

“Currently Practical Neurosurgery”

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Usefulness of Bipolar Forceps and Generator with High Frequency Technology (Vesalius o qf gnMCN™) for Point Coagulation and Tissue Adhesion Prevention

Application for Point Coagulation and Tissue Adhesion of Bipolar Forceps and Generator with High Frequency Technology (Vesalius o qf gnMCN™)

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Bipolar forceps is an indispensable instrument in modern neurosurgery. The adequate coagulation character has led to the innovation of its modifications. However, adherence of the charred tissue on the bipolar forceps tips may cause several severe problems and sometimes damage to the surrounding tissues. The Vesalius™, with its high frequency technology can be a good system for reducing adherence of the charred tissue and can perform a point coagulation. We report the efficiency of the new bipolar forceps (Vesalius™) by using the laboratory and clinical examinations.

Key words: Vesalius TM, bipolar forceps, high frequency technology, point coagulation

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2007.12.7. 受理

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I. Introduction

There is no argument that it is essential to achieve precise coagulation/haemostasis in neurosurgical procedures. Since Greenwood⁴⁾ introduced the bipolar coagulation device for neurosurgery in 1940, various bipolar systems have been developed (1, 5-7, 9) and put into

clinical use. However, tissue adhesion on the bipolar forceps tips not only prevents appropriate and effective haemostasis but also requires frequent cleaning during the surgery, causing considerable stress for clinicians. In October 2006, a high frequency bipolar coag-

ulation system named Vesalius mod. MCN was developed and released in Japan (Fig. 1A, B, C).

In this study, through a series of bench experiments and a clinical trial, we confirmed that Vesalius, which uses higher radiofrequency (4MHz) than conventional systems, can achieve point coagulation without either over-

heating of the forceps tips or tissue adhesion.

As we found that this coagulation system provided appropriate and effective haemostasis for neurosurgical convenience and was likely to contribute to shortening of the surgical time, we are going to report the results of the assessment including its forceps tips temperature and the degree of tissue damage.

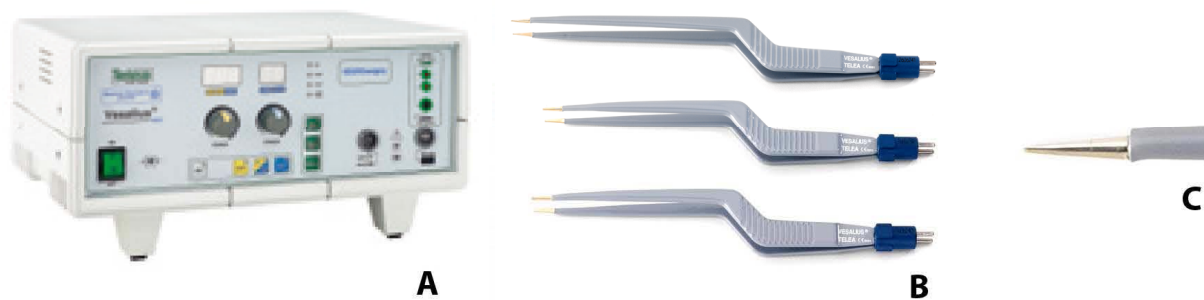


Fig.1 A: Molecular resonance generator (Vesalius mod. MCN™, 2501008). B,C: Bipolar forceps suitable for high frequency technology

II. Subjects & Methods

We made a comparison among a high frequency bipolar forceps set (Vesalius mod. MCN 2606224, Tokibo Co., Ltd.; forceps tips size: 0.4mm; Vesalius hereinafter), a bipolar forceps with heat pipe technology (IsoCool, 8135050S, Johnson & Johnson K. K., Codman; forceps tips size: 0.5mm; IsoCool hereinafter) and a standard bipolar forceps (Hardy Non-Stick Bayonet, 12-1235NS, Ouwa Trading Co., Ltd.; forceps tips size: 0.5mm; NS-Hardy hereinafter).

Malis bipolar coagulation system CMCIH (Johnson and Johnson K. K., Codman) was used with IsoCool and NS-Hardy and the coagulation output was set at 30 Mails Unit (M.U.), taking into account the output advocated by Kumon et al.⁵⁾ and the average output used in actual surgeries. As for Vesalius, Vesalius model MCN (2501008 Tokibo Co., Ltd) was used with the coagulation output set at 14 Vesalius Unit (V.U.), equivalent to the output power (7,2W) which also corresponds to 30 M. U. The coagulation time was set at 5 seconds for all the

systems in view of the current application time during surgeries.

1. Comparison of temperature at the forceps tips

Dipped in saline, the temperature of the forceps tips of Vesalius was compared with that of NS-Hardy and IsoCool. The change of temperature at forceps tips was monitored by an infra-red thermography (Handy Thermo TVS-200 Nippon Avionics Co., Ltd) and analysed using PE Professional (Nippon Avionics Co., Ltd.).

2. Tissue adhesion on the forceps tips (Histological study)

Using chicken eggs, the forceps tips of Vesalius, NS-Hardy and IsoCool were examined whether egg yolk would adhere to the tips of each system. The results were compared with the naked eye.

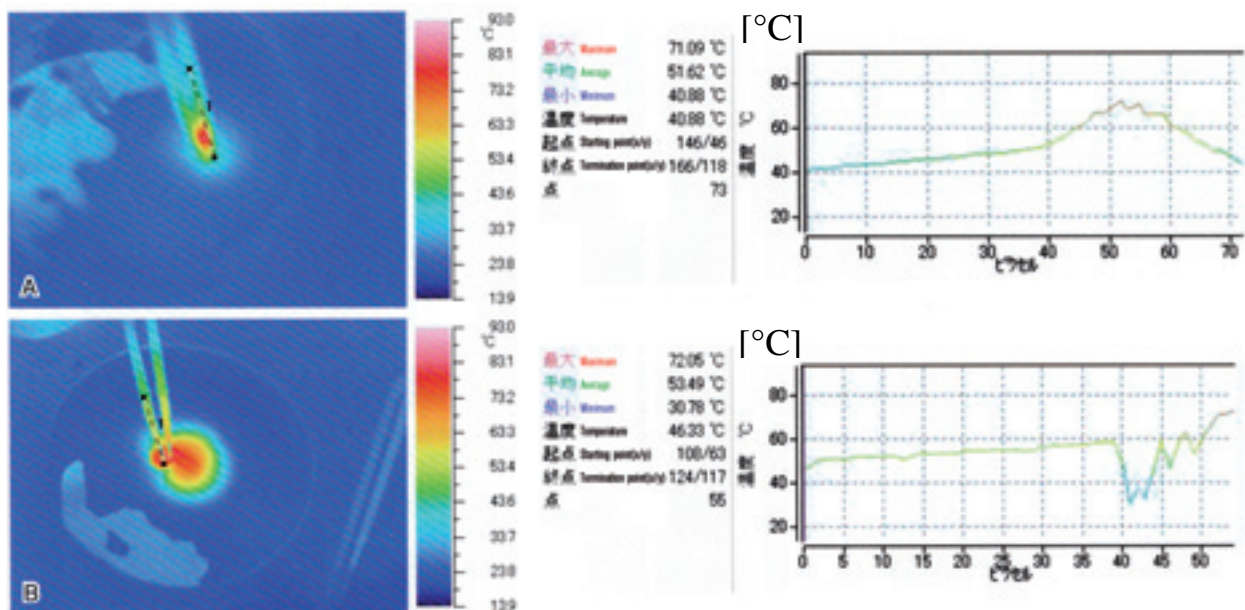
3. Tissue adhesion on the forceps tips (Histological study)

Coagulation was performed on the cerebellar cortex of a piglet using Vesalius and the coagulated part was formalin-fixed and paraffin embedded. Histological sections (5 μm thick) were prepared and stained with haematoxylin and eosin. Coagulation area and histological damage (the degree of corrugation) due to coagulation were compared to the samples prepared by the similar method using NS-Hardy.

4. Tissue adhesion on forceps tips (Clinical trial)

We studied a patient with tuberculom sellae meningioma who underwent surgical treatment.

Tumorectomy by right frontotemporal craniotomy was performed using Vesalius for dissection of the tumour and coagulation of its feeding vessels.



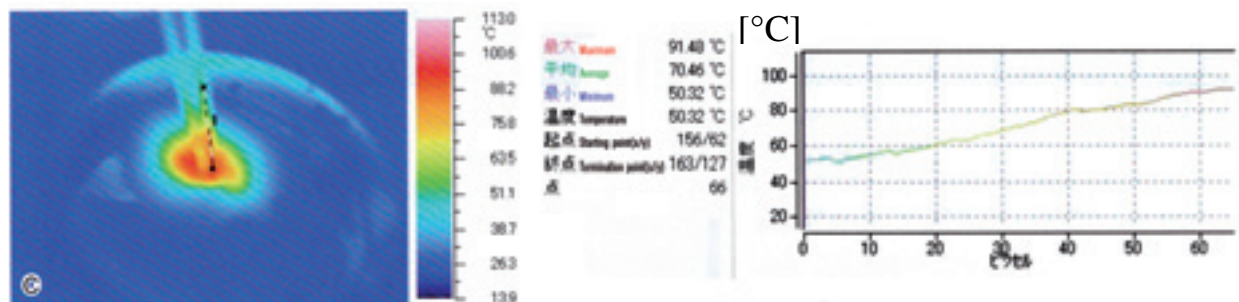


Fig.2 Thermography showing surfaces of the tip of the bipolar forceps during electrical coagulation in the normal saline. A: Vesalius mod. MCN™, 2606224. B: IsoCool™ 8135050S. C: Hardy Non-Stick Bayonet, 12-1235NS.

III. Results

1. Temperature at the forceps tips

Compared to NS-Hardy and IsoCool, the temperature rise of Vesalius was more localized to the forceps tips. The maximum temperature of Vesalius was 71.09°C (**Fig. 2A**) and that of IsoCool was 72.05°C (**Fig. 2B**), both being the ideal temperature below 80°C. Meanwhile, with NS-Hardy, the heated region of saline was larger and the maximum temperature was 91.48°C, higher than 80°C (**Fig. 2C**).

2. Tissue adhesion on the forceps tips (Investigation with the naked eye)

The coagulated tissue (protein) adhesion test

tissue adhesion at the forceps tips of Vesalius (**Fig. 3A**) or IsoCool (**Fig. 3B**). In NS-Hardy's case, coagulated tissue adhered to the forceps tips, causing a rupture of egg membrane and leakage of egg yolk (**Fig. 3C, D**).

3. Tissue adhesion on the forceps tips (Histological study)

In case of NS-Hardy (**Fig. 4A, B**), the tissue damage due to coagulation obviously extended beyond the size of the forceps tips. Also it was clear that the depth of degeneration and the degree of corrugation was more significant compared to Vesalius (**Fig. 4C, D**).

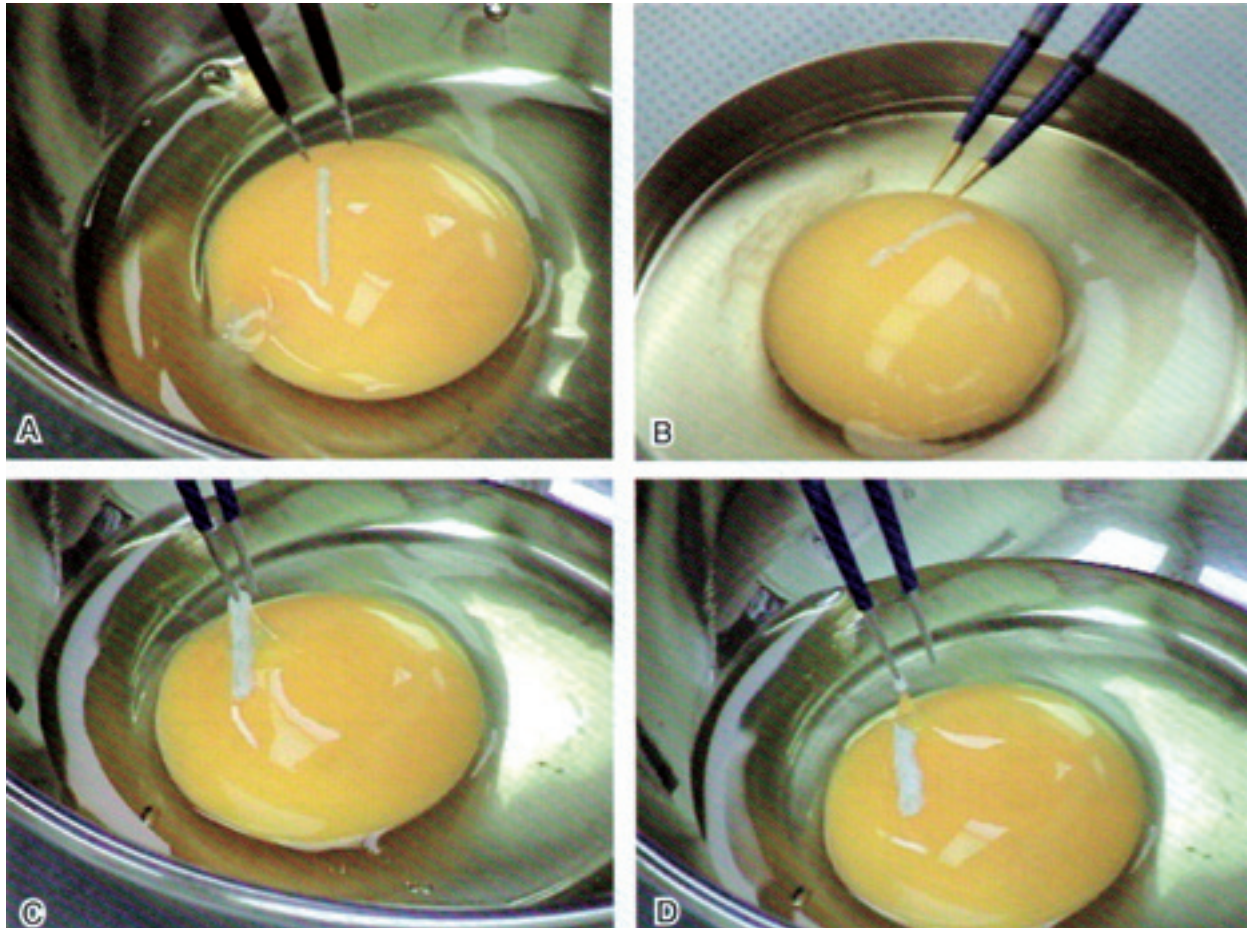


Fig.3 Photograph of the tip of the bipolar forceps showing immediately after coagulation of the surface of the egg.

A: Vesalius mod. MCN™, 2606224.

B: IsoCool™ 8135050S.

C, D: Hardy Non-Stick Bayonet, 12-1235NS.

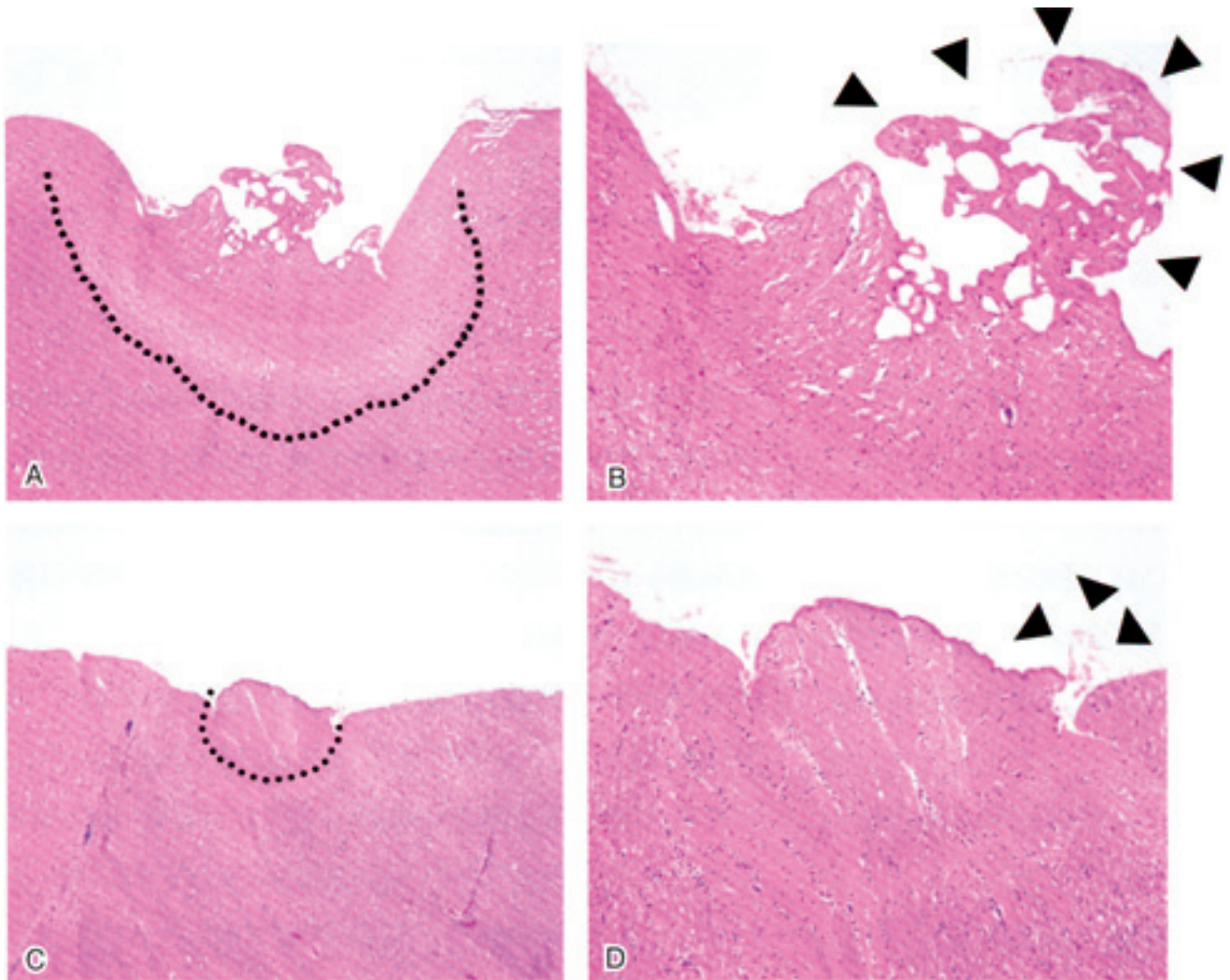


Fig.4 Histological study (HE stain, x100) of the pig brain cortex coagulated with bipolar forceps.
A, B: Hardy Non-Stick Bayonet, 12-1235NS. C, D: Vesalius mod. MCN™, 2606224.

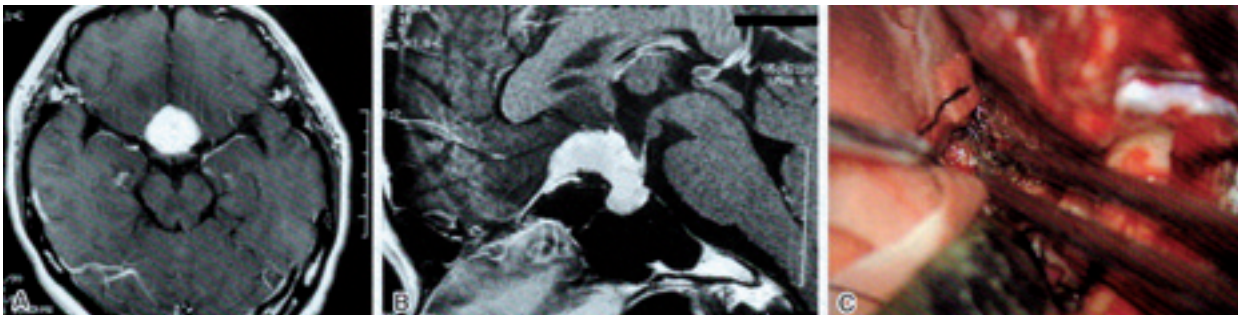


Fig.5 Gadolinium-enhanced MR images revealing meningioma around tuberculum sellae (A: axial view. B: sagittal view). C: operative view of tumor coagulation in tuberculum sellae meningioma with Vesalius.

4. Tissue adhesion on the forceps tips (Clinical trial)

In tuberculum sellae meningioma (Fig. 5A, B, C), it took approx. 3 hours in a row to dissect the tumour and to achieve haemostasis by

coagulation. Throughout the operation, the forceps tips required no cleaning and generated no heat injury in the surrounding critical structures (optical nerve and pituitary stalk in this case).

IV. Discussion

Effective haemostasis is by all means indispensable in neurosurgical procedures and there is no argument about the importance of the use of an appropriate bipolar forceps which accommodates each surgical manipulation. It is possible that tissue adhesion at the forceps tips will cause the frequent interruption of the surgery for cleaning, extended surgical time, and stress to the practitioner. But more controversially, it may distract the practitioner's attention from the surgical site. Also there is a risk to pull out the surrounding critical structures with a bipolar forceps adhered to the coagulated tissue.

As it is generally considered that the tissue starts to coagulate at around 70-80°C, a bipolar forceps with the tips integrated with a new cooling system based on heat pipe technology has been recently developed and is attracting attention for its usefulness.

On the other hand, Vesalius can be called a next generation coagulation system which enables appropriate and effective point coagulation based on the entirely different method.

In principle, Vesalius's high frequency energy (4MHz) resonates with water binding energy to generate less kinetic energy (surplus heat)

resulting that the temperature at the forceps tips is maintained at 65-80°C.

As for the temperature change at the forceps tips, it is known that the region of temperature rise enlarges at the medium or higher coagulation power level. In fact, with NS-Hardy, the high temperature region extends further around the forceps tips and the tips temperature exceeded 80°C. However, the forceps tips of Vesalius and IsoCool were maintained below 80°C under the same environment and the high temperature regions of both systems were well localized, indicating their effectiveness in point coagulation. The tissue adhesion test and histological evaluation using chicken eggs revealed that the degrees of histological damage (corrugation) were distinctly different between NS-Hardy and the other two systems.

Furthermore, no damage to the critical structures surrounding the coagulated point during the clinical use confirmed the safety of application of Vesalius. Another remarkable advantage is that the forceps tips did not require any cleaning despite repeated dissections and haemostasis procedures throughout the surgery which lasted several hours. The system fully demonstrated its

effectiveness in the clinical setting. Also, Vesalius provides a high cost-benefit performance since the bipolar forceps set is reusable.

Though this study was operated under the single

condition with the coagulation power and time set at the clinical level (30 M.U., 14 V. U., 5 sec), further comparative analysis using various coagulation settings will be desirable for more precise and reliable assessment of the product.

V. Conclusion

By applying high frequency energy (4MHz), Vesalius can achieve coagulation without causing tissue adhesion at the forceps tips. Therefore heat leakage which is said to inflict damage to the surrounding critical structure can be limited to the minimum.

The apparatus is considered as an effective tool

for neurosurgical procedures which require precision and control.

Acknowledgement

We sincerely appreciate Tokibo Co., Ltd. for their cooperation in preparing for this article.

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This is a translation of the original article from Currently Practical Neurosurgery/ 脳神経外科速報 vol 18, no.5, 2008.5

