

The Advantages and Disadvantages of Skin Staple Suture Compared with Traditional Suture in Brain Surgery in Primary Hospital: A Randomized Controlled Study

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Abstract: *Objective:* This paper aims to compare the effect of skin staple suture and traditional silk suture in scalp suture surgery. *Methods:* A total of 80 craniocerebral surgery patients were included in this study, and the patients were randomly divided into observation group and control group, with 40 cases in each group. The observation group used disposable skin stapler to suture the scalp incision, and the control group used conventional silk suture to suture the incision. Statistical analysis was carried out on 6 indicators including suturing speed, healing under-scab, incision necrosis, incision cerebrospinal fluid (CSF) leakage, incision infection, and postoperative "centipede-shaped" scar incidence rate of the two suture methods. *Results:* There was no significant difference between the groups in terms of postoperative healing under-scab, incision necrosis, incision CSF leakage, and intracranial infection ($P > 0.05$). The suturing speed in the observation group was 15.2 ± 0.7 cm/min, which was significantly faster than 7.4 ± 0.3 cm/min in the control group ($P < 0.05$). The incidence of "centipede-shaped" scars in the observation group was significantly lower than that in the control group at 1 to 6 months after operation ($P < 0.05$). *Conclusion:* Compared with traditional silk suture, skin staple suture has obvious advantages in suture speed and cosmetic effect.

Keywords: Brain surgery; Suture; Skin staples; Postoperative complications

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1. Introduction

Surgery is an unavoidable and common problem in current medical work, and the quality of wound healing and its effects on the appearance are often concerns of surgeons and patients. Surgical patients often have incision problems that affect their prognosis. Once incision infection, incision darkening or liquefaction necrosis, poor incision healing, and other adverse events occur, these will lead to additional medical procedures and increased workload of medical workers. It will prolong the hospitalization time of patients and lead to re-hospitalization,

which will result in an increase in medical costs. In neurosurgery, the above-mentioned incision problems are particularly prominent due to the particularity of tissues and organs, and serious life-threatening complications may even occur. Therefore, it is important to monitor and minimize postoperative wound complications. Studies have shown that methods that help to reduce incision complications include adequate hemostasis, the use of prophylactic antibiotics, and shortened operation time. In addition, related studies have suggested that different types of suture materials are closely related to postoperative incision complications ^[1]. Medical workers are constantly exploring the improvement of suture methods and materials either through technical improvements or the development of new suture materials ^[2,3], such as the application of subcutaneous and intradermal sutures, absorbable sutures, zipper type stapler, stapler and biological protein glue, etc.

With the improvement of medical technology and the accumulation of experience in microsurgery, minimally invasive surgery is the trend of development, as is neurosurgery. However, a considerable number of operations still require craniotomy. Craniotomy is still one of the most common operations in neurosurgery, and patients who require and receive craniotomy constitute a considerable population. Based on such a large population of craniotomy patients, choosing a scalp incision suture scheme which is efficient without ruining the patient's appearance is one of the key choices faced by neurosurgeons. In recent years, convenient disposable skin staplers (skin staples) have been applied in clinical practice and its use has gradually expanded ^[4-7]. However, the safety and effectiveness of skin staple in scalp suturing is not yet fully understood ^[4-7]. In our clinical department, we found that skin staple has more advantages than traditional silk thread in wound healing, such as less darkening and necrosis of the scalp, less occurrence of cerebrospinal fluid (CSF) leakage and the resulting intracranial infection, but these lack clinical data support. Therefore, the purpose of this study was to explore whether it has advantages compared with traditional suturing methods. In this study, 80 patients with craniotomy were included in our department, and they were divided into skin staple suture group and traditional silk suture group by random number table method. The speed of incision suture and the incidence of adverse events after surgery were compared between the groups, including healing under-scab, deterioration of the incision, leakage of CSF from the incision, intracranial infection, and "centipede-shaped" scar of the incision.

2. Materials and methods

2.1. General information

A total of 80 patients who underwent craniotomy and decompressive surgery in our hospital from June 2019 to September 2022 were selected as research objects, including intracranial hemorrhage and/or cerebral hemorrhage after head trauma caused by various reasons, such as swelling, spontaneous cerebral hemorrhage, cerebral infarction, brain tumor, etc. Due to the need to evaluate the incision healing, all the patients selected in this study had Glasgow Coma Scale (GCS) scores ≥ 5 points before operation. 80 patients were divided into observation group (40 cases) and control group (40 cases) by random number table method.

The patients were numbered according to the order of their enrollment, the RANDBETWEEN function was used to generate a random number table based on Excel, a number from the random number table was randomly selected and continued down in order, so that each number corresponded to a random number, and then grouped according to the parity of the random number, among which the number corresponding to the even number was divided into the observation group, otherwise it is the control group.

The observation group used skin staples (disposable skin stapler) to suture the scalp. There were 24 males and 16 females in this group, the age ranged from 15 to 83 years, with an average of 48.5 ± 0.7 years old. All are Class I incisions, and the types of incisions are supratentorial horseshoe-shaped, coronal valve or frontotemporal "question mark" surgical incisions. The incision length was 19–32 cm, with an average of 25.5

± 0.3 cm.

In the control group, the scalp was sutured with silk thread, including 22 males and 18 females, aged 18–81 years, with an average of 41.6 ± 0.2 years old. All are Class I incisions, and the types of incisions are supratentorial horseshoe-shaped, coronal valve or frontotemporal “question mark” surgical incisions. The length of surgical incision was 18–33cm, with an average of 25.2 ± 0.2 cm.

The gender, age, type, and length of incision were comparable between the two groups, and there was no significant difference between the two groups ($P > 0.05$).

2.2. Method

All patients underwent conventional scalp hemostasis during the operation, common silk suture muscle, sarcolemma, absorbable thread interrupted subcutaneous suture, conventional epidural, or subcutaneous drainage. The skin incision suturing method of the observation group was using skin staples to suture the scalp. The width of the staples was 0.6cm, and the spacing was 0.4–0.8cm. In the control group, the skin incision was sutured through full layer with silk, the suture width was 1.0–2.0cm, and the stitch distance was 0.8–1.3cm. The indicators below for each patient in the two groups were recorded separately:

- (1) The time and length of incision suturing, and the calculated speed, expressed in cm/min.
- (2) The incidence of healing under-scab.
- (3) The incidence of skin necrosis at the edge of the incision 3–15 days after surgery, whether there is skin darkening and necrosis, and the area exceeds 1×0.5 cm is the standard.
- (4) The incidence of incision leakage of cerebrospinal fluid after surgery.
- (5) The incidence of intracranial infection after surgery.
- (6) Appearance of “centipede-shaped” scars 1–6 months after surgery.

2.3. Statistical analysis

SPSS19 and GraphPad Prism 9.1 software were used for data analysis. For continuous variables, the normality test was performed first. If the data conformed to the normal distribution, it was expressed as mean ± standard deviation (SD), and the comparison between groups was performed by *t* test, otherwise the median and its interquartile range (M, Q25–Q75) were used, and the rank sum test was used for comparison between groups. Categorical variables were expressed as percentages (n, %), and χ^2 tests were used for comparison between groups, and the study defined $P < 0.05$ as a statistically significant difference.

3. Results

Comparison of intraoperative suture speed showed that the suture speed of the observation group was 15.2 ± 0.7 cm/min, which was significantly faster than that of the control group, 7.4 ± 0.3 cm/min (**Table 1**), and the difference was statistically significant ($P < 0.05$). All 80 patients were followed up for 1–6 months after operation. In the observation group (**Figures 1 and 2**), 3 cases had skin darkening and necrosis at the incision margin, 1 case had incision leakage of cerebrospinal fluid and required secondary suturing, 2 cases had intracranial infection, 5 cases had healing under-scab, 3 cases had “centipede-shaped” scars 1–6 months after surgery, and no cases had incision infection. In the control group (**Figures 3 and 4**), there were 7 cases of skin darkening and necrosis at the incision margin after operation, 4 cases of incision leakage of cerebrospinal fluid which required secondary suturing, 4 cases of intracranial infection, 8 cases of healing under-scab (**Figure 5**), 29 cases of “centipede-shaped” scar 1–6 months after operation (**Figure 6**). The incidence of postoperative skin necrosis at the incision margin, cerebrospinal fluid incision leakage, intracranial infection, healing under-scab,

and “centipede-shaped” scar 1–6 months after operation in the observation group were compared with those in the control group (**Table 1**), the difference was not statistically significant ($P > 0.05$), suggesting that there was no significant difference between the observation group and the control group. The incidence of “centipede-shaped” scars in the observation group was significantly lower than that in the control group at 1–6 months after operation, and the difference was statistically significant ($P < 0.05$), as shown in **Table 1**.

Table 1. Differences in suturing speed and adverse events between the observation group and the control group

Group	Suturing speed	Necrosis	CSF leak	Intracranial infection	Healing under-scab	Centipede-shaped scar
Observation group	15.2 ± 0.7	3 (7.5)	1 (2.5)	2 (5.0)	5 (12.5)	3 (7.5)
Control group	7.4 ± 0.3	7 (17.5)	4 (10.0)	4 (10.0)	8 (20.0)	29 (72.5)
<i>P</i> value	$P < 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P < 0.05$



Figure 1. Wound picture after skin staple suture surgery



Figure 2. Wound picture after skin staple suture surgery



Figure 3. Black exudate from the wound after silk suture operation



Figure 4. Black fluid leak from the wound after silk suture operation



Figure 5. Healing under-scab appearing after silk suture surgery



Figure 6. “Centipede-shaped” scar appearing after silk suture surgery

4. Discussion

Everyone has a desire for beauty. With the progress of the times, the quality and appearance of wound healing have attracted more and more attention from doctors and patients. Therefore, the number of plastic surgery hospitals are increasing. The incision healing is important, especially in brain surgery. Poor incision suturing increases postoperative complications, and intracranial infection may even affect the patient's life, also determines the appearance of incision after healing, which would bring negative effects to both patients and doctors. The traditional silk suture method requires needle threading, thread guide, needle entry and exit, knotting and thread trimming, which are affected by the operator's technique, proficiency, and knotting strength. Plus, it may be time-consuming and laborious, and can only achieve the effect of closing the incision with high complications and poor plastic effect, and since the surface of the thread is rough, it is easy to adhere to the skin tissue, causing line-knot reactions and rejection reactions. It may not be obvious in other operations, but due to the particularity of brain surgery, its defects often bring more serious consequences. For example, if the suturing is too tight and affects the blood supply, it will easily lead to darkening and necrosis of the skin, and if it is too loose, it will easily cause non-healing incision. If the incision does not heal or the suture is loose, there will be leakage of cerebrospinal fluid from the incision, leading to incision and/or intracranial infection, increased bleeding from the incision, thick scar, healing under-scar or empyema, that easily lead to incision dehiscence and/or infection. The left out silk will result in granulation hyperplasia or local sinus infection of the wound, which requires multiple dressing changes, and sutures and stitches removal, it is also prone to scar hyperplasia and "centipede-shaped" scar of the incision. Moreover, the incision margin does not grow hair, which affects the appearance, prolongs hospitalization time, and increases hospitalization cost, thus bringing physical, mental, and financial burdens to patients.

If there is a method that can make the surgical incision heal better in appearance, with fewer complications, and is simple and fast, it will undoubtedly be the ideal suturing method that people are pursuing ^[8,9]. Skin incision suturing with skin staples has the following advantages:

- (1) Like a stapler, it does not require high technical requirements, as long as the skin is aligned, and then pressed and sutured, it is simple and fast ^[10].
- (2) The staples are made of titanium alloy, which has low rejection and tissue reactivity. It does not enter the subcutaneous tissue, and is moderately tight, thus avoiding the problems of traditional silk sutures that are too tight affecting the local blood supply, and too loose to heal poorly, and it will not linearly cut the skin, which is conducive to incision healing.
- (3) The surface of the staples is smooth. When removing the staples, a special matching remover is used without pulling, and the skin staples will automatically lift out of the skin when the remover is kneaded, hence reducing the pain and promoting incision healing ^[11].
- (4) The postoperative incision heals well, with only linear scars left on the incision without pigmentation, horizontal stretch marks caused by traditional silk threads, and with rare "centipede-shaped" scars.

It may be precisely because of the above advantages that the use of skin staples (skin staplers) to suture wounds is becoming more and more widely used in clinical applications.

Skin suturing is the last step of the operation, but its importance cannot be ignored, especially in brain surgery, if the wound healing is poor, it will affect the appearance. If the wound healing is poor and the cerebrospinal fluid leaks, it will not only increase the economic burden, but even affect the prognosis and endanger the life of the patient. Fan *et al.* reported that the postoperative incision infection rate in mainland China was 4.5% from 2001 to 2012 ^[12], Cheng *et al.* reported that the incision infection rate reported in developed countries in 2011 was only 2.0% ^[13], while it was as high as 11.8% in developing countries ^[14]. If the

scalp incision is infected and cerebrospinal fluid leaks, it may cause subcutaneous and/or intracranial infection. According to the 2021 edition of the Chinese Expert Consensus on the Diagnosis and Treatment of Central Nervous System Infections in Neurosurgery ^[15], the incidence of intracranial infections after neurosurgery ranges from 4.6% to 25% ^[16], which accounts for 0.8–7% of neurosurgical central nervous system infections (CNSIs) ^[17]. But because of different diseases, hospitals, surgical methods, and diagnostic criteria, the incidence of CNSIs after surgery is not the same, the incidence of intracranial infection in our hospital is 5.0–10%, which is basically consistent with the current data. A number of studies have shown that postoperative cerebrospinal fluid leakage, operation time, and secondary surgery are the main risk factors for intracranial infection after craniotomy ^[18,19]. Importantly, postoperative cerebrospinal fluid leakage is an independent risk factor for intracranial infection ^[20]. Operation time > 4 hours and receiving ≥ 2 craniotomies ^[21] significantly increased the incidence of intracranial infection ^[22]. Any factor that prolongs the operation time will increase the chances of intraoperative bleeding and postoperative infection, and craniocerebral operations are often time-consuming and traumatic. This group of data shows that disposable skin staplers are used in neurosurgery, which can speed up surgical suturing and have better plastic effects, but the occurrence of postoperative cerebrospinal fluid leakage, healing under-scab, skin necrosis at the edge of the incision, and intracranial infection rate did not differ significantly.

In summary, the results of this single-center, randomized controlled study showed that compared with traditional silk sutures, there was no significant difference in the rates of skin darkening, necrosis, cerebrospinal fluid leakage, and healing under-scab after skin incisions sutured by disposable skin staplers. However, the suturing is faster and has an added plastic effect. At the same time, the disposable skin stapler has low technical requirements, even for first-time users, it can be easily mastered, while the use of ordinary silk suture has certain requirements for suture technology, and our center believes that the incidence of cerebrospinal fluid leakage in the skin stapler group is higher in clinical work. The incidence of cerebrospinal fluid leakage in the observation group in this study was lower than the control group, but there was no statistical difference between the two groups. In conclusion, the use of disposable skin stapler to suture the incision in brain surgery has obvious advantages over traditional silk suture, and it is worthy of further promotion and application in clinical practice. There are limitations in the design of this project, such as:

- (1) The above data are only the data of this center, and different centers may have different data.
- (2) It simply counts the number of cases of wound darkening, but fails to make statistics on the length of the incision in question and the area of darkening.

Disclosure statement

The authors declare no conflict of interest.

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