Surgical Treatment of Vascular Malformations in the Hand

33

Piero Di Giuseppe

Abstract

As the hand is an organ of many different structures, located in a small space, with a high functional value, congenital vascular malformations (CVM) may easily involve many tissues, presenting complex clinical pictures that are difficult to treat. Surgical treatment is possible but general principles of hand surgery should be followed. Skin incisions should be carefully planned to save hand function. Bleeding is reduced by the use of a tourniquet. Magnification with a microscope during surgery is crucial for a precise dissection and recognition of neurovascular pedicles. In case of nerve involvement, external neurolysis is the first choice, as interfascicular treatment is a risky procedure. Total or partial resection of infiltrated muscles should be carefully performed, according to their function. Intraosseous arteriovenous (AV) malformations are best treated by direct occlusion through alcohol or glue injection, avoiding surgery.

Introduction

The hand has a very complex function strictly related to its particular anatomy: its sensorial and motor functions are interdependent [1]. Congenital vascular malformations (CVM) in the hand may involve any structure, and are often atypically distributed [2]. As many different tissues of high functional value are located in a small space, clinical pictures can be extended and complex and can involve skin, bones, nerves, muscles and tendons, posing special therapeutic problems. To surgically treat CVMs in the hand, the fourth principle of Belov should be followed: a functional radical operation should be performed, meaning as radical as possible, to avoid recurrences, and as sparing as feasible in order to preserve or restore hand function [3, 4].

Surgical strategies can consist of single or multiple stage surgery, alone or associated with other procedures, such as sclerotherapy, embolization or laser treatment [5–7].

Surgical techniques should respect general principles of hand surgery, including skin incisions and skin undermining and the selection criteria of structures to be resected according to their function. Techniques and timing of hemostasis and postoperative bandage should also be performed correctly.

General Principles of CVM Surgery in the Hand

Skin Incisions

The skin in the hand works like a distinct organ with its own passive motor function. The dorsal skin of the hand is more elastic, while the palmar skin is more adherent and sensitive. The elasticity of the skin in the web spaces allows independent movements of the fingers; scar contracture precludes mobility even if all the other structures are normal. When skin incisions are planned scar lines should be mainly at the level of skin creases in order to avoid scar contracture.

There are some typical incisions in hand surgery. Each of these incisions can be performed alone or combined with others. CVMs may be sometimes difficult to approach through conventional incisions; atypical incisions may sometimes be necessary.

Incisions for hand surgery should respect some basic principles:

1. Limited skin undermining and preparing of flaps that offer large exposure of the deep structures should be planned.

R. Mattassi, D.A. Loose, M. Vaghi (eds.), *Hemangiomas and Vascular Malformations*.

2. Web spaces and joint creases should be respected by broken incisions to avoid scar contracture (Fig 33.1a).
3. Scars from previous surgery influence the choice of new incisions. A flap should not be performed with a previous scar at its base. Incisions should be planned in order to permit extensions, when necessary. Drawing the contour of the CVM mass on the skin before marking the incision lines is helpful in order to better approach the malformation (Fig. 33.2a).

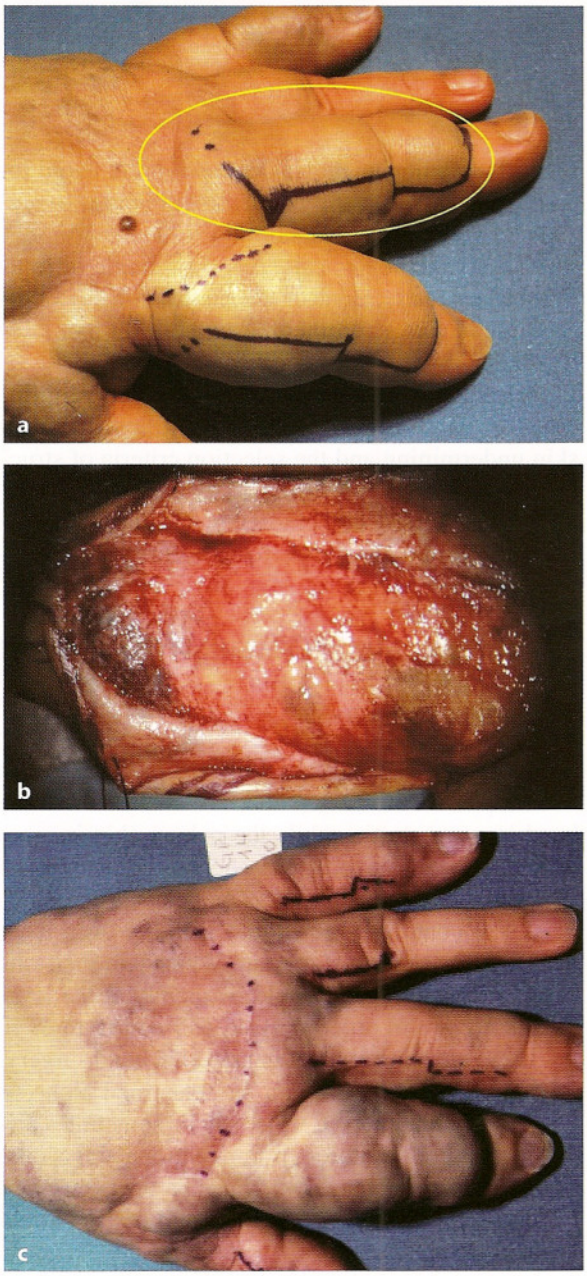


Fig. 33.1. Multistage surgical treatment of venous malformation of the hand. **a** Marking of incisions on the dorsolateral aspect of the middle finger. **b** Subdermal surgical undermining under microscope shows the avascular plane and exposition of the involved tissue (skin sparing technique). **c** Late result showing scars from previous operations at the time of index finger surgery. Figures 33b, 33c reproduced from [8]

Skin Sparing Technique

Skin sparing is possible by subdermal undermining, which should be carefully done with a scalpel to preserve subdermal vascular networks. This allows minimal blood loss and saves skin flaps for coverage (Fig. 33.1b). It is best performed under a microscope or with loupe magnification.

Use of a Tourniquet

A tourniquet reduces bleeding and is useful for microsurgical techniques, especially in venous malformations. In arteriovenous (AV) malformations, a tourniquet is best applied after preparation of the fistulous area, as fistulae may be difficult to recognize during ischemia [8].

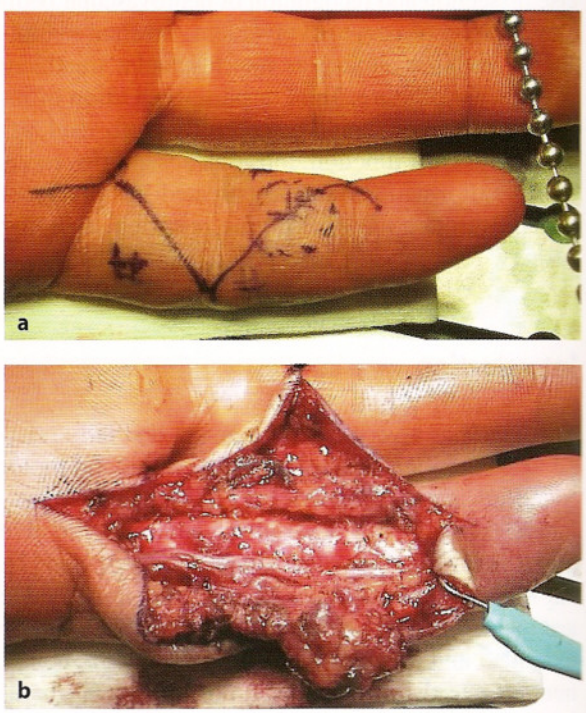
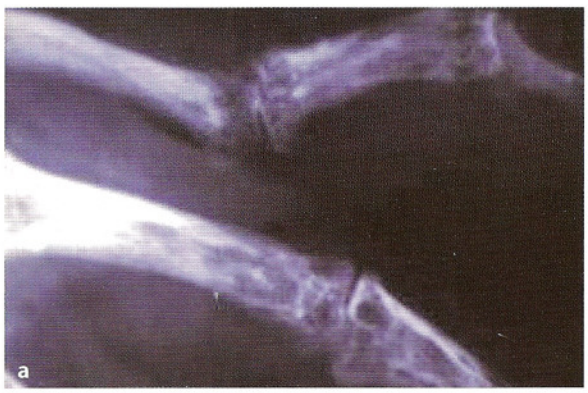
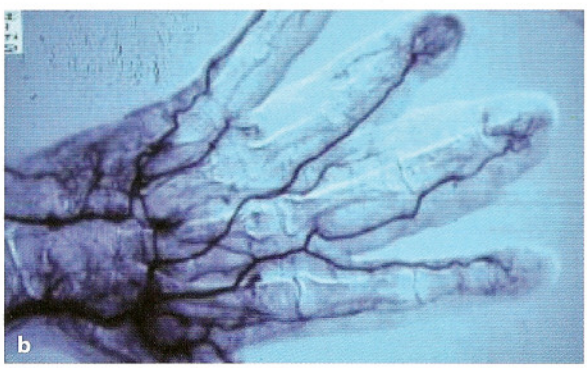


Fig. 33.2. Arteriovenous malformation in the volar aspect of the little finger. **a** Two fistulae areas guided the choice of a Brunner incision. **b** Neurovascular bundles used as a guide for the dissection of the malformed tissue. Tourniquet and microscope control reduced bleeding and resulted in a safe radical excision

Microscope

CVMs often enclose nerves and a direct approach may be difficult and risky for the patient. In these cases microsurgical techniques permit neurovascular pedicles to be isolated with extreme precision, following their course inside the vascular lesion. The resulting dissection is then much more precise and permits not only the integrity of the nerves to be respected, but can also be used as a guide during the dissection of CVM (Figs. 33.1b, 33.3b, c).





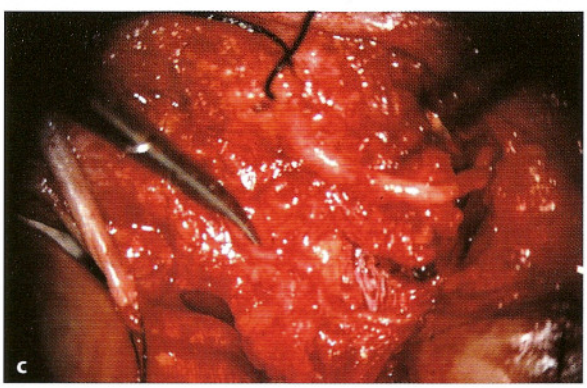


Fig. 33.3. Venous malformation. **a** Important bone involvement with proximal interphalangeal (PIP) joint instability mainly in the ring finger. **b** Angiography shows multiple digital artery damage during previous operations. **c** Dissection of nerves and arteries is more accurate and safe under microscope magnification

This technique lengthens surgery time but allows a precise dissection which is essential in difficult cases [8].

Tissue Involvement: Clinical Pictures and Surgical Treatment

One of the main challenges in this surgery is the involvement of surrounding structures, such as bone, nerves, muscle, tendons, ligaments and skin. CVM inside tissues may cause infiltration or compression [9].

Skin Involvement

In venous CVM, the skin is thinned by compression. A subdermal dissection is possible, preserving skin flaps and reducing bleeding ("skin sparing technique") (Fig. 33.1) [10].

In AV CVM, the subcutaneous tissue is involved and the skin is damaged by ischemia or direct infiltration.

In lymphatic CVM, the subcutaneous tissue is firmly infiltrated and fatty tissue is hypertrophic. The best procedure is an en bloc resection of the CVM after a precise skin drawing of involved areas with a correct orientation of final scars (Fig. 33.4).

However, the involvement of other tissues is the main challenge in surgical treatment of VM of the hand: the most difficult to treat areas are bones and nerves. Tendons are seldom affected, while synovia and muscles are commonly involved.

Bone Involvement

Bones can be affected in venous, AV and also in lymphatic CVMs.

Standard radiograms are the best diagnostic method and should be always performed before surgery of CVMs (Figs. 33.3a, 33.5b). Percutaneous direct bone puncture and intraosseous pathological vessel occlusion by ethanol or glue injection seems to be the best treatment. In many cases these procedures should be performed before surgery (Fig. 33.5a–c) [11].

Nerves

Nerves may be surrounded or infiltrated by a CVM. The main dilemma is to choose between resection

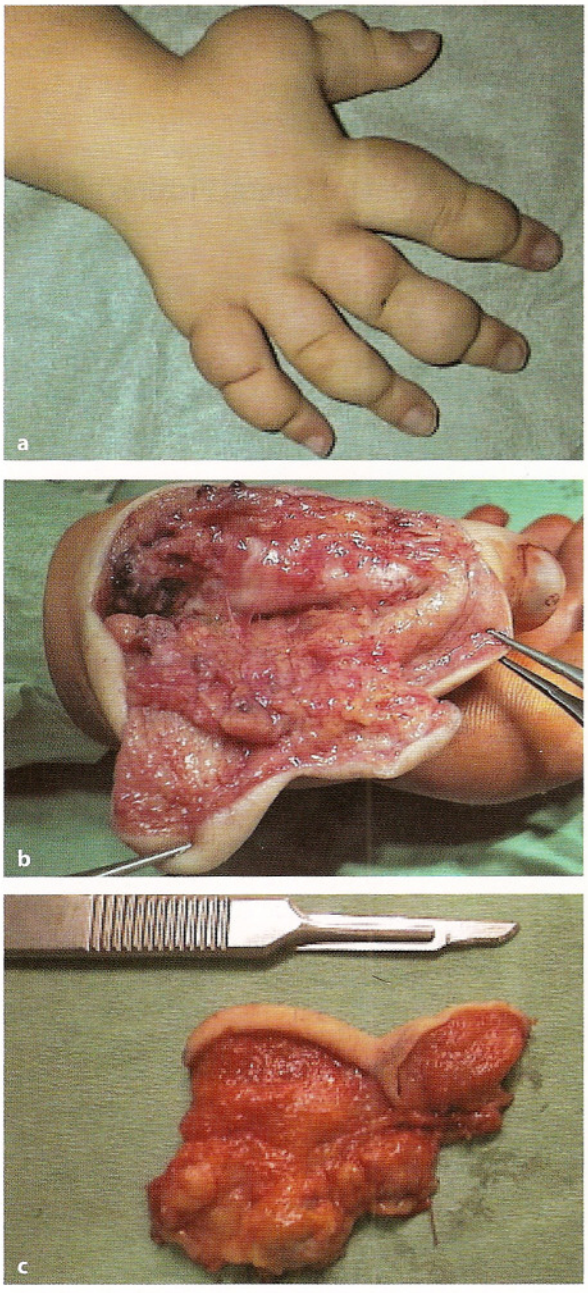


Fig. 33.4. En bloc excision of lymphatic malformation in the thumb of a young girl. **a** Clinical picture. **b** Radical resection of a planned segment of skin and underlying hypertrophic subcutaneous tissue. **c** Specimen of the removed tissue

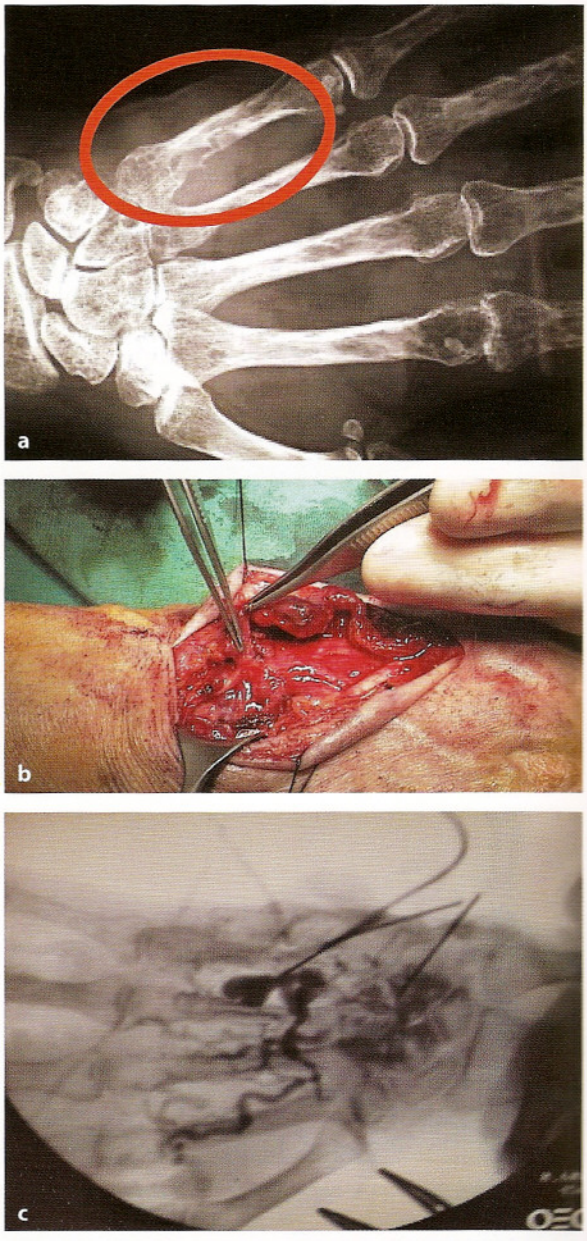


Fig. 33.5. Arteriovenous malformation with intraosseous fistulae. **a** Radiogram shows the extent and site of bone involvement (*red circle*). **b** Subcutaneous AV fistulae have been removed and communicating vessels to the bone are clearly seen. **c** Direct alcoholization of bone fistulae reduced the malformed tissue in a few minutes

of surrounding malformed vessels only, or to extend surgery inside the nerve. In our experience, external decompression should be the first procedure used to reduce symptoms (Figs. 33.2, 33.6).

Internal interfascicular neurolysis is a risky procedure and may lead to irreversible nerve damage, immediately or later as a result of scarring. Selective resection and nerve grafting should be the final option, performed only in case of severe pain and after failure of external resection of CVMs.

In case of nerve damage during surgery, immediate repair by suture or graft should be performed. To prevent damage, the best procedure is to follow the nerves as a guide through the malformation starting from a non involved area (Fig. 33.2). A direct approach can be risky.

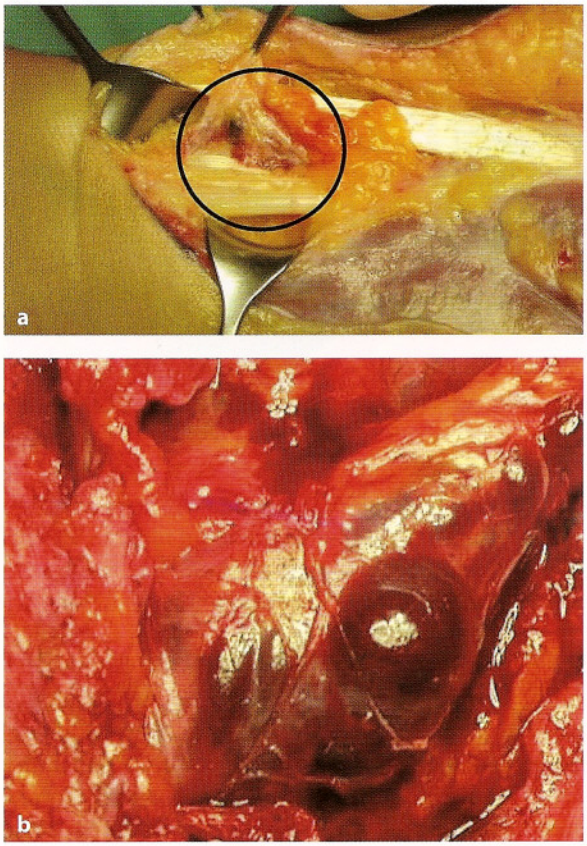


Fig. 33.6. Arteriovenous malformation involving nerves in the forearm. **a** External compression of the median nerve in the proximal forearm (*circle*). **b** AV fistulae infiltrating the epineurium of the median nerve near the wrist

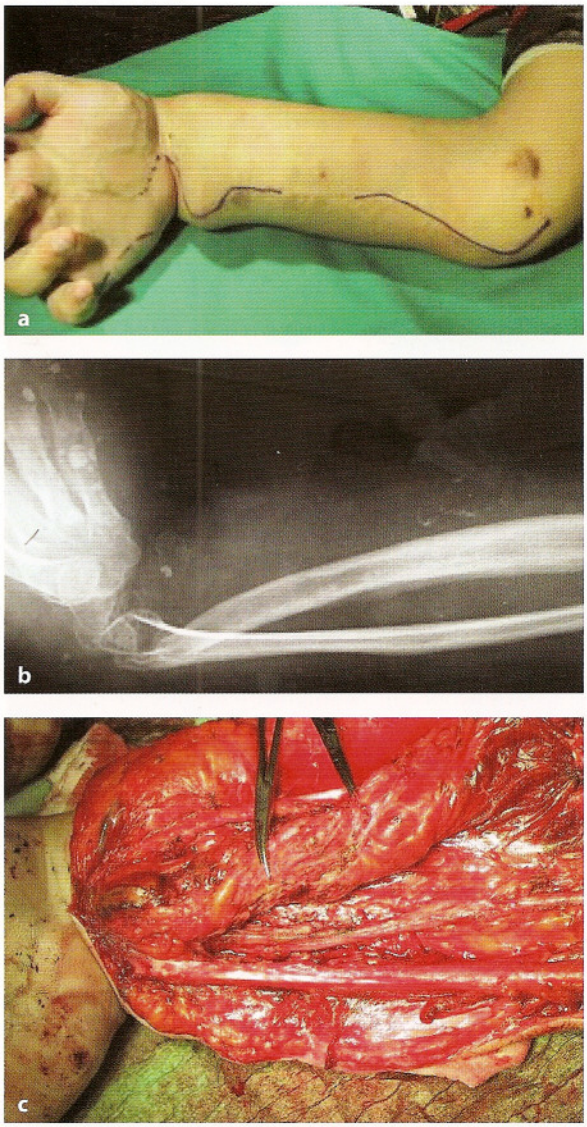


Fig. 33.7. Extended venous malformation with secondary deformities of bones mainly at the wrist, wrist stiffness and flexor muscle contracture following several operations and sclerotherapy. **a** Incision along the ulnar side of the forearm. **b** X-ray shows wrist bones deformity and phlebolites. **c** Dissection of the ulnar nerve from the elbow to the wrist. Flexor carpi ulnaris muscle entirely removed and flexor digitorum superficialis elongated

Muscles

Total resection of expendable muscles is a common procedure (Fig. 33.7), especially when they are extensively infiltrated. Partial resection of an important muscle or a group of muscles is also possible according to the severity of infiltration and the possibility of maintaining or restoring function. Non resectable infiltrated muscles can be treated by foam sclerotherapy, direct alcohol injection or echoguided lasertherapy [9].

Tendons

Tendons are generally not involved directly by CVMs. However, tendon sheets are frequently involved; synovectomy is a safe and effective operation (Fig. 33.8).

Attention must be paid to important structures such as pulleys of flexor tendons and complex extensor digital systems.

Conclusion

Surgical treatment of CVM of the hand is feasible. If properly planned, it can be effective and safe. A multi-stage and multidisciplinary approach is recommended. Some technical devices such as the microscope and tourniquet can be used. Both devices allow a bloodless and accurate dissection of malformed tissues to be performed, particularly in the

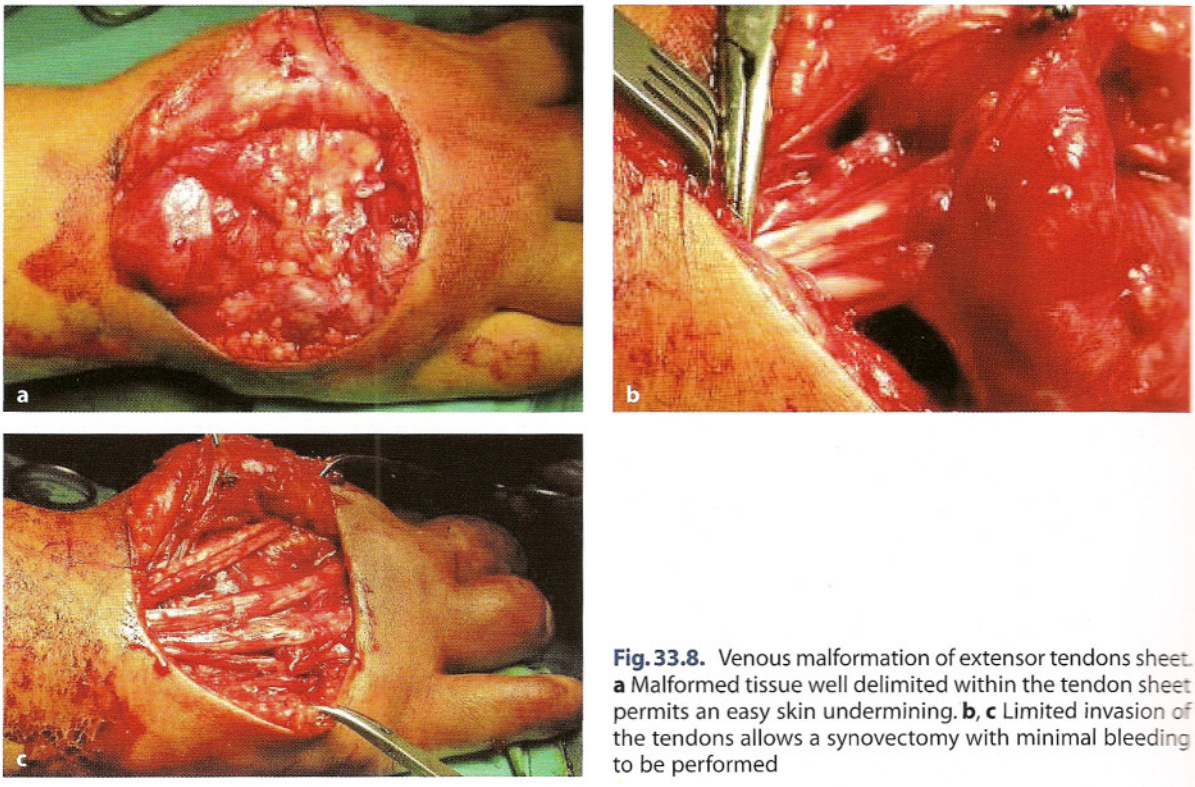


Fig. 33.8. Venous malformation of extensor tendons sheet. **a** Malformed tissue well delimited within the tendon sheet permits an easy skin undermining. **b, c** Limited invasion of the tendons allows a synovectomy with minimal bleeding to be performed

treatment of venous anomalies, which are the most common CVM. Nerves can be used as a guide for dissection of CVMs and skin can be saved by a careful subdermal undermining.

Tissue involvement of VM is a major problem in the hand. The more difficult challenge is infiltration of nerves and bones. For nerves, external neurolysis is our first choice, for bones direct sclerotherapy is useful. Muscles are frequently involved and can be totally resected if judged expendable. Tendons are seldom affected, but if the synovial sheet is involved it can easily be removed.

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