Utility of the Method Using the Tsukisui Device to Control Intraoperative Bleeding Applied to Neurofibroma Resection

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Summary: The resection of neurofibromas in Von Recklinghausen’s disease [neurofibromatosis type 1 (NF-1)] is frequently complicated due to size, location, hypervascularity, and tissue friability. A repeat resection, however, is necessary for patients with functional problems such as unexpected tumor bleeding or with changes in esthetic appearance. This report describes application of the method using the Tsukisui device to resecting NF-1 tumors while minimizing blood loss. The method using the Tsukisui device was applied for the resection of 8 NF-1 tumors (5 patients), and intraoperative blood loss, operative time, and postoperative complications were recorded. In all cases employing this method, intraoperative blood loss was <360 ml (10–360 ml), and none of the patients developed postoperative hematoma or other notable bleeding complications. The method using the Tsukisui device, which provided excellent hemostasis and was associated with few complications, shows promise for application to neurofibroma resection. (Plast Reconstr Surg Glob Open 2013;1:e85; doi: 10.1097/GOX.0000000000000023; Published online 19 December 2013.)

Neurofibromatosis is a genetic disorder that primarily affects the cell growth of neural tissue. The disorder can cause tumors to grow on the nerves at any location at any age. The most common type, neurofibromatosis 1 or NF-1 (previously known as von Recklinghausen’s neurofibromatosis or peripheral neurofibromatosis), is an autosomal dominant disorder affecting about 1 in 4000 individuals. Multiple hyperpigmented areas (café-au-lait macules) and neurofibromas are characteristic findings in affected individuals.1

Tumors are often removed for cosmetic reasons or to control unexpected active bleeding. However, NF-1 resection is frequently complicated due to factors such as size, location, hypervascularity, and tissue friability, which make achieving complete hemostasis a challenge. In addition to intraoperative hemorrhage, bleeding often occurs during the postoperative period and may be life threatening. This report describes the application of the method using the Tsukisui device, which is conventionally used to pass wires through bone in facial fracture surgeries, to NF-1 resection, aiming at minimal blood loss.

PATIENTS AND METHODS

Using the Tsukisui device, we resected 8 NF-1 tumors from 5 patients (1 man, 4 women; age, 14–41 y) between August 2011 and March 2013. Neurofibromas were located in the anterior neck, chest, abdomen, groin, and thigh, and tumor size ranged from small (≤1 cm) to large (>3 cm). Operative times varied from 30 to 120 minutes, with an average of 70 minutes. Intraoperative blood loss was recorded for each tumor, and none exceeded 360 ml. There were no cases of postoperative hematoma or significant bleeding complications.

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from 4 cm × 8 cm to 10 cm × 34 cm. Peri- and post-operative bleeding, the need for blood transfusion, size of the resected tumor, operative time, and post-operative complications were recorded in all 8 cases.

Operative Technique

The method requires the use of the Tsukisui device (Keisei Medical Industrial, Japan) (Fig. 1). Expected tumor size for resection was determined based on the volume of the tumor that could be grasped by the hand without applying tension, and an excision line was marked. Using the Tsukisui device, 1-0 silk was pierced into the base of the grasped tumor to make a knot. Each knot was overlapped to eliminate the inflow of blood into the expected tumor resection site. Change in tumor color after being knotted at its base was then confirmed. Tumor resection was performed after achieving complete ischemia, and no complications such as uncontrolled tumor bleeding were encountered. Following tumor resection, the dermal layer was sutured with 3-0 absorbable monofilaments. Nylon suture was used to close the skin incision (Fig. 2). Finally, the knots used to achieve ischemia were removed.

RESULTS

In all cases in which the method using the Tsukisui device was applied, perioperative blood loss was ≤360 ml (10–360 ml; mean, 87.5 ml) (Table 1). None of the patients required blood transfusion or the placement of drains. Operative time was 20–54 minutes (mean, 39.25 min). Two cases were complicated by partial wound breakdown due to hematoma but healed within 2 weeks.

Case Report

A 14-year-old girl with a soft mass on her anterior neck underwent surgical resection of the mass by applying the method using the Tsukisui device (case 6, Table 1) (Fig. 3). Resection size was 12 cm × 9 cm. Total perioperative blood loss was 360 ml, and no blood transfusion was required. There was partial wound breakdown of the suture scar during healing. After applying conservative treatment such as ointment, the open wound healed within 2 weeks.

DISCUSSION

The most immediate challenge for surgical management is hematoma and bleeding, especially when the dissection is intralesional. In severe cases, the amount of blood loss can increase the patient’s risk of death. A number of authors have reported signifi-

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Fig. 1. The Tsukisui device (Keisei Medical Industrial) used in the method.

Fig. 2. Procedure of the method using the Tsukisui device. A, Pierce the skin with the Tsukisui device and thread the device. B, Reverse the movement back through the base of the tumor. C, Tie off the thread and confirm change in skin color. D, Excise the tumor. E, Suture the dermis and epidermis.
cant blood loss during surgery that required high-volume transfusion. Several operative techniques have been developed to prevent perioperative hemorrhage and include electrosurgery, application of adhesive or thrombotic materials, and intravascular embolization before surgical intervention. The use of electrosurgery devices such as monopolar, bipolar, and ultrasonic coagulators is simple and easy. However, these devices are ineffective in friable tissues as the coagulated tissue edge can easily collapse and cause bleeding. It is difficult to control hemorrhage in such cases because it is generally difficult to find the edge of vessels in collapsed tissue. Although the use of adhesive materials such as fibrin glue, platelet gel, and tranexamic acid are convenient, hemostasis achieved with these materials is not reliable and limited and often leads to rebleeding which cannot be easily controlled surgically. Therefore, these materials should not be used alone to achieve hemostasis.

Several reports have described preoperative intravascular embolization. Embolization is a useful means for managing acute hemorrhage and is suitable for most tumors regardless of location. Technical advancements in embolization techniques, such as microcatheter systems, have increased the potential for safe and effective treatment of life-threatening hemorrhage with an endovascular approach. However, embolization carries a risk of skin necrosis, which necessitates time-sparing treatment. Additionally, the precise vessel to embolize cannot always be identified.

Konno and Kishi demonstrated the effectiveness of using the LigaSure system in neurofibroma excision. Specifically, LigaSure achieves stable and reliable hemostasis by means of a simple technique. A mean burst pressure >900 mm Hg can be obtained for vessels of 3–7 mm diameter, which is comparable to the results obtained using surgical clips and sutures on vessels of the same size range. However, one of the most problematic aspects of using LigaSure is the long operative time required. On the other hand, the method using the Tsukisui device does not require the long operative time as additional time for electrical coagulation is not necessary. In addition, the method using the Tsukisui device does not require any special operative skills; an operator who has acquired ordinary plastic surgery skills can easily perform it. The only disadvantage of this method is that the size of the tumor that can be

### Table 1. Background and Outcome of Cases Treated by the Method Using the Tsukisui Device

| Case | Age (Sex) | Size and Site of Resection (cm) | Operative Time (h:min) | Perioperative Bleeding (ml) | Blood Transfusion | Complication |
|------|-----------|---------------------------------|-----------------------|----------------------------|------------------|--------------|
| 1.   | 40 (F)    | 5 × 12 cm left lateral chest    | 0:35                  | 30                         | None             | None         |
| 2.   | 35 (M)    | 18 × 8 cm left anterior chest  | 0:40                  | 120                        | None             | Partially open wound |
| 3.   | 39 (F)    | 8 × 35 cm left thigh to buttock | 0:45                  | 70                         | None             | None         |
| 4.   | 35 (M) (case 2, repeat surgery) | 12 × 4.5 cm left anterior chest | 0:40                  | 10                         | None             | None         |
| 5.   | 41 (F)    | 4 × 8 cm right groin            | 0:20                  | 10                         | None             | None         |
| 6.   | 14 (F)    | 12 × 9 cm anterior neck         | 0:54                  | 360                        | None             | Partially open wound |
| 7.   | 40 (F) (case 3, repeat surgery) | 10 × 34 cm left anterior thigh | 0:40                  | 90                         | None             | None         |
| 8.   | 41 (F) (case 5, repeat surgery) | 19 × 5 cm right lower abdomen   | 0:40                  | 10                         | None             | None         |

**Fig. 3.** Patient 6: A 14-year-old girl with a soft mass on her anterior neck at initial presentation (A), during the method using the Tsukisui device (B), and at 6 mo postoperative (C).
resected tends to be limited because the base of the tumor must be tied safely with a suture to achieve a complete ischemia. Too large a mass cannot be resected in one surgery by applying the method using the Tsukisui device; however, complete hemostasis can be achieved for even a large mass by performing 2 surgeries.

**CONCLUSION**

In conclusion, surgical treatment of neurofibroma can be complicated by difficulties in achieving hemostasis. The method using the Tsukisui device, which provided excellent hemostasis and was associated with few complications, shows promise for application to neurofibroma resection.

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