

Management

Management

Many patients with asymptomatic varicose veins do not progress - to develop complications, although a significant proportion do, and there is no clear confirmatory evidence that treating such patients prevents the development of future complications. There is clear evidence, however, that those with symptoms and/or complications see a significant quality-of-life benefit from treatment to remove or ablate refluxing superficial veins. When interventional treatment is planned there are considerable variations in practice and treatment strategies. A detailed description of the nuances, merits and criticisms of the various options is beyond the scope of this chapter; however, a description of the basic treatment modalities available is presented below. An experienced surgeon will have his/her own preferred methods, but will frequently employ several or all methods in chosen circumstances, not infrequently in the same patient. Compression hosiery relies on graduated external pressure to improve deep venous return and reduce venous pressures. It may be knee length or thigh length; there is no evidence which length of stocking is more effective and hence below-knee stockings are usually prescribed as they are easier to don and have much better patient acceptance. Compression hosiery is classified according to the pressure it exerts: the British classification class 1 stockings exert pressure of 14–17 mmHg, class 2 exert 18–24 mmHg and class 3 exert 25–35 mmHg. Compression hosiery significantly improves varicose vein symptoms but is not popular with patients, with compliance rates and long-term tolerance being universally poor. There is no evidence to suggest that compression hosiery prevents the occurrence or progression of varicose veins. Furthermore, incorrect application of compression hosiery can have serious consequences (pressure necrosis, tourniquet effects); thus assessment, prescription and application of compression hosiery should be limited to those with the appropriate skills and training. There are level 1 trial data to demonstrate that interventional treatment offers superior improvements in quality of life and is cost-effective. Compression is therefore to be regarded as an adjunct to assessment or treatment, unless by patient choice.

Endothermal ablation Endothermal ablation technologies replaced surgical ligation and stripping as the gold standard treatment once randomised trials demonstrated that they were marginally safer, have extremely high technical efficacy, offer superior quality of life post procedure (with a rapid recovery) and equivalent improvements in quality of life in the longer term. The techniques are cost-effective as they can be performed as an outpatient under local anaesthetic. The basic concept is that a treatment device is inserted into the incompetent axial vein percutaneously. The vein is surrounded by tumescent local anaesthetic solution. This compresses the vein onto the treatment device, emptying it of blood. It also hydro-dissects tissues such as nerves away from the zone of injury. Finally, it acts as a heat sink, mopping up excess thermal energy to prevent remote damage. The treatment device then produces thermal energy that destroys the structure of the vein, resulting in permanent occlusion. Two broad technologies exist: laser ablation and radiofrequency ablation (RFA). Laser ablation Endovenous laser ablation (EVLA) utilises a small flexible glass fibre that is inserted into the vein. Laser energy (typically at a wavelength of 1470 nm) is transmitted down the fibre and is absorbed at the point of treatment at the end of

the fibre. Absorption of this radiation results in a vigorous generation of thermal energy. The tip of the fibre may be bare, focusing the energy in a very small area; divergent forward firing, spreading the energy over a larger area; or divergent side or radial firing. It is postulated that the last two designs allow a more even distribution of energy, reducing vein wall perforations that Friedrich Trendelenburg, 1844–1924, Professor of Surgery successively at Rostock (1875–1882), Bonn (1882–1895) and Leipzig (1895–1911), Germany. The Trendelenburg position was first described in 1885. bruising. There is no clear evidence to support one design over another. This procedure is very good for treatment of any vein that will allow the passage of a guidewire. No technique has reported a higher technical efficiency rate. The procedure begins with ultrasound-guided marking of the truncal vein to be treated and the site of proposed cannulation. The varicosities are also marked at this stage if concomitant treatment (phlebectomy or foam sclerotherapy) is to be undertaken. The patient is then positioned on the procedure couch in the reverse Trendelenburg position. For the GSV, the patient is supine with the hip of the leg to be treated externally rotated and slightly flexed. A pillow under the contralateral hip/lower back may improve patient comfort. For the SSV the patient is positioned in the prone position. The vein is then cannulated percutaneously under ultrasound guidance, at the lowest point of reflux. Some devices allow passage of the fibre directly through a short sheath, while others use a wire first, allowing passage of a catheter that then carries the laser fibre. The former is slightly faster with fewer steps; the latter allows greater success with more tortuous veins. Accurate positioning of the fibre tip with ultrasound is crucial (Figure 62.16), but the exact location is controversial, with some surgeons positioning the tip several centimetres distal to the junction and others aiming for a flush occlusion. Proponents of the former cite that this strategy protects the deep vein from inadvertent damage and/or thrombosis. Proponents of the latter argue that neoreflux in junctional tributaries is a common pattern of recurrence and that in expert hands the rate of deep vein injury is no different and the thrombosis rate may be lower (presumably as there is minimal patent stump - in which to form thrombus). Following the administration of perivenous tumescent anaesthesia (Figure 62.17), the ablation can be performed. Practice varies as to the power of the laser and the withdrawal speed, but commonly an energy delivery -

Deep vein Figure 62.16 Endovenous laser ablation; B-mode longitudinal imaging during catheter tip positioning at the saphenofemoral junction. The saphenofemoral junction is highlighted (in blue) with an arrow pointing to the catheter.

There is no clear evidence to guide the optimal power and pullback speed. Compression is usually applied following treatment, but there is no consensus over the method, degree or duration, and this is true of postprocedural compression with all techniques. Radiofrequency ablation RFA uses the same treatment principles, but an electromagnetic current is used to create the thermal energy. A range of different devices have been created but the most popular, which has the most supportive evidence, is the ClosureFast™ device (Medtronic) (Figure 62.18). This device has a wire coil on the end of a treatment catheter. The generator passes an electrical current through the coil until the surrounding temperature reaches 120°C. This is then maintained for a treatment cycle of 20 seconds. The coil is then withdrawn for a set length and another treatment cycle is commenced. Coils of 3 cm and 7 cm are produced, with the latter increasing the speed of treatment, while still being suitable for most anatomies. RFA. The evidence is generally equivocal, with both treatments having relative advantages and

disadvantages; choice often comes down to personal preference. Both are excellent treatment options and can be applied successfully to the majority of patients. There have been a range of studies comparing EVLA and RFA. The evidence is generally equivocal, with both treatments having relative advantages and disadvantages; choice often comes down to personal preference. Both are excellent treatment options and can be applied successfully to the majority of patients. Some summary points: Both treatments have a very high efficacy (>95% closure rate) and are suitable for treatment of the vast majority of patients presenting with superficial vein reflux in association with superficial axial incompetence. Veins that are very tortuous may still be suitable for endo-thermal ablation but require a guidewire and in the case of EVLA, a catheter-based, rather than direct fibre system. Both techniques offer this.

(a) (b) Figure 62.17 (a) Ultrasound-guided infiltration of perivenous tumescent anaesthetic via a long spinal needle. The anaesthetic solution is infiltrated using an electronic foot-operated pump; (b) ultrasound image of a perivenous 'halo' of anaesthetic solution around the vein and catheter in transverse section.

Figure 62.18 Radiofrequency ablation with ClosureFast™ introducing the treatment catheter through a sheath. The distal 7 cm of this device comprises a metal coil.

allowing direct and targeted delivery of adjuvant foam sclerotherapy, e.g. to ablate areas of neovascularisation. This is more difficult with radiofrequency catheters due to a smaller lumen (0.018 versus 0.035 in), but it is still possible. Advantages in favour of RFA over EVLA include: The core skill set to plan and perform these procedures is the same; however, EVLA requires an understanding of power settings and pullback speeds, whereas a radio-frequency device typically has a set treatment cycle on a single button press. This reduces the device-specific learning curve and the possibility of a novice making a mistake with the energy delivery. The automatic treatment cycle also frees the surgeon's focus, allowing better communication with the patient and with care, concurrent treatment, e.g. infiltrating local anaesthetic into the tributaries and performing phlebectomy, reducing procedural times. EVLA requires specific laser safety protocols including the design and function of the room as well as specific training for the operator and theatre team. This can have an impact on the set-up and flexibility of the service. RFA may be associated with a marginal reduction in pain and bruising, although this has not been shown to impact on periprocedural quality of life or recovery. Advantages in favour of EVLA over RFA include: When it comes to veins that are very large in diameter (>15 mm) EVLA can be a better option, allowing an increase in energy delivery and higher efficacy rates. EVLA consumables are typically much less expensive; however, costs vary by device and market and the price difference has reduced over time. A standard EVLA fibre may be used to treat perforators, whereas a specific additional device is typically required for perforator management remain uncertain. As endothermal ablation treats only junctional and truncal incompetence, debate exists regarding the management of varicosities. These can be managed concomitantly or sequentially by either phlebectomy or sclerotherapy. Concomitant phlebectomy (Figure 62.19) results in a more rapid improvement in disease-specific quality of life, and allows the vast majority of patients to complete treatment in a single visit. Non-endothermal, non-tumescent ablation Endothermal ablation was a large step forwards in the management of superficial incompetence; however, all techniques require the injection of tumescent local anaesthetic solution and this can be uncomfortable for the patient. Other techniques that avoid injection are being developed. - Ultrasound-guided foam sclerotherapy Sclerotherapy is the original non-endothermal, non-tumescent technique and has been performed for over 100 years. It involves the injection of a sclerosing agent directly into the superficial veins. The most commonly used is sodium tetradecyl sulphate. The direct contact with detergent causes cellular death and initiates an inflammatory response, aiming to result in thrombosis, fibrosis and obliteration (sclerosis). Blood deactivates the action of the sclerosing agent and the doses administered need to be limited to avoid adverse effects, causing a trade-off between poor efficacy and safety. This led to the development of ultrasound-guided foam sclerotherapy (UGFS). The use of foam increases the effective volume of the agent, maximising endothelial contact and displacing any blood that deactivates it. The procedure commences with the patient standing, and the sites of venous cannulation are selected and marked using ultrasound. With the patient supine, the major venous trunks and superficial varicosities to be treated are then all cannulated using ultrasound guidance prior to any injection (Figure 62.20). Once all injection sites are cannulated the foam can be prepared. The most widely used method is that of Tessari; this utilises two syringes connected using a three-way

Figure 62.19 Phlebectomy performed under tumescent anaesthesia following endothermal ablation. Figure 62.20 Foam sclerotherapy; cannulation of veins during ultra

sound-guided foam sclerotherapy.

tap. A 1:3 or 1:4 ratio mixture of sclerosant and air is drawn into one syringe, and is then oscillated vigorously between the two syringes about 10 or 20 times (Figure 62.21). The foam produced in this way is stable for about 2 minutes so it should be injected as soon as it has been made. The leg is then elevated to empty the veins of blood, and injection of foam commences first with superficial varicosities and ends with injection of the GSV or SSV . Only 1–2 mL of foam should be injected at a time and the distribution of the foam should be monitored and massaged with the ultrasound probe. When the foam is visualised at the site of junctional incompetence no further foam should be injected. The maximum volume of foam that should be injected at a single session should not exceed 10–12 mL as the incidence of complications is directly related to the volume of foam injected. Compression is then applied as following endothermal ablation. While it is postulated that compression may have a larger effect upon efficacy for this treatment, practice is not informed by evidence and a wide variation exists. Outside of a small number of centres, the efficacy of UGFS is significantly worse than for endothermal ablation, leading to high reintervention rates, and the rates of complications such as phlebitis and pigmentation can be high. UGFS does however carry some significant advantages: It avoids tumescent anaesthetic and is therefore a less painful procedure (although postoperative pain is probably similar). No axial or tributary veins are too tortuous. It also allows the treatment of calf veins with overlying skin damage or ulceration without the need to pierce through damaged skin. Consumable treatment costs are very low . These factors mean that many surgeons using endothermal techniques also use foam sclerotherapy as an adjunct in specific circumstances. Catheter-directed sclerotherapy and mechanochemical ablation The efficacy of sclerotherapy relies on endothelial contact with fresh, undiluted sclerosant. Some have therefore experimented with catheter-delivered sclerotherapy rather than trying to milk the sclerosant down the vein lumen. There is no good evidence to date that this increases efficacy and the technique is not in widespread use. A related technology that has shown more promise is mechanochemical ablation (Figure 62.22). This involves a lead wire from the end. treatment device that deploys an ang This

attaches to a motorised handle. The catheter is placed within the vein lumen as for endothermal ablation. The trigger - on the handle is depressed, spinning the wire around and liquid sclerosant is infiltrated via the catheter simultaneously during catheter withdrawal. It is thought that the spinning wire causes physical damage to the endothelium and allows a deeper penetration of the sclerosant into the vein wall. The technique is possible in most cases without tumescent anaesthesia, although a small number of patients find the procedure uncomfortable - and the device can 'snag' on the vein, tearing it or rarely stripping it altogether. Comparative studies with endothermal ablation suggest similar early efficacy rates but increased medium-/ long-term recanalisation rates. The axial ablation is usually less painful than endothermal ablation, but this advantage is lost when it is combined with phlebectomy of the tributaries; therefore, it is uncertain whether it can replace endothermal ablation, unless axial ablation is to be performed in isolation. Treating longer veins can also be challenging owing to limitations in catheter length and the safe dose of sclerosant. It is a good choice for a patient with needle phobia who is happy to forgo treatment of varicose tributaries. Endovenous glue The final non-tumescent technique is the endoluminal application of cyanoacrylate adhesive (Figure 62.23). Again, this involves a treatment catheter placed within the vein lumen. A handle is used to infiltrate the adhesive in 0.1-mL applications via the catheter. The vein is then compressed, sealing the results are similarly promising and lumen closed. Early efficacy patients experience minimal intraprocedural pain. Long-term results and the optimal management of tributaries are unknown (similar to mechanochemical ablation). The consumable costs are currently the highest for any venous ablative technique.

Figure 62.21 Foam sclerotherapy; Tessari method of foam sclerosant preparation. Figure 62.22 Mechanochemical ablation device (reproduced with permission from Vascular Insights).

Open surgery The principles of traditional ligation and stripping are to fully dissect the point of junctional incompetence and to remove the refluxing axial vein and dilated tributaries. The operation is usually performed under general anaesthesia but locoregional anaesthesia is used by some; the infiltration of tumescent local anaesthesia around the axial vein prior to stripping may have some advantages, but is not widely used. The role of open surgery as a primary treatment of a refluxing superficial axis has been considerably reduced with the development of the minimally invasive techniques described above, the long-term results of which are at least comparable to open surgery but with significantly less morbidity and faster recovery . Experienced endovenous surgeons do still use open surgery in some circumstances and a venous surgeon needs to be trained and experienced in this area. Surgical adjuncts including phlebectomy and, occasionally , perforator ligation are much more commonly used, and the former has been shown to have a significant impact upon outcome. Saphenofemoral ligation and great saphenous stripping An oblique groin incision is made at the level of, and lateral to, the pubic tubercle, ideally above the groin crease. The GSV is identified and dissected to the SFJ, which should be clearly established before the vein is divided to avoid disastrous inadvertent transection of the superficial femoral vein. The anatomy is often variable but six GSV tributaries may be encountered close to the SFJ: /uni25CF Laterally: /uni25CF superficial inferior epigastric vein; /uni25CF superficial circumflex iliac vein. /uni25CF Medially: /uni25CF superficial external pudendal vein; /uni25CF deep external pudendal vein. /uni25CF Distally: /uni25CF anterior accessory of the great saphenous vein; /uni25CF posteromedial thigh vein. Classically , these are ligated distal to their divisions. A flush SFJ ligation is then performed and the GSV retrogradely stripped to around the knee (Figure 62.24).

Phlebectomy is performed as discussed above. Closure of the cribriform fascia, with sutures or synthetic patches over the ligated SFJ, does not reduce groin recurrence. - - Stripping to the lowest point of reflux may improve results, but at a cost of increased saphenous nerve complications and is not widely performed. More recently, some surgeons have argued that surgical trauma and subsequent inflammation in the groin are associated with neovascularisation, which in turn may lead to recurrence. Furthermore, others hypothesise that it is the loss of the normal groin tributaries that may be responsible for driving the process of neovascularisation. These concepts have led some to believe that ligation of the refluxing vein should be distal to the tributaries and that the junction itself should be left untouched. There is no clear clinical evidence to support these hypotheses.

Figure 62.23 Endovenous glue device (reproduced with permission from Medtronic Inc.). Femoral vein Ligature Point of division Great saphenous vein Figure 62.24 Saphenofemoral junction ligation and great saphenous vein stripping.

Saphenopopliteal junction ligation and small saphenous stripping Preoperative duplex to mark the position of the SPJ is highly recommended (Figure 62.25). The patient is positioned in the prone position, a transverse incision is made over the premarked SPJ, the fascia is divided and the SSV is exposed. The SPJ can then be formally dissected with a flush ligation or the SSV can be gently retracted and ligated as proximally as possible. No good evidence exists to favour one technique over the other; proponents of the flush ligation would argue that it avoids leaving a stump of SSV, a common source of recurrence, while proponents of the simple SSV ligation technique argue that it reduces the incidence of the most common serious complications - nerve injury and popliteal vein injury. The SSV can then either be stripped or the proximal section excised. Those who strip argue that ligation of the vein can be better it reduces the incidence of recurrence, while opponents feel it increases the incidence of sural nerve injury. There are no randomised trials comparing these techniques. Once again, phlebectomy is then performed. Adjunctive surgical techniques Phlebectomy This may be performed following treatment of junctional incompetence and axial vein reflux, or as a sole treatment under local anaesthetic in patients with isolated tributary incompetence, or possibly in very early axial reflux, which duplex ultrasound. Phlebectomy is usually performed through small stab incisions using small mosquito forceps and/or phlebectomy hooks that have been demonstrated to be superior - in terms of bruising, pain and generic quality of life - to transilluminated-powered phlebectomy (Figure 62.19). Perforator ligation The majority of studies assessing the role of perforator ligation have been in patients with venous ulcers, analysing the effects on ulcer healing; even in this situation randomised data are lacking. The role of perforator ligation in patients with uncomplicated varicose veins is even less clear. In uncomplicated varicose veins perforators may be ligated through a small, duplex-guided incision, while in patients with skin changes subfascial endoscopic perforator ligation may be preferred, although the benefits are unproven. Perforators can also be ablated with endovenous techniques. Complications of standard varicose vein surgery Complications (minor and major) are reported in up to 20% of patients who undergo traditional varicose vein surgery. Wound infections, the most common complication, are reduced by prophylactic antibiotics. Nerve injury is the most common serious complication. The incidence of saphenous nerve neuralgia is up to 7% following GSV stripping to the knee (the incidence is higher with stripping to the ankle). The incidence of sural nerve neuropraxia and common peroneal nerve injury may be as high as 20% and 4%, respectively, following SSV surgery. The incidence of venous thromboembolic complications is approximately

0.5% following varicose vein surgery; however, patient risk factors must be individually assessed and appropriate prophylaxis administered according to guidelines. Recurrent varicose veins

Approximately 10–20% of patients who present to hospital with varicose veins have had previous intervention. Prospective data on long-term results following intervention for recurrent varicose veins are sparse and the criteria for defining recurrence are variable. Significant clinical recurrence 5–10 years following varicose vein surgery occurs in 10–35% of patients, but minor/duplex-detected recurrence is much more common, being of the order of 70%. Causes of recurrence include: neovascularisation in the residual axial vein, inadequate initial ligation, re-surgery and new junctional reflux. Neovascularisation is the development of new veins within postsurgical tissue. These over time can span the tissue between veins lack valves and over a ligated junction and nearby tributary veins. If significant in size and/or number, these may contribute to recurrent venous hypertension. Recurrence is more common following SSV surgery than following GSV surgery, and in patients with high body mass index, while stripping of the incompetent axial vein reduces recurrence rates. Limited data suggest that recurrence rates recur following endovenous thermal ablation may be lower than

Figure 62.25 Preoperative marking of the saphenopopliteal junction and small saphenous vein mapped using duplex scanning.

atypical distribution and duplex assessment is mandatory (Figures 62.26 and 62.27). Open surgery for recurrent varicose veins is associated with a high (40%) complication rate, the most common being lymph leak and wound infection, thus endovenous interventions would seem to offer an attractive alternative, where feasible. Summary box 62.1 Varicose veins

are one of the most common conditions causing a physical impairment in quality of life. Interventional treatment improves quality of life and is highly cost-effective. Anatomical and physiological assessment using duplex ultrasound is invaluable in the diagnosis and planning of treatment. Ultrasound-guided endovenous ablation has revolutionised treatment, minimising procedural morbidity while being highly effective.

Figure 62.26 Recurrent anterior abdominal wall varicose veins following saphenofemoral junction ligation complicated by iliac deep vein thrombosis.

Management

- The very best results are seen in specialist multidisciplinary ulcer services. The cause of a venous leg ulcer is venous hypertension and the keystone of management is to decrease this hypertension using venous ablation and compression therapy.

Figure 62.28 A Marjolin's ulcer (a squamous cell cancer arising in a chronic venous ulcer).

In patients with venous leg ulcers, treatment of superficial venous incompetence has been demonstrated to accelerate healing and reduce recurrence; therefore, expeditious referral to a vascular service for assessment is recommended. Compression. The most clinical and cost-effective compression regimes are two-layer compression hosiery or four-layer compression bandaging. The latter includes: Orthopaedic wool: distributes the pressure and reduces

undue pressure on sensitive areas susceptible to pressure damage. Also helps to absorb excess exudate that escapes the primary dressing. /uni25CF Cotton crepe: smooths the wool and holds it in place. /uni25CF Elastic bandage: first compressive layer, contributes about one-third of the interface pressure. /uni25CF Cohesive bandage: second compressive layer, increases stiffness and adds approximately two-thirds of the interface pressure. The ideal interface pressure in pure venous ulceration is 35–40 /uni00A0 mmHg. Skilled application of these dressings is essential for both safety and efficacy, and the best results come from specialist nursing teams based either in secondary care or in the community. Compression in mixed ulcers is controversial, but emerging evidence suggests that it is both safe and effective when performed and monitored appropriately. With an ankle-brachial pressure index (ABPI) of 0.5–0.8 modified compression with an interface pressure of 30 mmHg is safe and effective and pressures of up to 40 mmHg have been described in studies using inelastic bandages without ill effect. Contrary to conventional thinking, studies have shown an increase in perfusion in patients treated in this way, presumably by a reduction in capillary back pressure. Patients do see respectable healing rates in this group, but they remain lower than in those patients with an ABPI >0.8. It is not clear whether revascularisation followed by full compression yields better results, but this is common practice. Patients with an ABPI <0.5 or an ankle pressure <60 /uni00A0 mmHg must undergo revascularisation prior to any compression treatment. Other treatments Pentoxifylline, which increases microvascular perfusion by decreasing plasma cellular viscosity and cytokine inhibition, has been demonstrated to be a useful adjunct to compression by augmenting ulcer healing. Horse chestnut seed extract has been shown to be a safe and efficacious treatment for chronic venous hypertension, improving symptoms and reducing leg volume. A number of biological dressings have been developed, including fetal keratinocytes and collagen meshes, which have been shown to improve healing; however, they are cost-effective for the majority of ulcers. Pinch grafts and ulcer excision with mesh grafting have been shown to provide good early healing with moderate long-term results (50% healed at 5 years). Cellulitis and all other specific ulcer-healing drugs are of dubious validity. A large range of topical therapies and primary dressings have similarly failed to have an impact. Management

As with all traumatic injuries, the management priorities are the assessment and management of issues affecting the airway, then breathing and then circulation. Venous injuries have the potential to threaten life through massive bleeding and patients require vascular access, circulatory support and blood products. Trauma patients with life-threatening haemorrhage are at risk of hypothermia, acidosis, functional and consumptive coagulopathy and paradoxical thrombosis, and these issues need to be prevented where possible and managed when present. Venous pressures are low and so, where there is access to the site of injury, pressure will control bleeding and in most cases offer definitive management. Intervention is required where pressure cannot be applied, or where the loss of venous function itself threatens life or limb. Intervention can include reduction and stabilisation of a fracture (e.g. pelvis), endo-venous embolisation or stent grafting. A small proportion of venous injuries will require formal exploration and ligation or repair. Different types of repair are shown in Figure 62.39; the type of repair carried out depends on the extent of the venous injury, including how much venous wall has been lost or damaged. Lateral sutures and vein patches are ideal methods of repair and end-to-end anastomosis is satisfactory, provided that it is not carried out under tension. A jump graft may be required. Vein replacement should be by autogenous tissue whenever possible, using vein harvested from another site, e.g. the internal jugular vein or the GSV from an undamaged limb. Artificial grafts, such as polytetrafluoroethylene (PTFE) grafts, are at risk of infection and have given poor results in

recent conflicts. The use of anticoagulants and an arteriovenous fistula to reduce the risk of thrombosis in the vein graft are controversial and depend on the associated injuries that are present. In

- contaminated wounds, tetanus toxoid and antibiotics should be given. A fasciotomy should always be considered if there is a concomitant arterial and venous injury .

(b) (c) (d) Figure 62.38 Types of venous damage: (a) incision; (b) transection; (c) irregular laceration; (d) avulsion of a tributary.

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