DEVELOPMENT OF OBLITERATION IN THE GREAT SAPHENOUS VEIN AFTER INFLUENCE OF HIGH-FREQUENCY ENDOVENOUS WELDING BY DATA OF MORPHOLOGICAL AND ULTRASONIC STUDIES

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ABSTRACT

Introduction: Acute ascending thrombophlebitis (AAT) of the great saphenous vein (GSV) is one of the problems in modern surgery.

The aim: Study of morphological and ultrasonic changes in a thrombosed vein following the influence of high-frequency endovenous electrical welding and assessment of the efficacy of application of this method to treatment of acute ascending thrombophlebitis.

Materials and methods: During the period of 2016-2018, surgery departments of Kyiv City Hospital No. 8 provided surgical treatment for 52 male and female patients with AAT of the GSV, who underwent high-frequency endovenous electrical welding (EVEW) with help of an EK300M Svarmed apparatus. The patients’ age ranged from 19 to 78 years (their mean age was 51 ± 2.63 years).

According to the international CEAP (clinical-etiological-anatomical-pathophysiological) classification, C2 was revealed in 4 cases, C3 in 19, C4 in 13, C5 in 9 and C6 in 7. Sections, prepared in compliance with standard methods, were morphologically examined. Photo archiving was made with use of a ZEISS light optical microscope (Germany) and «Axio Imager. A2» data processing system. Duplex ultrasonography (DUS) was performed with help of a TOSHIBA Nemio XG (Japan) device, equipped with a convex transducer having the working frequency of 3.5-5 MC and a linear transducer at a range of 7.5-12 MC. Ultrasonic studies were carried out 2-7 days after the operation. Remote results were assessed after 3, 6 and 12 months.

Results: Morphological examinations of vein preparations after EVEW with standard haematoxylin-eosin staining revealed homogenization of thrombotic masses in the venous lumen and a close relationship of the veins with the treated vascular wall; in the majority of examined cases, thrombotic masses totally obliterated the venous lumen. All the layers of the venous wall – internal, middle and external – coalesced into a single homogenous complex. Specific staining on elastic fibers revealed their total destruction in the lumen and a close relationship of the veins with the treated vascular wall; in the majority of examined cases, thrombotic masses totally obliterated the venous lumen. All the layers of the venous wall – internal, middle and external – coalesced into a single homogenous complex. Specific staining on elastic fibers revealed their total destruction in the adventitia. Total occlusion of the GSV was observed sonographically in 49 of 52 cases (94.24%) on days 2-7 after the influence of EVEW. Within 3-6 months, 3 cases (5.76%) developed some partial recanalization. During 9-12 months, colour mapping revealed preservation of some partial and haemodynamically insignificant recanalization in 2 cases (3.84%). One case (1.92%) developed the complete and haemodynamically significant recanalization of the whole welded segment of GSV.

Conclusion: Analysis of ultrasonic studies showed that despite the total destruction of the whole venous wall during the first days after the influence of EVEW there were areas of parietal blood flow in 5.76% of cases. During a remote period of follow-up from 3 to 6 months the above changes could develop partial and haemodynamically insignificant recanalization in 3.84% of cases. Within the period of follow-up from 9 to 12 months those areas of blood flow could lead to the complete and haemodynamically significant recanalization of the welded GSV in 1.92% of cases. High-frequency EVEW of the thrombosed GSV in AAT caused the total destruction of thrombotic masses and all layers of the venous wall and made it possible to achieve the total obliteration of the welded vein in 94.24% of cases.

KEY WORDS: thrombophlebitis, morphology of veins, electrical welding of live tissues, ultrasonic study

INTRODUCTION

AAT of the GSV is one of the problems in modern surgery [1]. It is not in all cases that conservative methods of treatment prevent development of complications of AAT [2]. Extraction of the thrombosed trunk of GSV on a probe or with separate cuts is the most widespread surgical method for treating this disease [3, 4]. But due to a high injury rate of these methods most phlebologists prefer use of mini-invasive methods of thermal ablation [5, 6]. A widespread use among modern innovative technologies in different fields of surgery is got by the method of high-frequency electrical welding of live tissues (HFEWLT) [7-10]. The mechanism of HFEWLT consists in the fact that passage of high-frequency electrical current through soft tissues causes some partial destruction of cells, denaturation and coagulation of protein molecules with the resultant connection (welding) of the tissues, approximated after their cutting [9, 11, 12].

The method has become widely used in surgery of abdominal wall herniae, proctology, emergency surgery, biliary surgery, thoracic surgery [13-15]. Recent years have witnessed publications on application of high-frequency electrical welding for eliminating vertical reflux in varicose veins of the lower extremities, i.e. endovenous
electrical welding (EVEW) [16]. On the basis of morphological studies the authors showed that the influence of EVEW on a vein, changed by varicosity, causes structural changes in the venous wall in the form of collagen disorganization, dystrophic changes of cells with different extents of membrane destruction and endothelial necrosis with a resultant occlusion of the vein and its subsequent fibrous transformation [16]. In order to improve results of treatment of AAT of GSV, we used the method of EVEW of the thrombosed GSV [17]. Our previous morphological study demonstrated that a 15-second exposure in the «manual mode» was the optimum mode of high-frequency electrical welding for coagulation of the thrombosed GSV [18]. Those findings served for us as the basis when using the above mode in our subsequent clinical work.

THE AIM

Study of morphological and ultrasonic changes in a thrombosed vein following the influence of high-frequency EVEW and assessment of the efficacy of application of this method to treatment of AAT.

MATERIALS AND METHODS

During the period of 2016-2018, surgery departments of Kyiv City Hospital No. 8 treated 52 male and female patients with AAT of GSV, who received treatment by means of EVEW with help of an EK300M Svarmed apparatus. The patients’ age ranged from 19 to 78 years (their mean age was 51±2.63 years). The exposure to the energy effect on the thrombosed GSV lasted 15 seconds in the «manual mode». The efficacy of EVEW of the thrombosed GSV was assessed on the basis of ultrasonic data. All the patients underwent DUS with help of a TOSHIBA Nemio GSV was assessed on the basis of ultrasonic data. All the patients underwent DUS with help of a TOSHIBA Nemio device, equipped with a convex transducer having the working frequency of 3.5-5 MC and a linear transducer at a range of 7.5-12 MC. Ultrasonic control was performed 2-7 days after the operation. Remote results were assessed after 3, 6 and 12 months.

RESULTS

Morphological examinations of vein preparations after EVEW with standard haematoxylin-eosin staining revealed homogenization of thrombotic masses in the venous lumen and a close relationship of the veins with the treated vascular wall; in the majority of examined cases, thrombotic masses totally obliterated the venous lumen. All the layers of the venous wall – internal, middle and external – coalesced into a single homogenous complex (fig. 1).

The venous wall was oedematous. Both fine bullous structures, located in all layers of the wall, and large confluent «bulla», which caused an uneven dissection of the vascular wall with formation of aneurysms, were observed. Tissues around the bullous structures were homogenized (figs. 2–4).

Specific staining on elastic fibers revealed their total destruction in the internal and middle coats, thinning and fragmentation of elastic fibers in the adventitia (fig. 5).

The soft tissues, adjacent to the vessel, and underlying trophic structures were mainly preserved (fig. 6).

Owing to an oedema of the venous wall, ultrasonography on days 2–7 after the operation revealed a larger diameter of GSV in the whole area of EVEW influence. In 49 of 52 cases (94.24%) the venous lumen along its entire length was filled with hypoechochogenic thrombotic masses without any signs of blood flow, thereby demonstrating the complete occlusion of GSV. In 3 of 52 cases (5.76%) the lumen of the welded vein revealed areas of parietal blood flow 1–2 cm long: in 1 case in the upper third of the thigh in the confluence of GSV flow, in 1 case in the place of localization of Hunter’s perforator, and in 1 case in the place of localization of Dodd’s perforator.

During a remote period of 3-6 months the colour flow mapping (CFM) mode in the above 3 cases (5.76%) revealed partial canalization. The lumen of the vein with a smaller diameter contained areas of some haemodynamically insignificant blood flow 1–5 cm long. The blood flow was found in the volume of up to two-thirds of the venous lumen with hyperechogenic and parietally fixed thrombus remnants. In one case the recanalized segment was connected with the functioning Hunter’s perforator, in another one with Dodd’s perforator, and in the third one with the functioning GSV flow in the upper third of the thigh (fig. 7).

Within the term of 9-12 months, colour mapping revealed in 2 cases (3.84%) preservation of some partial and haemodynamically insignificant recanalization 1–3 cm long. The blood flow was found in the upper and medial thirds of the thigh: in 1 case in the place of confluence of GSV flow, in another one in the place of localization of Dodd’s perforator. One case (1.92%) revealed the complete and haemodynamically significant recanalization of the whole welded GSV segment from the inguinal area to the knee level. The recanalized segment of GSV was connected with the functioning Hunter’s perforator (fig. 8).

On longitudinal scanning, the venous wall in the recanalized GSV was thickened; B mode revealed heterogeneous echoicity of the wall; CDM mode demonstrated flow past

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reflex spasm that further resulted in the desired effect of occlusion of the vascular lumen: a more close contact of the thrombotic masses with the venous wall endothelium was produced [7, 15, 18]. The above macroscopic changes had their morphological basis in the form of homogenization of the thrombotic masses and their coagulation with the endothelium. Consequently, a single homogenous complex “thrombus-wall of the vein” formed, it causing occlusion of the vascular lumen and being clinically manifested with discontinuation of blood flow. Also, specific Weigert’s staining morphologically showed that the influence of EVEW in the manual mode with a 15-second exposure spread on all the layers of the venous wall – internal, middle and external – and was accompanied with destruction of the elastic carcass of the wall, thereby creating conditions for deformation of the venous wall in the outside-inside direction with a reduction in the vascular diameter. Specific van Gieson’s picrofuchsin staining morphologically proved that collagen and smooth muscular fibres underwent dys-

DISCUSSION

The morphological study of extracted veins in AAT of GSV was carried out after EVEW in the manual mode with a 15-second exposure. Macroscopically, the lumen of veins, sent for the examination, contained thrombotic masses. The venous veins were deformed and unevenly thinned, in some areas the vein lumen was varicose dilated. It should be noted that the influence of EVEW was spread both on the thrombotic masses, which at the moment of the current effect were in the lumen of examined veins, and on the vascular wall. It was macroscopically revealed that the influence of EVEW on the venous wall caused its marked parietal formations, which protruded into the vein lumen, and the recanalized area was visualized in the centre of the vessel (fig. 9).

Fig. 7. CFM mode. A partially recanalized GSV segment after the influence of EVEW 3-6 months before; the blood flow up to 3 cm long, hyperechogenic thrombus remnants (↓↑), the functioning flow connected with the recanalized segment (↓↑). The longitudinal scan.

Fig. 8. A. B mode. GSV after 12 months following the influence of EVEW (↓↑), connection with Hunter’s perforator (↓↑). B. CDM mode. Reflux in Hunter’s perforator connected with the recanalized GSV segment. The transverse scan.

Fig. 9. CDM mode. GSV after 12 months following the influence of EVEW. The recanalized area is in the centre of the vessel (complete recanalization). The longitudinal scan.
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1. High-frequency endovenous electrical welding of a thrombosed great saphenous vein in acute ascending thrombophlebitis causes total coagulation of thrombotic masses and homogenization of all layers in the venous wall, making it possible to achieve the total obliteration of the welded vein in 94.24% of cases.

2. The presence of the functioning flow and perforator veins after high-frequency endovenous electrical welding of a thrombosed great saphenous vein during a remote period causes a partial recanalization in 3.84% of cases and the complete one in 1.92% of cases.

REFERENCES


Authors’ contributions:
According to the order of the Authorship.

Conflict of interest:
The Authors declare no conflict of interest.

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