

HISTORY of VENOUS SURGERY (3)

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Venous surgery apart from varicose veins

It is going to develop in several directions.

Treatment of deep vein thrombosis of the lower and upper limb during the acute phase.

○ ***In the lower limb***

1. Thrombectomy

Thrombectomy is the resection of a blood clot and was the first surgical procedure performed in the treatment of acute deep vein thrombosis. (Fig 23) In the lower limb, conduct of this procedure is attributed to the German surgeon L awen in 1937. In principle: thrombectomy has three objectives: prevention of pulmonary embolism; treating a thrombosis itself, and preventing or limiting the occurrence of sequelae, post-thrombotic syndrome. Combined with anticoagulant therapy – which made it possible – but also competed with it, this operation was recommended in France by Leriche, and then Fontaine, after the second world war. It was favourably received by a few surgical teams but did not enjoy total support by all vascular specialists ... all the more so and subsequently, as the result of the availability of medical therapies and new techniques, the objectives proposed by thrombectomy were called into question

2. Fibrinolysis

Its principle is based on administration of a product (a fibrinolytic agent) in a patient presenting with a thrombosis, which activates a substance in the blood which is inactive, plasminogen. The fibrinolytic agent converts fibrinogen into fibrin. Fibrin has the ability to lyse blood clots, and this process is called fibrinolysis or thrombolysis.

In 1968, the first treatment was reported in Scandinavia (Robertson). The fibrinolytic agent was delivered by intravenous infusion. This method of administration had the disadvantage of delivering the fibrinolytic agent to the thrombus in a non-targeted manner and carried the risk of bleeding

Fibrinolysis *in situ* was introduced in 1991 (Okrent, USA). Its principle consists of delivering the fibrinolytic agent with a catheter in contact with or even in the thrombus. This explains why fibrinolysis *in situ* is more effective with lower doses, thus decreasing the risk of bleeding.

3. Thrombectomy via an intravenous device inserted transcutaneously.

Its principle consists of inserting into the venous lumen at a distance from the thrombosis a catheter with a specific mechanism up to the clot to break it up and to suction it. It is possible to combine this mechanical action with fibrinolysis (Fig 24)

4. Caval barriers

One of the major complications of a lower limb DVT is the migration of a blood clot from a lower limb vein into the pulmonary arteries. The result is a pulmonary embolism, of variable severity but which can be fatal. To prevent this type of complication, the first interventions consisted of performing venous ligation downstream of the thrombus, generally, of the

inferior vena cava, starting in the early 20th century. Subsequently, peri-caval clips were used which divided the venous lumen into several channels (Adams - De Weese, USA, 1958). This maintained the venous circulation but prevented the migration of large emboli. (Fig 25) Subsequently, the use of a clip was replaced by placement of an endovenous filter. The first such filter was based on the same therapeutic principle: it was inserted via a peripheral vein but without open surgery of the inferior vena cava, and thus was much less invasive. It was developed and used by L. Greenfield (USA) in 1972. (Fig 26 a). Since then, many such filters have been developed. They can be placed under ultrasound control at the patient's bedside. Lastly, insofar as the risk of a pulmonary embolism can be transient, temporary or removable filters (Fig 26 b) have been developed.

○ *In the upper limb*

Even though, a deep vein thrombosis is much less frequent than in the lower limb, the first venous thrombectomy was performed on the upper limb in 1910 by a German surgeon, Dr Schepelmann. Only axillary and subclavian vein thromboses, that is, veins at the root of the upper limb, require surgery according to some authors, in particular US doctors. Just as in the lower limb, currently thrombolysis in situ has replaced thrombectomy.

From the time of Paget (1866) and von Schrötter (1901), it has been known that a thrombosis of the subclavian vein can be associated with compression of vasculo-nervous structures at the junction of the thorax and the upper limb in the area between the clavicle and the first rib. Under these circumstances, an additional procedure is performed – when treatment of a venous thrombosis with thrombolysis has been chosen – removal of compression by partial resection of the clavicle (A. De Weese, USA, 1971) or removal of the first rib (Ross, USA, 1984).

Surgery for treatment of a reflux and/or obstruction of the internal iliac and gonadal veins

It must be kept in mind that these abnormalities can be responsible for various disorders with a chronic course and responsible for chronic venous disease, gynaecological, and urinary disorders (pelvic venous insufficiency syndrome).

○ *Obstructive syndromes*

Venous obstruction is defined as the existence of a complete blockage – referred to as obliteration - or partial blockage of the venous lumen. Only deep vein obstruction results in pathophysiological abnormalities depending on their location. Generally, obliteration of a distal vein has no effect and, in particular, it is in the lower limb that obliteration of a proximal vein is harmful, in particular that of the iliac and the caval veins. Such obliteration may be related to a lesion of the venous lumen, most often the post-thrombotic syndrome, but also may be due to external compression of the vein by a tumour or an organ in ectopic position.

Initially, and according to the principles of arterial surgery, the bypass technique has been used. The first venous bypass procedure was performed in 1948 by a Uruguayan surgeon, EC de Palma who used the GSV as a vascular substrate to compensate for obliteration of the iliac vein. Subsequently; prosthetic materials have also been used.

Apart from obstruction related to cancer where if it is necessary to resect the vein and to replace it, within the last 10 years treatment with an endovenous stent has become the preferred technique. In fact, this technique involves dilatation of the stenotic area or rechannelling in case of an occlusion, performed by inflating a balloon catheter. This

catheter is inserted by transcutaneous approach by venipuncture of a distant vein on a guide wire. Once the obstruction site has been removed or the vein rechanneled by the balloon, the stent is positioned in the lumen of the vein to prevent repeated stenosis . (Fig. 27, 28 a, b) This type of endoluminal surgery is less invasive than open surgery such as bypass grafting.

○ *Reflux syndromes*

We will only discuss the deep veins, since a reflux into the superficial veins corresponds to varicose veins.

This reflux can involve the lower limb veins and pelvic veins

1. Reflux syndromes in the lower limb

When it extends from the groin to the calf, it produces a constant, major increase in venous pressure which is especially deleterious. As in the case of an obstruction, the aetiology may be primary, secondary or congenital.

Regarding primary aetiology, the valve can be identified and the procedure is called a valvuloplasty.. The first such procedure was performed in 1968 by R. Kistner (Hawaii, USA), the pioneer of deep vein reflux surgery. Different valvuloplasty techniques have subsequently been proposed which can be classified as follows::

internal valvuloplasty. The vein is opened and the valve is identified under direct visual control (Fig 29)

external valvuloplasty. The vein is repaired without opening it (Fig 30)

Among secondary aetiologies where the cause identified is the post-thrombotic syndrome, the valve was destroyed by the thrombosis and cannot be repaired. Among congenital causes, the valves may be absent or atrophied, and thus the same holds true . Therefore, other surgical techniques have to be used :

- Transplantation of a venous valvular segment. In 1982, Taheri (USA) and Raju (USA) proposed using the humeral and axillary veins which have a functional valve and that can be collected undamaged and transplanted into the lower limb (Fig 31)

- Transposition .This technique consists of transposing the vein which is the site of a reflux onto another lower limb vein, below its competent valve .(Fig 32) R. Kistner (USA) invented this technique in 1982.

- Neo-valve. The creation of a neo valve using venous tissue from the patient was proposed by P. Plagnol (France) in 1999 and by O. Maleti (Italy) in 2002. (Fig 33 a, b)

Bio-prosthetic valves are undergoing investigation

2. The gonadal and/or pelvic vein reflux syndromes

In women, they can cause gynaecological disorders such as pelvic congestion syndrome (H.Taylor, USA, 1949), vulvar or perineal varices and lower limb varicose veins. In men, gonadal vein reflux causes dilatation of the testicular veins and can cause infertility. Such a reflux can be treated with sclerotherapy, but in cases of major reflux, surgical ligation of the gonadal or pelvic veins is performed. Currently, coil embolisation of refluxing veins and sclerotherapy (R. Edwards, USA, 1993) are used in combination. The purpose of this procedure is to obliterate the veins which are the site of a reflux. (fig 34 a, b). In 1993, R. Edwards (USA) proposed this technique .

Surgery of venous aneurysms

A venous aneurysm is defined as the existence of an increase in size of a vein equal to at least twice the normal diameter of the vein considered. It is difficult to identify the date and the author of the first surgical treatment of a venous aneurysm. A rare disorder, venous aneurysm most often is located in the popliteal vein. Agreement exists on treatment of aneurysms with open surgery depending on their morphology and the existence of blood clots or not in the

aneurysm sac. After resecting the aneurysm, venous continuity is restored whenever possible (Fig. 35, 36)

Surgery to treat the “nutcracker syndrome”

This term, associated with Tchaikovski’s ballet, refers to disease resulting from compression of the left renal vein between two arteries: the aorta and the superior mesenteric artery which accounts for its name . (Fig 37) Such compression can cause lumbar pain, haematuria and pelvic congestion syndrome by reflux of the left gonadal vein. Although surgical treatment is rarely indicated, many techniques have been proposed. First, open surgery techniques, consisting either of reimplantation of the left renal vein, or the kidney itself, or performing a venous bypass, with their purpose being to eliminate compression. More recently, the nutcracker syndrome has been treated with endovenous stents. (M. G. Neste USA 1996). (Fig 38)

Surgery for congenital venous malformations

Congenital venous malformations in their severe form remain a challenge to treatment, the most serious one in phlebology. Within the last 20 years, a relatively precise consensus classification has become available which makes it possible to divide such malformations into two groups : venous and arteriovenous malformations, with the latter being most severe. Historically, surgery, sclerotherapy and embolisation have been used separately or in combination. A certain number of pioneers are associated with advances in this field. Let us mention the following in alphabetical order : S. Belov (Bulgaria), P.O. Burrows (USA), J.Y. Kim (Korea), B.B. Lee (Korea), D.A. Loose (Germany), E.E. Scott (USA), D.E. Szilagy (USA), J.L. Villavicencio (USA), W. Yakes (USA). Currently, there is agreement on combined use of different surgical methods after multidisciplinary meetings.

4-7-2-6 Surgery for venous tumours. Among venous tumours we can differentiate primary venous tumours, that is, those that develop in the venous wall. They are rare and can be benign or malignant and are treated by resection of the vein with possible restoration of venous continuity depending on tumour location. Secondary tumours are an extension of an adjacent cancer or metastatic spread of cancer or a distant cancer. Surgery is used to treat them in some cases. Historically, it can be observed that over time surgery to remove a tumour has benefited in terms of survival from traditional vascular reconstruction procedures.

Surgery for venous trauma and wounds

This type of surgery has benefited from advances in intensive care and vascular reconstructive surgery, both in term of survival as well as absence of sequelae. As a historical footnote, the French president Sadi Carnot died in Lyon in 1884 from a torn portal vein following an abdominal stab wound in an assassination attempt by the immigrant anarchist, Cesario Casero (fig 39). A. Carrel, the French surgeon who trained in Lyon and then immigrated to the USA and who later received the Nobel prize, wrote that, if that the time, it had been possible to repair blood vessels, a field in which he distinguished himself, the president would have survived. In 1947 the famous Spanish matador Manuel Laureano Rodríguez Sánchez also known as Manolete died of an injury to the femoral vein after having been impaled by the bull « Islero “from Don Eduardo II ‘s cattle farm during a bullfight His name subsequently was associated with a special type of high pass manoeuvre with the cape used in bullfighting known as the « manolete » where the bull charges behind the bullfighter into his red “muleta” (fig 40, 41, 42).

The Korean and Vietnam wars enabled military surgeons to better codify veins which had to be separated from those which had to be ligated (N. Rich, USA)

CONCLUSIONS and FUTURE PERSPECTIVES

It is not within the scope of this paper on the history of venous surgery to discuss the advantages and disadvantages of the different methods, their results and their indications, all the more so since the speed with which new techniques are introduced would quickly make this document obsolete

But, a few comments should be made:

Surgery in the broader sense based on its etymological definition is increasingly less invasive, and this has transformed the quality of life of patients postoperatively.

It is likely that a certain number of venous disorders no longer require surgery insofar as their pathogenesis is better elucidated and that medical therapy will have an increasingly greater role, whether used separately or in combination with surgery;

Lastly, economic considerations will definitely have an impact on the future course of venous disease. The efficacy of treatment will have to take into account the cost to benefit ratio.

Captions for figures (3)

Fig 23 Thrombectomy of the iliac venous axis with a **Fogarty** catheter

Source : Perrin M., Nicolini Ph. Traitement des thromboses veineuses profondes des membres inférieurs par fibrinolyse in situ et thrombectomy. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Chirurgie vasculaire, 43-167, 2001.

Fig .24 Mechanical thrombectomy+ fibrinolysis

- A. The catheter is inserted on a guidewire into the thrombotic deep vein
- B. Two balloons are inflated upstream and downstream of the clot to prevent an embolism during the following phase of surgery
- C. A fibrinolytic agent is injected between the 2 balloons while a monitor produces an oscillating movement on the central guidewire to break up the clot
- D. The catheter and the guidewire are removed at the end of the procedure

Fig 25. Adams De Weese filtre. It was placed around the vena cava whose lumen thus segmented allowed passage of blood but not of large emboli.

Fig 26 a.Greenfield's caval filter inserted via percutaneous approach into the venous lumen at a distance from the inferior vena cava is placed in the latter to prevent passage of large emboli, in some cases from a lower limb deep vein thrombosis

Fig 26 b. Repeat venography with another type of filter placed in the inferior vena cava

Fig. 27. Treatment of post-thrombotic obstruction of the iliac vein by stent placement

On the left: venography in a patient who presented with a post-thrombotic right iliac vein obstruction. Note the irregular appearance and narrowing of the venous lumen

On the right, the vein has resumed its normal diameter after balloon dilatation and stent placement which are well visible in the postoperative venography

Fig 28 a .Bi-femoral catheterisation with primary compression of the left iliac vein..

A shunt circulation was developed by the pre-sacral venous plexus, the left para-lumbar vein and the anastomotic network of the left iliac axis into the right iliac axis

Courtesy : J. Leal Monedero & S. Ezpeleta Zubicoa

Fig 28b. Same patient after stent placement

Courtesy : J. Leal Monedero & S. Ezpeleta Zubicoa

Fig. 29. Internal valvuloplasty of a valve in a deep vein

From left to right and from top to bottom : Dotted line tracing and opening of the vein by a T- incision (veinotomy) ; in the incised vein, the valve is identified and appears translucent; valvular repair is carried out by stretching its free borders with over and over sutures; after the repair has been completed, the 2 free borders of the valves (see Fig.2c) are now in contact, the valve is again competent ; closure of the vein with sutures.

Fig.30. External valvuloplasty of a valve in a deep vein

As in internal valvuloplasty(fig. 25), the procedure consists of placing the 2 free borders of the valves under tension (see fig.2). To do this, separate sutures are placed on the venous wall at the 2 commissures (see fig.2) of the valve.

Source Maleti O., Lugli M., Perrin M. Surgery du reflux veineux profond. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Chirurgie vasculaire, 43-163, 2009.

Fig.31. Transplantation of a venous valvular segment

From top to bottom

A, B, C A segment of axillary vein is collected after verifying that it has a competent valve

An equivalent length of vein presenting a reflux is resected.

The venous valvular segment collected is transplanted. Here, only the proximal anastomosis has been performed, the distal anastomosis will restore continuity of the venous axis. Thus, a competent valve is placed in the venous axis which is the site of the reflux

Source Maleti O., Lugli M., Perrin M. Surgery du reflux veineux profond. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Chirurgie vasculaire, 43-163, 2009

Fig. 32. Transposition

The femoral vein presents a reflux in the middle segment. The vein located to the left is the great saphenous vein which has competent terminal and subterminal valves. The incompetent femoral vein is transposed below the competent valves of the GSV

Source Maleti O., Lugli M., Perrin M. Surgery du reflux veineux profond. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Chirurgie vasculaire, 43-163, 2009

Fig. 33 a .Creation of a bicuspid neovalve (Maleti's technique)

From top to bottom

- After opening the vein a few centimètres along its axis, the operator starts to divide its wall on one side into two layers

- This detachment stopped in the middle allows to construct a sac which corresponds to a valve in a normal subject(see fig.2)

-The same technique is performed on the other side thus creating a valve with 2 valvular cusps (see fig.2)

Courtesy : O.Maleti MD

Fig 33 b. Creation of a monocuspid neovalve (Maleti's technique)

- On the left. Post-thrombotic thickened venous wall

- On the right, a monocuspid valve was created by separation from the wall

Courtesy : O.Maleti MD

Fig 34 a. Selective venography of the right gonadal vein demonstrating a reflux The left gonadal vein has been embolised (with sclerosing foam+ coil embolisation)

Courtesy : J. Leal Monedero & S. Ezpeleta Zubicoa

Fig 34 b. Same patient after bilateral embolisation of the gonadal veins

Courtesy : J. Leal Monedero & S. Ezpeleta Zubicoa

Fig 35. Open surgery of a venous aneurysm

The aneurysm contains a large thrombus. After resecting the aneurysmal sac, continuity of the venous axis is restored by closing the vein with a suture.

Fig 36. Open surgery of a venous aneurysm

If the aneurysm occupies the entire circumference of the vein, the operator proceeds differently, but by suturing the vein end to end, continuity of the venous axis is also restored.

Fig 37. Nutcracker syndrome .Selective venography with compression of the left renal vein with an incontinent gonadal vein.

Fig 38 . Nutcracker syndrome Stenting of the left renal vein.

Fig.39. The assassination of the French President Sadi Carnot in an open horse-drawn carriage, discovered on the front page of an illustrated supplement in “Le Petit Journal”, a French daily newspaper of the time.

Fig 40 The hieratic pose of the matador Manolete during a *bullfight* was a reference for several decades

Fig 41 The famous “*manoletina*” pass created by Manolete is a high pass manoeuvre with the cape into the *muleta*

Fig 42 Manolete just after he was injured. His sword sheath is compressing his groin just after the accident