusted to set the working angle and fixed, but there were restrictions when the head was fixed in a laterally rotated position, and many patients showed marked artifact due to respiratory motion during the procedure.

To solve these problems, we began to use Vac-Lok cushion (CIVCO Medical Solution, Kalona, IA, USA) (new fixation device) since December 2014. In this study, we evaluated pain after the procedure using the new fixation device, compared the head contact pressure with that using the conventional fixation device, and evaluated the precision of fixation.

### Vac-Lok cushion (new fixation device)

This fixation device is originally a supportive fixation device to be used for radiotherapy. It is filled with fine



**Fig. 1** (A) Picture of the Vac-Lok cushion. The cushion is equipped with a quick-release valve (black arrow). Common medical suction devices and tubes can be connected to this valve. (B) The Vac-Lok cushion is filled with small polystyrene beads. (C) The Vac-Lok cushion cradles the head and stiffens immediately after the internal air is removed via the quick-release valve.

polyurethane beads. For fixation, the tube is connected to the aspiration orifice shown in the diagram, and a negative pressure is applied using a usual medical aspirator (**Fig. 1**). This increases the density of the foaming beads, which are hardened in a shape that fits the patient's head and retain the shape.

The conventional fixation device was an accessory of the angiographic system and firmly fixed the head to the bed. The new fixation device was fixed to the bed using a strong medical adhesive tape and cloth band. The devices were used for head fixation under general anesthesia, and intra-procedural loosening of fixation was not observed in any patient.

## Material and Methods

A questionnaire survey was carried out post-procedurally in patients who underwent intracranial endovascular therapy under general anesthesia after the introduction of the new fixation device. The questionnaire consisted of two questions: (1) Is there pain around the head? and (2) Is there pain in the neck or shoulders? The questions were answered by choosing one from (i) Yes, there is pain, (ii) No, there is no pain, (iii) There is discomfort, (iv) There is a feeling of fatigue, and (v) others (free description).

Concerning the precision of fixation and clinical assessment, a questionnaire survey was carried out in radiation





Fig. 2 (A) Picture of the Palm Q contact pressure indicator. (B) Measuring pressure on the occipital part of the head using a conventional fixation device. (C) Measuring pressure on the temporal part of the head using a Vac-Lok cushion.

technologists in charge of angiography and neurosurgeons to evaluate the usefulness of the new fixation device. The responders were asked to compare the new and conventional fixation devices and freely describe their advantages and disadvantages regarding the setting, precision of fixation, methods for use, user friendliness, and images obtained using the devices.

As the sustained compression by the fixation device was considered to be involved in post-procedural pain, the pressure applied to the scalp during fixation was measured using a body pressure indicator and compared between the new and conventional fixation devices.

In 15 healthy volunteers, the same radiation technologist fixed the head and measured the pressure using the new and conventional fixation devices. In fixing the head, the degree of fixation and the absence of pain were checked with the subjects as for angiography under local anesthesia.

The body pressure indicator PalmQ (CAPE, CO., LTD., Kanagawa, Japan) was used for the measurement. Five sensors 30 mm in diameter were built in a 10 cm × 10 cm square

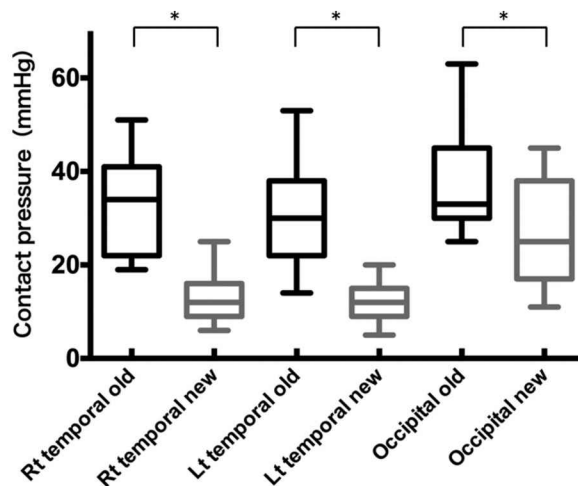
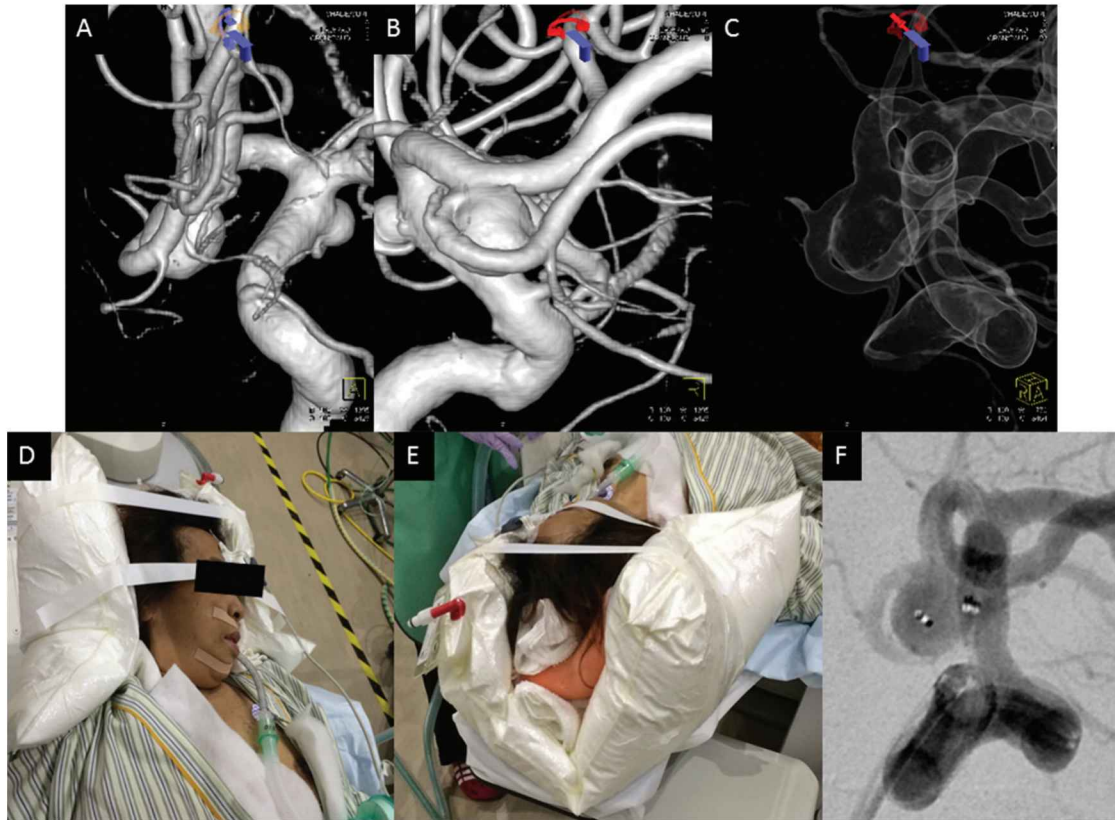


Fig. 3 The contact pressure on the volunteers' heads significantly decreased compared to the conventional method using the Vac-Lok cushion at each measuring point. Asterisks indicate  $p < 0.01$ .

sensor pad, and the pressure could be measured in a range of 0–200 mmHg. The device simultaneously measured the pressures at five points and indicated the maximum of the five values on the monitor. The measurement was carried



**Fig. 4** (A) A-P view of a preoperative 3D angiogram obtained in a neutral head position. (B) Lateral view of a preoperative 3D angiogram obtained in a neutral head position. (C) Working angle view of a preoperative 3D angiogram. This view cannot be obtained in a neutral head position, due to interference from the flat panel and the bed. (D, E) The patient's head is fixed in an anteflexed position and rotated to the left approximately 30° using a Vac-Lok cushion. A medical urethane foam and towels insert are placed between the patient's head and the Vac-Lok cushion to hold the head in position. (F) An intraoperative angiogram of the working angle.

out by applying the center of the pad to the right temporal region (5 cm above the external auditory meatus), left temporal region (5 cm above the external auditory meatus), and occipital region (occipital protuberance) (**Fig. 2**). The head was fixed with the sensor pad attached, the pressure was measured 5 times at each site, and the mean of the five measurements was calculated. The mean pressures at the three sites were compared between the new and conventional fixation devices.

Statistical analysis was performed by the Wilcoxon rank sum test using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan).<sup>2)</sup>

## Results

A questionnaire survey was carried out in 21 consecutive patients who underwent intracranial endovascular therapy using the new fixation device between December 2014 and November 2015.

### 1. Pain around the head

The answers were (i) in 0, (ii) in 19, (iii) in 1, (iv) in 0, and (v) in 1 (“Hair got all sweaty”).

### 2. Pain of the neck and shoulders

The answers were (i) in 0, (ii) in 20, (iii) in 1, (iv) in 0, and (v) in 0.

In the questionnaire survey, no complaint of pain was reported after the change to the new fixation device.

From the questionnaire survey of the neurosurgeons and clinical radiation technologists who conducted the treatment, the following advantages of each fixation device could be extracted.

#### • Advantages of the conventional fixation device

Ease of fixing the head

Ease of reproducing the working angle at follow-ups

#### • Advantages of the new fixation device

Mitigation of post-procedural pain

Reduced artifact due to respiratory motion

Freedom of fixation of the head at any desired angle.



## Pressure measurements using the new and conventional fixation devices

The maximum pressure measured on the head surface in the 15 healthy volunteers was significantly lower at all three sites when the new compared with conventional fixation device was used (Fig. 3). The median value of the maximum body pressure at each measurement site decreased from 33.7 (23.8–41.1) to 11.7 (8.8–15.0) mmHg in the right temporal region, from 29.8 (25.4–35.6) to 12.2 (8.7–14.1) mmHg in the left temporal region, and from 32.9 (29.7–42.6) to 25.0 (17.2–35.8) mmHg in the occipital region after the conventional fixation device was changed to the new device (Fig. 3).

## Case presentation

### A 63-year-old female (Fig. 4)

Coil embolization was performed under general anesthesia for anterior communicating aneurysm. A working angle at which the aneurysm and parent vessel could be separated without overlapping with the internal carotid artery was selected. The patient's neck was fixed in slight flexion and 20–30° left rotation to obtain the working angle. This head position was secured by inserting medical urethane foam and towels into the gap between the head and Vac-Lok cushion and cradling the head together with the sponge in the Vac-Lok cushion. The working angle could be maintained without strain, and the procedure could be completed with little artifact due to respiration. The precision of fixation during the procedure was satisfactory, and no pain or pressure ulcer appeared after the procedure.

## Discussion

The results of measurement of the body pressure during the use of the conventional and new fixation devices showed that the pressure on the head surface was significantly lower with the new device compared with the conventional device. The pressure at each measurement site is considered to have been reduced as the new fixation device supported the entire head by cradling it in curved surfaces and avoided concentration of pressure at particular points.

The luminal pressure of the human capillaries is reported to be about 32 mmHg.<sup>3)</sup> Circulatory insufficiency of the capillaries is considered to occur at higher pressures, and a study on the prevention of pressure ulcer has recommended controlling the local body pressure below 40 mmHg.<sup>4)</sup> After the change to the new fixation device, the body pressure was below 40 mmHg in nearly all patients even in the occipital region, in which the measured body pressure was highest at

25.0 (17.2–35.8) mmHg, suggesting that the new device is also superior from the viewpoint of pressure ulcer prevention. The decrease in the pressure exerted on the head is also considered to have contributed to the mitigation in the post-procedural pain.

In addition, the results of the questionnaire survey of the clinical radiation technologists and neurosurgeons were generally favorable, and the advantages of the new device compared with the conventional device in endovascular therapy mentioned by the responders including the reduction of artifact due to respiratory motion, marked flexibility of fixation in a rotated or flexed/extended head position, and firmness of fixation. The disadvantages included the necessity of some experience for effective fixation and difficulty in reproducing the working angle at follow-up angiography.

It is particularly worth mentioning that the new device allows firm fixation by freely adjusting the patient's head position rather than adjusting the device, and this feature is extremely useful for setting an optimal working angle.

## Conclusion

By fixation of the head using Vac-Lok cushion, the pressure exerted on the head surface during fixation was reduced, and post-procedural pain was mitigated. Since the device also provided high-precision fixation and allowed fixation with free adjustment of the head position, an optimal working angle could be readily obtained. The device is considered to be very useful for head fixation for intracranial endovascular therapy.

## Disclosure Statement

There are no conflicts of interest to disclose regarding this paper.

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