The Suture Applicator for Replacing a Bone Flap
—Technical Note—

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Abstract

A new instrument was developed for passing and holding sutures during the replacement of a bone flap. The new device is a simple straight aluminum shaft, 6 cm in length and 0.7 mm in diameter with a groove on both ends for holding the suture. The shaft can be easily bent with the fingers to attain the desired curve and more suitable manipulation. Passing the shaft through the straight hole in the cranium or the cranial flap was very easy and convenient. No dural damage occurred during 80 procedures using this shaft. No needle holder or forceps for temporary clipping sutures were necessary, which reduced the operative time and mental and physical burden on the operator and the nurses. The mean time per hole with our instrument (45.8 ± 9.2 sec) was significantly shorter compared to conventional methods with a circular needle, needle holder, and many forceps for temporary clamping of sutures (65.6 ± 13.2 sec).

Key words: instrumentation, cranioplasty, skull

Introduction

Replacement of a bone flap generally involves passing sutures through straight holes in the skull and the bone flap using a circular needle, a needle holder, and many forceps for clamping the sutures. However, this method is inconvenient and has several problems, such as the difficulty in passing a circular needle through a straight hole, the danger of dural injury caused by the sharp circular needle, the large number of forceps corresponding to the number of holes required for temporary clamping of both ends of each suture, and the difficulty in passing the suture, which is often wet, through a hole in a bone flap with the fingers.

We have developed a new instrument for passing and holding the sutures when replacing a bone flap to solve these problems and to perform the procedure more easily and quickly in neurosurgical operations.

Instrumentation and Method

The new device (Yufu Itonaga Co., Ltd., Tokyo) is a simple straight aluminum shaft, 6 cm in length, 200 mg in weight, and 0.7 mm in diameter with a groove on each end for holding the suture (Fig. 1). The shaft is flexible and can be bent as desired. One end of the shaft carries a black marker.

The procedure is started after suturing the dura in a watertight manner.

1. The monofilament nylon or braided nylon suture is held at approximately 10 mm from the end with the groove on each end for holding the suture. The shaft can be easily bent with the fingers to attain the desired curve and more suitable manipulation. Passing the shaft through the straight hole in the cranium or the cranial flap was very easy and convenient. No dural damage occurred during 80 procedures using this shaft. No needle holder or forceps for temporary clipping sutures were necessary, which reduced the operative time and mental and physical burden on the operator and the nurses. The mean time per hole with our instrument (45.8 ± 9.2 sec) was significantly shorter compared to conventional methods with a circular needle, needle holder, and many forceps for temporary clamping of sutures (65.6 ± 13.2 sec).

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5. The end of the suture is released from the marker end (Fig. 2F).

6. The marker end of the device is completely passed through the corresponding hole of the cranial flap end (Fig. 2G). The end of the suture released from the marker end is then recovered on the same end. At this stage, the suture has been passed through both holes of the skull and the bone flap is held with the shaft (Fig. 2H).

7. Finally, all sutures are ligated with the fingers after releasing the ends from the shaft.

Between May 1996 and July 1997, 169 cranioplasties were done at our institute. The new instrument was used in 80 cranioplasties for securing the cranial flap with the consent of the patient. The conventional method with a 1/2 circular needle (17–22 mm), needle holder, and many forceps for temporary clipping of sutures was used in 79 cranioplasties. The choice of these two methods was determined randomly and all operations were performed by the same neurosurgeons of the authors (S.K. and H.N.). The time for securing the cranial flap (from the end of dural closure to completion of fixing the cranial flap) was measured and the number of holes for fixation counted in all operations. We used braided nylon for suturing in all operations.

The instrument was easily bent with the fingers to attain the desired curve and more suitable manipulation. Passing the straight shaft through the straight hole in the cranium or the cranial flap was very easy. No dural damage occurred during the procedures using this shaft, because the tips were not sharp. As no needle holder or forceps for temporary clipping of sutures were necessary, the operative time and the mental and physical load on the operator and the nurses were reduced. Additionally, the cost involved in the frequent breakage of the circular needle was avoided.

The time for replacing the cranial flap with our instrument was 295.5 ± 85.1 sec (mean ± SD), the number of holes for fixing the flap was from 3 to 9 (6.5 ± 1.6), and the time per hole was 45.8 ± 9.2 sec.
With the conventional method, the time was 407.3 ± 98.2 sec, from 3 to 9 holes (6.3 ± 1.5), and time per hole was 65.6 ± 13.2 sec. The number of holes was not significantly different (p = 0.488), but the total time for replacement and the time per hole were significantly shorter using our instrument (p = 0.0001, Mann-Whitney U test).

Discussion

The new instrument reduces cranioplasty time significantly, as the sutures can be passed easily without requiring many instruments. Compared with a circular needle, there was little possibility of dural damage.

The needle threader was originally an instrument for making a feather jig of fly fishing. Thread sutures can be easily passed through holes with this threader, but many clamping forceps are still necessary. Furthermore, insertion of the tip into a hole in the skull may be difficult, because this threader was not designed for inserting into a hole. On the other hand, our instrument was designed for cranioplasty. The most suitable length and diameter were determined for easy insertion, and the grooves on bilateral ends act as forceps for clamping the suture ends. Our device is made of aluminum which is rustproof and harmless to the human body.

Recently, bone fixation with a titanium plate has become common in neurosurgery and craniomaxillofacial surgery. Compared to nylon or thin wire sutures, the plate provides good stability. The plate is recommended for fixation of the zygoma or mandible after skull base surgery. However, we believe that fixation with sutures is sufficient for ordinary cranioplasty from both surgical and economic considerations. When using this instrument, it is important for the operators to make straight holes with a sufficiently oblique angle to penetrate the cut surface of the skull bone, not to the reverse surface. Unless appropriate holes are made, the nylon suture is difficult to pass easily and safely even with our device.

This instrument is also convenient for laminoplasty, but in deep operative fields such as the spinal or suboccipital regions a longer shaft may be better.

Acknowledgments

This instrument was awarded a prize at the 6th Conference on Japanese Neurological Techniques and Tools in Chiba, Japan.

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References


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Commentary

I would like to congratulate Dr. Kondo on his new development of a suture applicator. Introduction of this new instrument will shorten the entire operation time, so making the patient less susceptible to infection. It would be interesting to know if the author could make some comments on how strong this operative instrument is biomechanically in terms of how many times you could repeat bending or tailoring the curve in accordance with the direction of the drilled holes in the skull, before it broke from metal fatigue or whether no such thing has happened before. From my limited experience of the straight needle of Keith, which is of course solid and non-malleable, it is much more difficult to pass a suture through a drilled hole in the extreme oblique cut edge which includes the diploe and the inner table, compared with a circular needle. In the case of operative procedures using a free bone flap as in cranioplasty, this is not a problem, however, in other operations such as in procedures using an osteoplastic bone flap, threading sutures in the surrounding skull prior to completion of your
dissection might limit somewhat the working space on operative exposure.

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The authors describe a new tool that helps to pass a thread through bony holes during cranioplasty. There are several ways to fix a cranial bone flap after craniotomy. Titanium plate fixation is one of the newest techniques for this procedure but is quite expensive. It would be a matter of financial debate to use this method in every case. Thread fixation is the most standard and cheapest method, and is suitable for routine usage. The authors have invented a new instrument that helps a surgeon in passing threads through bony holes in the skull and bone flap. The principle of this paper is to use a straight thread passer through straight holes in the cranium, which is quite reasonable. The real novelty is in the ends of the instrument. Both ends are so shaped to hold a thread when the needle passes through a bony hole. A thread can easily be gripped and freed from the end device manually. It should be noticed that the time required to pass threads in bone holes during cranioplasty was 295.5 seconds with the new method in contrast to 407.3 seconds with the conventional method. Although the innovation in this study is quite simple, small tricks such as used in this invention could be one of the most important components for building up standard and conventional surgical techniques. The result of this paper will also have a financial impact. The cost of this device is so reasonable that it could be used as a routinely disposable instrument such as a needle. This invention will shorten the duration of the surgery, and contribute to lowering financial stress on the medical services.

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