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Sequential multi-layered hemostatic sutures for stepwise removal of arteriovenous malformations: The pineapple technique

Dear Sir,

Arteriovenous malformations (AVMs) are a mass of vessels forming abnormal connections between arteries and veins and thus shunting of blood from a high-pressure into a low-pressure system.[1] The presence of AVMs can cause disfigurement and patient distress, tissue destruction, obstruction of vital structures, pain, spontaneous bleeding, ulceration with infection or even sepsis, and rarely cardiac overload and failure.[2]

Treating AVMs is challenging due to the high risk of massive peri-operative blood loss and incomplete excision leading to subsequent recurrence. Usually, preoperative angiography with embolization followed by surgical resection is performed. Although surgery can cure AVMs, complete excision is rarely possible due to their poorly defined margin, tissue penetration and involvement of vital structures. Various methods have been described to facilitate safe surgical resection, such as preoperative embolization, low-pressure anesthesia and auto-transfusion with limited success.

In our series of 8 patients surgical resection was indicated as debilitating or life-threatening symptoms were present such as spontaneous massive bleeding, neurologic symptoms secondary to compression and tissue necrosis. The sequential multi-layered hemostatic suture technique presented produces the visual effect of pineapple skin and facilitates a controlled debulking or complete excision of AVMs while drastically reducing the incidence of uncontrollable intra-operative bleeding. It also expedites surgery significantly. Intra-operative use of Doppler can prevent the insertion of hemostatic sutures through vital structures.

From 2004 to 2013, 8 cases of AVMs have been treated using this novel technique. Head and neck, upper and lower limb lesions were treated. We use CT-angiography to delineate the structure of the AVMs, and an MRI scan to visualize soft tissue penetration and its relation to vital structures. The exact part of the lesion which could be safely excised, without endangering any vital structures is noted. Numerous round 3—0 PDS™ hemostatic sutures are placed through the superficial layer of the AVM. The section of the mass surrounded by sutures is excised and new hemostatic sutures are placed on the raw surface. Repeated cycles of debulking and hemostatic suture placement ensure a controlled staged excision of the AVM with a small amount of blood loss. The mass is serially excised from a superficial layer to the deep (Figure 1). Eventually, complete excision of the mass can occasionally be achieved if vital structures are safe. Finally, the base of the wound is carefully reviewed to ensure haemostasis. If required, reconstruction can follow after considering the size, location and cosmetic outcome. Postoperative treatment of residual lesion with embolization or injection with sclerosing agents can be performed if indicated.

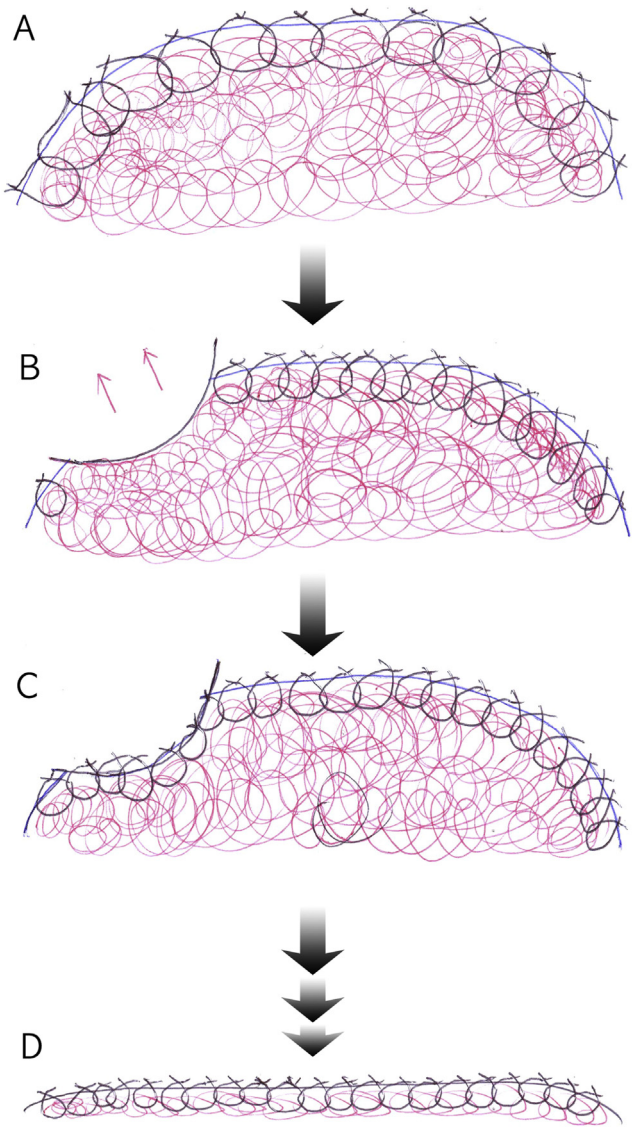

Figure 1 Graphic illustration of suture placement. (A) Dense hemostatic sutures are placed through the superficial part of the AVM. (B) Debulking of part of the AVM. (C) Replacement of hemostatic sutures over the area which has been removed. The above process is repeated until the desirable bulk of the lesion has been excised. (D) Cross sectional view of the final result, with hemostatic sutures controlling any residual lesion.

A 43-year old patient presented with an enlarging AVM of the neck. Progressive, positional upper limb numbness was reported. The lesion was 9 × 5 cm^2 in size, deep to subcutaneous tissues, with ill-defined borders to palpation and non-tender. The patient had embolization of the lesion twice before. CT-angiogram demonstrated branches of the left common carotid artery and the left subclavian artery supplying the AVM and close proximity to major neurovascular structures. The AVM was nearly completely excised using the technique described (Figure 2). Intraoperative blood loss was measured to be below 150 cc, and the patient suffered no peri-operative complications.

Methods previously used to treat AVMs include symptomatic treatment of their sequelae such as dressing for ulcers or spontaneous bleeding control, selective embolization, surgical debulking/excision, or a combination. Selective embolization is a popular option and can be used primarily or as an adjuvant modality to surgery.[3,4] But recurrence is common after embolization such lesions by a process of re-canalization. Embolization also carries a significant risk of tissue ischemia of unpredictable extent and subsequent necrosis.[4]

Debulking, is indicated when surgery is performed urgently to control massive bleeding or when the lesion encroaches on vital organs or structures. Due to the nature of the lesions, when debulking or excising AVMs, intraoperative uncontrolled bleeding is a major concern. Creation of compartmentalization for the lesion was designed with combination of surgical debulking with a sclerosing agent into each compartment aimed at control of bleeding.[5] Disadvantages arising from use of sclerosing agent include inflammation and induction of edema leading to other complications, for example, pain, fibrosis and infection.

Our method relies on vessel collapse after mechanical ligation. As the excision progresses from a superficial to a deeper layer, keeping the anatomy of vital structures in mind can prevent injury. This "pineapple technique" can also be applied for the excision of any type of vascular tumor or in the palliative debulking of extensive cancerous masses.

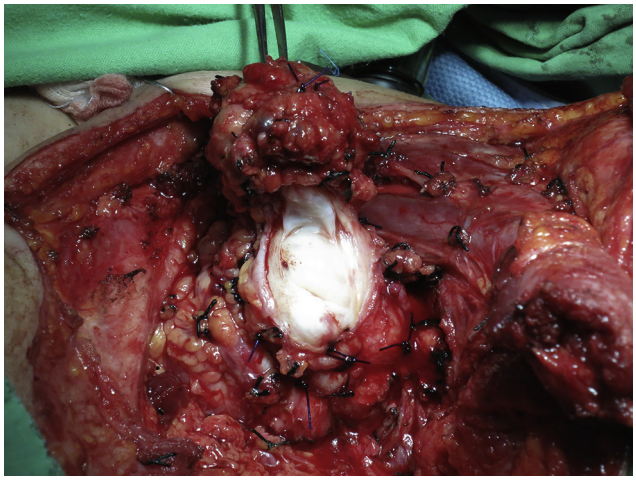

Figure 2 The vessels had been well controlled with round 2—0 PDS™ sutures before division of the outer part of the AVM. It resulted in minimal bleeding from the resection margin. Then more sutures were applied before further excision of the rest of AVM.

In summary, the four essential points of our technique are[1]: serial excision from superficial layer to the deep layer,[2] use of intraoperative Doppler during the serial excision allows protection of vital structures behind the lesion,[3] facilitating near total excision and[4] minimizing the risk of inside tissue necrosis resulting from the surgery.

Acknowledgment

The authors declare that they have no conflicts of interest to disclose.

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