

**REDUCTION OF THE POSTOPERATIVE THROMBOGENIC
RISK IN RECONSTRUCTION ON THE OBSTRUCTED
SUPERIOR CAVAL VEIN WITH AUTOVENOUS IN SITU
FLAP**

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Abstract

The experimental and anatomical studies show the possibilities to use the autovenous in situ flap from the AV, RSV and BCVs in reconstruction of the obstructed SCV. The authors discuss the possibilities to reduce the postoperative thrombogenic risk in reconstruction on the obstructed SCV with the next reconstructive surgical procedures with autovenous in situ flap:

- The closure of the lateral partial defect of the wall of the SCV with the in situ flap from the AV.
- The closure of the lateral partial defects of the wall of the SCV, with the in situ RSV and RBCV flap and medial partial defects – with LBCV flap.
- The complete replacement of the SCV with LBCV.

Concerning the reduction of the postoperative thrombogenic risk, the reconstruction of the obstructed SCV with the autovenous in situ flaps has several advantages:

- The techniques keep the proper vascularization of the autovenous in situ flaps, and reduce the ischemia in the flap, which leads to the best preservation of the endothelial cells.
- The techniques permit the postoperative dilatation of the implanted vein; the use of the additional oblique incision of the vein leads to the increase of the diameter of the anastomotic ring.

In the area of the anastomosis, the veins were sutured with separate single sutures; the advantage of the separate single sutures in comparison with the continuous suture is that the separate single sutures do not limit the postoperative dilatation of the LBCV in the area of the anastomotic ring.

The separate single sutures are more favourable for the invasion of the endothelial cells from the flap to the recanalized SCV.

The reduced number of the created anastomoses reduces the duration time of the surgery.

The similarity in the histological structure of the wall of the SCV, BCVs and SVs favoured the adaptation of the inserted venous flap in the new local haemodynamic conditions.

This set of alternative surgical techniques leads to the reduction of the postoperative thrombogenic risk in the surgery of the obstructed SCV. In addition, for the reduction of the postoperative thrombogenic risk, the regional postoperative heparinization through the branch of the cephalic vein was used.

Key words: superior caval vein syndrome, autovenous in situ flap, azigos vein, left subclavian vein, brachiocephalic vein

Abbreviations: superior caval vein – SCV; azigos vein – AV; right subclavian vein – RSV; right brachiocephalic vein – RBCV; left brachiocephalic vein – LBCV

Introduction. Several diseases are considered to cause the SCV syndrome [1–4]. According to the extent of affection of the SCV, three degrees (light, medium and severe) of the clinical manifestation of this syndrome can be discerned (Table 1), while according to the localization and dissemination of the obstructive process, four types of anatomical localization can be distinguished (Table 2). The extent of development of a compensatory dilatation of SCV collateral vessels in the course of SCV syndrome depends on the localization and velocity of development of the obstructive process and involvement of the venous lumen.

In cases of insufficient compensatory dilatation of these veins, a surgical treatment is required. KLASSEN et al. [5] are the first to apply the plastic reconstruction of the obstructed SCV in the patients with SCV syndrome under clinical conditions. In subsequent years, a series of new surgical techniques for the treatment of this syndrome have been introduced [6–14]. However, as LEE et al. [15] emphasize, although the experimental and clinical data have shown that a superior patency rate can be achieved using the autogenous vein grafts, bypass of such a large vein requires a conduit with similar diameter and length. In the recent years, caval vein stenting has been introduced [3, 16]. Although the surgical treatment is usually preferred for the therapy of caval vein obstruction, the results obtained are characterized by a significant morbidity rate [3].

The postoperative thrombosis is one of the most dangerous and life-threatening complications of SCV syndrome surgery and thus the optimal treatment of the SCV syndrome remains still controversial. Aiming at reducing the postoperative thrombogenic risk in surgical treatment of the SCV syndrome, a set of reconstructive surgical procedures with autovenous in situ flaps has been elaborated [17]. The purpose of this article is to objectively evaluate the possible role of these surgical procedures in this severe disease.

Clinico-experimental considerations. The reconstructive surgical procedures with autovenous in situ flaps depend on the following:

- the causes for the development of SCV syndrome;
- the degree of SCV obturation in SCV syndrome as illustrated by the data shown on Table 1;
- the anatomical localization and dissemination of the obstructive process as displayed by the data shown on Table 2.

It has been proved in experiments on 10 dogs that AV as in situ flap is suitable for closure of the lateral partial defect of the wall of the SCV (Fig. 1) [12]. The opportunity for usage of the RSV and RBCV (Fig. 2) as in situ flap for closure of the lateral partial defects of the wall of the SCV and the opportunity for usage of LBCV (Fig. 3A, B) as in situ flap for closure of the medial partial defects were examined on 8 human cadavers [12]. The possibility to make use of a left BCV for complete SCV replacement has been assessed (Fig. 4) (Topalov I., unpublished clinical case).

According to Virchow's triad, there are endothelial, haemodynamic and haemostatic factors predisposing to thrombus formation. ROUDAUT et al. [18] define the basic characteristics of these three factors in prosthetic heart valves which we consider valid for the autovenous in situ flaps designed for SCV reconstruction. However, the intimate mechanisms of the interaction between these three groups of factors have specificity in the arterial and venous system. According

T a b l e 1

Degrees of SCV obturation in SCVS

Degree	Morphological characteristics and clinical manifestations
Light degree	It is determined by the partial SCV obturation. The characteristic symptoms are a slightly expressed cyanosis aggravating during bending-down of the head as well as prominence of the jugular veins and insignificant dyspnea. The venous pressure in the system of SCV increases and varies between 1.47 and 1.9 kPa (150–200 mm H ₂ O).
Medium degree	It is characterized by SCV obturation by 40%–70%. The characteristic symptoms are a more outlined cyanosis expanding to the neck as well as a manifested dilatation of the jugular veins and facial oedema, which intensifies by night. The patients complain of dyspnea, general fatigue and headache. The venous pressure in the system of SCV is elevated and its values vary between 1.96 and 2.94 kPa (200–300 mm H ₂ O).
Severe degree	It represents a manifestation of SCV obturation by more than 70%. The characteristic symptom is cyanosis of the neck, head, upper extremities and upper part of the thorax. A clearly outlined scleral injection exists. The jugular veins are strongly dilated and intense. The patients complain of severe dyspnea, ear buzzing, respiratory failure, headache, as well as of a manifested swelling of the face and neck. The venous pressure in the system of SCV is elevated over 2.97 kPa (more than 300 mm H ₂ O). The acute interruption of the blood flow through SCV leads to the elevation of the venous pressure within its system over 300 mm H ₂ O.

T a b l e 2

Types of surgical procedures in relation to the anatomical localization and dissemination of the obstructive process

Types of anatomical localization and dissemination of the obstructive process		Recommended reconstructive surgical procedures
Type one	Partial SCV obturation over the level of AV inflow with preserved passability of the latter.	The closure of the lateral partial defect of the wall of the SCV with the in situ flap from the AV (Fig. 1) [12].
Type two	SCV obturation over the level of AV inflow with preserved passability of the latter.	The closure of the lateral partial defects of the wall of the SCV with the in situ RSV and RBCV flap (Fig. 2) and medial partial defects with LBCV flap (Fig. 3A, B) [12].
Type three	SCV obturation along its whole course and of AV outflow in it as well.	Complete SCV replacement with LBCV (Fig. 4) (Topalov I., unpublished clinical case).
Type four	Bilateral BCV obturation with preserved AV passability.	Plastic reconstruction by using a synthetic vascular graft.

Note: We have elaborated and recommended three approaches for venous blood flow drainage in order to diminish the unfavourable influence of the venous stasis caused by SCV clampage during the intervention:

1. Intraluminal shunt.
 2. Extraluminal shunt.
- Combined intraluminal and extraluminal shunt.

to WEKSLER [19] while in the arteries the endothelial injury plays a major initiating role at the first interacting stage of haemostasis, in the veins, in which the stasis of blood circulation occurs more often, platelets have a lesser initiating

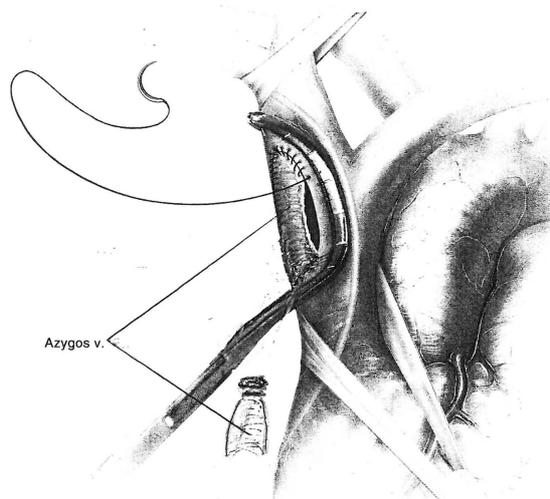


Fig. 1. The closure of the partial defect of the lateral wall of the SCV with the in situ flap from the AV

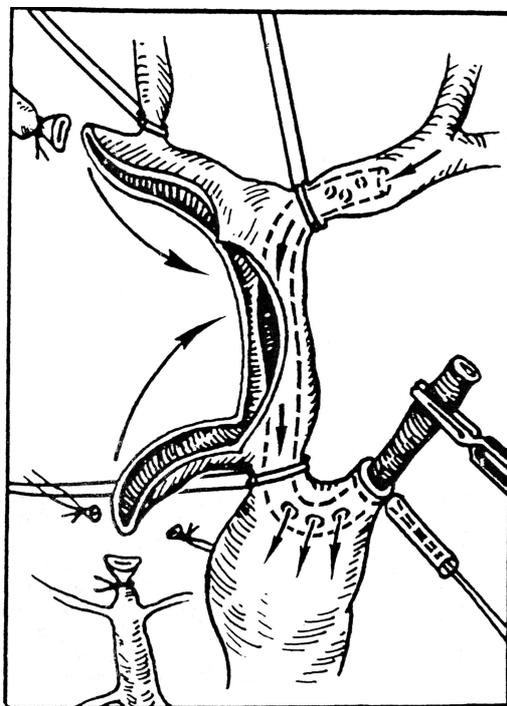


Fig. 2. The closure of the partial defect of the lateral wall of the SCV with the combined in situ flap – inferior flap from the AV and superior flap from the RBCV and RSV

role in the coagulation process. These circumstances showed the important role of the haemodynamic factors, including the haemodynamic disturbances related to the regional anatomical peculiarities of the venous system, for the thrombus formation.

In this respect, the reconstruction of the obstructed SCV with these flaps performed by us significantly contributes to thrombogenic risk reduction as follows:

The endothelial factors:

- The techniques maintain the proper vascularization of the autovenous in situ flaps and reduce the ischemia in the flap, which leads to the best preservation of the endothelial cells.
- The separate single sutures are more favourable for the invasion of the endothelial cells from the flap into the recanalized SCV.

The haemodynamic factors:

- The techniques permit the postoperative dilatation of the implanted vein. The additional oblique incision of this vein increases the diameter of the anastomotic ring.

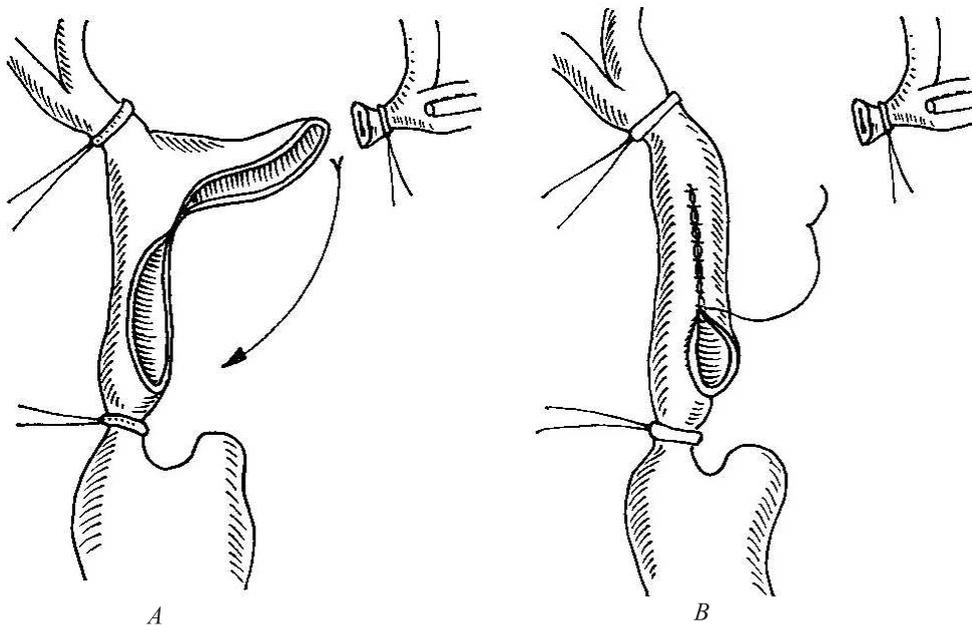


Fig. 3. The closure of the partial defects of the internal (medial) wall of the SCV with the in situ flap from LBCV

In the area of the anastomosis, the veins are sutured with separate single sutures. The advantage of these sutures over the continuous suture is that they do not restrict the LBCV postoperative dilatation in the aforementioned field.

– The reduced number of the created anastomoses reduces the duration time of the surgery.

The three approaches elaborated by us for venous blood flow drainage – intraluminal, extraluminal and combined shunt, contributed to the minimization of the effect of the venous stasis caused by SCV clampage during the intervention.

In addition, the histological structure of the wall of the SCV, BCVs and SVs is very similar. According to VANCOV's [20] classification of the human veins, the veins mentioned above belong to the group of veins with scanty developed smooth muscle cells in the wall. The scanty smooth muscle cells are circularly orientated. The internal layer of the wall is more compact in comparison with the external layer [20]. These circumstances favoured the adaptation of the venous flap inserted in the new local haemodynamic conditions.

The haemostatic factors:

– The regional postoperative heparinization through the cephalic vein branch with a diminished amount of the anticoagulant agent has been used to reduce the postoperative thrombogenic risk.

Conclusion. Our experimental and anatomical studies convincingly demonstrate the possibilities to use the autovenous in situ flap from the AV, RSV, LBCV

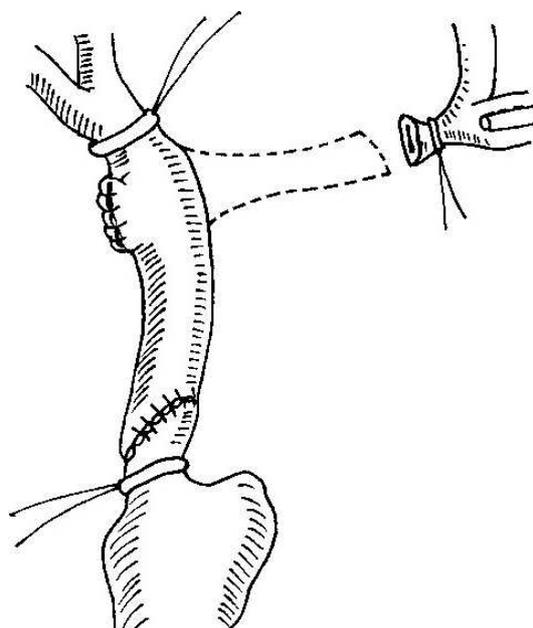


Fig. 4. The total replacement of the SCV with LBCV

and RBCV in the reconstruction of the obturated SCV. Our set of alternative surgical techniques diminishes the postoperative thrombogenic risk during this severe surgical intervention.

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