# EFFORT THROMBOSIS OF THE SUBCLAVIAN VEIN IN ATHLETES

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Upper-extremity deep venous thrombosisis is a potentially life-threatening condition. There are several predisposing factors, including thrombophilic states, malignancy and indwelling of central venous catheters, pacemakers and different kinds of ports. Cruveilhier described spontaneous axillary-subclavian vein thrombosis in 1816. The first detailed data on axillary-subclavian vein thrombosis originated from Sir James Paget in 1875. Vascular trauma from muscle strain was identified as a potential risk factor in 1894 by Von Schroetter. In 1948, Hughes came up with the term Paget-Schroetter syndrome (PSS), which he described in his review of 320 cases of subclavian vein thrombosis[1].

Paget-Schroetter syndrome or effort thrombosis is a relatively rare condition that affects young and healthy athletes, with an incidence of approximately 1 in 50,000 people per year. It occurs through vigorous repetitive activity of the upper limbs, as seen in wrestling, swimming or playing basketball. Although it was first described in a viola player who suddenly increased his practice time 10-fold, today it is most frequently seen in young athletes.

Extension, hyperabduction and retroversion of the arm are believed to be the causes of Paget-Schroetter syndrome. These movements lead to strain on the subclavian vein which causes microtrauma to the endothelium, triggering coagulation mechanisms.

Furthermore, the anatomic abnormalities of the upper thoracic outlet facilitate PSS. There is substantial evidence that abnormalities such as cervical rib, abnormal insertion of the costoclavicular ligament, hypertrophy of scalene tendons and congenital bands (Figure 1) predispose to the development of PSS[2,3]. The compression of these anatomical elements on the subclavian vein leads to stasis in the blood flow. As described by Rudolf Virchow, three elements contribute to thrombosis: haemodynamic changes (stasis, turbulence), endothelial injury (or dysfunction) and hypercoagulability[4]. In his study, Cassada showed that approximately two-thirds of patients with PSS had concomitant thrombophillia[5]. Other studies have shown that there is a higher frequency of Factor V Leidin and mutations of the prothrombin gene[6-8]. All these pathological changes lead to perivenular or endothelial inflammation, which progresses to fibrosis and adhesions of the subclavian vein. This can lead to intimal hyperplasia and thrombosis and

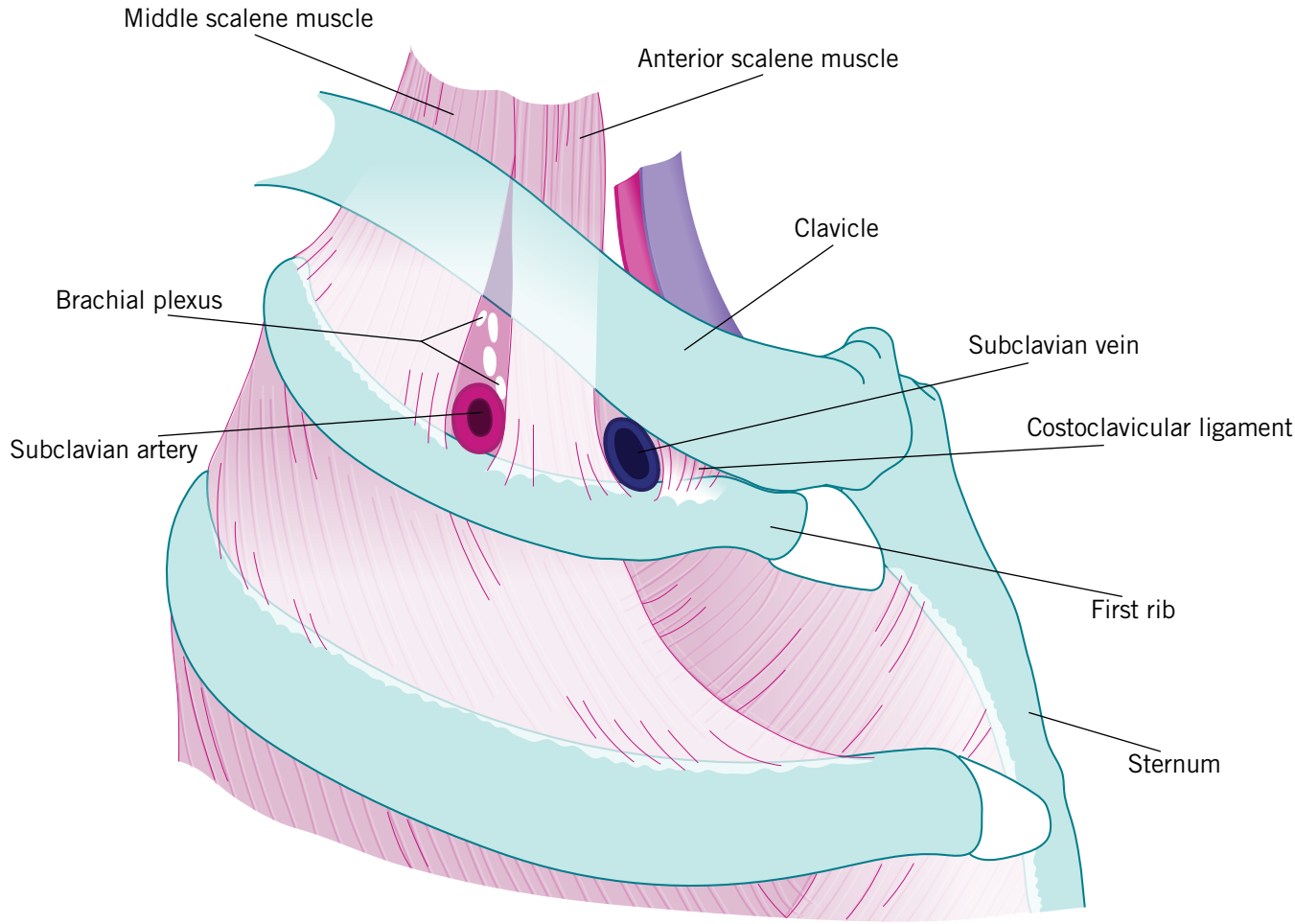


**Figure 1:** Anatomy of the upper thoracic outlet.

finally, to PSS. This inflammation, combined with fibrosis of the subclavian vein, contributes to subclavian vein thrombosis.

## CLINICAL PRESENTATION

Unlike other cases of upper extremity deep vein thrombosis, athletes with PSS are usually symptomatic. Sudden onset of pain, swelling in the dominant-arm, oedema and cyanosis (usually) of the dominant upper extremity are the most common symptoms and signs of PSS. As a result of thrombosis, collateral superficial veins of the ipsilateral shoulder and chest wall can be seen. Pain is exacerbated during physical activity and reduced with extremity elevation and at rest. As previously mentioned, PSS usually occurs due to vigorous repetitive activity of the upper limbs in young athletes.

Pulmonary embolism, post-thrombotic syndrome and recurrent thrombosis are thought to be the most common complications[3]. Pulmonary embolism is a potentially life-threatening condition with significant risk of incidence related to PSS. Post-thrombotic syndrome – characterised by pain and swelling – is linked to morbidity associated with effort thrombosis[3,9]. Post-thrombotic syndrome occurs in 15% of patients (up to 45%) with upper extremity deep vein thrombosis[9]. This condition is associated with discomfort and disability. Bearing in mind that PSS occurs in young athletes, even the slightest residual disability significantly affects quality of life.

## DIAGNOSIS

Athletes that present with abrupt spontaneous swelling (usually) of the dominant arm, associated with cyanotic discoloration and pain, must be considered for PSS. Once the diagnosis of PSS is suspected, there are several tests to perform in order to confirm the syndrome.

First of all, a set of functional blood and genetic coagulation tests can be done. These tests are typically negative (i.e. coagulation disorders), however bearing in mind that this disorder is primarily anatomical, these results alone are not conclusive enough to confirm the diagnosis[6].

Upper extremity duplex ultrasound scan is an inexpensive and widely available test in diagnosis of PSS. However, this scan is sometimes ineffective in determining the presence of subclavian vein thrombosis[10]. First of all, the presence of the superimposed clavicle makes it harder to determine the exact location and the extent of thrombosis. Also, the presence of expanded collateral veins can be mistaken for PSS. Generally, it can be said that this method is highly technician-dependent. With a false negative rate of 30%, this method is insufficient in the diagnosis of PSS[11].

Contrast-enhanced computed tomography (CT) and magnetic resonance imaging (MRI) angiography are the methods of choice nowadays. Both of these methods are highly sensitive. MRI presents the highest sensitivity (100%) and specificity among non-invasive procedures[12]. CT and MRI are able to provide very important information on the chronicity of the thrombus and the presence of expanded collateral veins. Furthermore, both CT and MRI show the anatomical influence of the first rib in the pathophysiology of PSS. Since these methods are more expensive than the upper-extremity duplex scan, they can be used as non-invasive diagnostic procedures when ultrasound studies are negative.

The most direct and accurate diagnostic test is through catheter-directed contrast venography. This method is relatively inexpensive, easy to perform and capable of providing accurate information about the exact location and extent of thrombosis. It can also give very significant information about the presence of expanded collateral veins. Furthermore, this method is the first step in administering thrombolytic therapy and therefore it plays a significant role not only in terms of the diagnostics of PSS, but it also has great importance in treatment, according to several authors[10].

TREATMENT

Contemporary treatment of PSS varies widely in medical practice. There is no strict consensus on treatment and there are several strategies in parallel use, however most cases rely on conservative treatment.

The aims of the treatment are to provide immediate relief of symptoms, prevent pulmonary embolism, reduce the chances of recurrent PSS and minimise the risk for development of post-thrombotic syndrome and last, but not least, to enable good quality of life. This last aim is very important, because, as mentioned, patients with PSS are mostly young and active people (athletes) and the need for prolonged chronic anticoagulation medication can be very uncomfortable.

For many years, the majority of patients were treated by limb elevation and anticoagulation therapy. Many authors reported successful outcomes for patients treated with anticoagulation, especially with treatment initiated immediately after symptoms commenced. However, this approach has been proven to be inadequate by some authors, and is linked with a high percentage of recurrent thrombosis, disability and residual symptoms[3,13].

In general, non-surgical management can provide satisfactory results in PSS treatment. The use of compressive sleeves and restriction of upper extremity activity, combined with upper extremity elevation has not brought any improvement in the results of treatment. Only the early administration of anticoagulant therapy (heparin combined with warfarin) has been shown to reduce the incidence of post-thrombotic symptoms[14]. This approach was conducted in the hope that thrombolysis combined with chronic anticoagulation therapy would create sufficient patency of the blood vessel, together with the expansion of collateral veins, to eventually lead to good results. There are several drawbacks of this method. The prolonged, chronic anticoagulation therapy may be a source of discomfort for patients. It is known that this kind of therapy increases the risk of intracranial or gastrointestinal haemorrhage. Unlike with the lower-extremity deep vein thrombosis, the ideal duration of anticoagulation therapy with the upper-extremity deep vein thrombosis is not known. Some authors advise anticoagulation therapy for 70 days. The most disappointing fact, recognised by several studies[13,15] is that there is still some risk of recurrent thrombosis with this therapeutic approach. Bearing this data in mind, it is obvious that this method is good enough for PSS treatment in athletes: it is cheap, simple and yet very effective, with few drawbacks. Post-thrombotic syndrome is relatively rare with this therapeutic strategy, so this method can be advised in otherwise healthy athletes with PSS.

***Paget-Schroetter syndrome or effort thrombosis is a relatively rare condition that affects young and healthy athletes, with an incidence of approximately 1 in 50,000 people per year***

Systemic fibrinolysis is superior to anticoagulation therapy in restoring patency of the subclavian vein. The main drawback of this method is the risk of haemorrhage[16].

As previously mentioned, catheter-directed contrast venography is the most sensitive method in the diagnosis of PSS. A contemporary approach to treatment recommends the use of thrombolytic agents to reduce the amount of thrombus within the subclavian vein. Local catheter-directed thrombolysis has a therapeutic value without systemic side effects. In the past, the effects of thrombolytic agents were not seen until 24 to 48 hours after administration. Recent changes in this therapeutic approach have led to catheter-based mechanical thrombectomy, combined with localised infusion of a significantly lower amount of thrombolytic agent[16]. This newer technique, combined with post-procedure anticoagulation therapy, reduces the duration of hospitalisation and provides almost instant relief of pain and other symptoms. There is still debate over the proper timing for this therapeutic approach. Some authors suggest that this therapy is suitable for patients presenting within 2 weeks of the onset of symptoms, while others have described good results in patients presenting with a delay of several weeks[8,17,18]. The latest thrombolytic agents, such as alteplase and reteplase, have surpassed older ones, like urokinase and streptokinase. Unfortunately, there are no exact protocols regarding the dosage and duration of this treatment and these protocols vary among different institutions.

All of these therapeutic strategies can provide quick pain relief and alleviate other signs and symptoms, with varying degrees of success. None of these methods, however, is capable of resolving a complicated case of PSS.

Thoracic outlet decompression (TOD) is an integral part of the treatment of complicated effort thrombosis. The aims of TOD are to decompress the subclavian vein and collateral veins (by removing the first rib and scalene and subclavian muscles), thereby restoring adequate blood flow through the veins and removing constrictive scar tissue around these veins. There is no consensus yet on the definitive timing and indications for the surgical intervention. Some authors advise TOD should be performed on patients with recurrent thrombosis after catheter-directed thrombolysis, if conservative therapy fails. Using these indicatiors, Lee showed that the need for surgery was less than 25% after a 13-month follow-up on catheter-directed thrombolysis[19]. On the other hand, some authors advise early and mandatory TOD[19]. A review of literature showed suboptimal results when surgery was delayed, resulting in a higher recurrence rate, incidence of post-thrombotic syndrome and residual symptoms[17,18].

Transaxillary TOD is the most common surgical approach. The removal of the first rib and division of its scalene attachment is done through the axilla. This surgical approach does not ensure a full exposition of the subclavian vein, so it cannot be reconstructed. Transaxillary resection of the first rib is very frequently combined with intraoperative or postoperative catheter venography, balloon angioplasty or stent placement, in order to deal with residual stenosis. The results obtained in various studies demonstrate that around 50% of patients have residual subclavian vein stenosis[13] as a result of thick scar tissue appearing around the blood vessel. This thick tissue occurs because of recurrent thrombosis and further worsens the course of disease. Balloon angioplasty is

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considered to be ineffective in such cases. Long-term anticoagulation is needed in order to reduce further complications, such as recurrent thrombosis or residual disabilities. It is obvious that this specific surgical approach can't provide adequate results in athletes with complicated PSS.

Since this transaxillary approach has several disadvantages, the most recent practice in highly selected cases involves an anterior approach. This approach guarantees complete resection of the first rib and adequate venous decompression. Also, it provides optimal exposure for venous system reconstruction. Molina et al demonstrated that immediate surgery (subclavicular decompression and patch angioplasty) in 114 patients was successful in 85% of patients who were treated within 2 weeks of symptom onset. Progressive subclavian vein fibrosis was found in 15% (17) of patients. These 12 had postoperative restenosis and 5 patients were considered to be inoperable[20].

The paraclavicular approach is the most refined approach. It involves making two incisions. This approach combines the advantages of the supraclavicular exposure used for neurogenic and arterial forms of thoracic outlet syndrome with infraclavicular incision, which allows for the resection of the first rib and adequate subclavian vein exposure. The paraclavicular approach offers vein decompression in all cases of effort thrombosis, regardless of previous treatments or initial diagnosis[10]. Furthermore, this approach is capable of restoring good venous flow in 50% of patients even without a more direct venous reconstruction.

## HOW TO TREAT PAGET-SCHROETTER SYNDROME?

Upon athlete presentation with the symptoms of arm swelling, pain and cyanotic discoloration, immediate Doppler ultrasonography is advocated. If the finding is negative, the next thing to do is a contrast CT scan or an MRI.

If these findings suggest the presence of PSS, with symptom onset of up to 6 weeks prior, the next thing to do is anticoagulation therapy, upper extremity elevation and rest. Alternatively, catheter-directed thrombolysis and prolonged anticoagulation therapy can be carried out. If symptoms have been present longer than 6 weeks, surgical intervention may become a method of choice in selected cases. Surgical intervention can provide adequate venous reconstruction guaranteeing satisfactory blood flow.

There is still a great deal of controversy about the need for post-procedure antociagulation therapy. This therapy should be taken into account in patients with proven thrombophilias and suboptimal surgical results (as a result of delayed onset of therapy).

## CONCLUSION

Effort thrombosis (or PSS) is a very complex and relatively rare disease, seen in young and active athletes. Unfortunately, most physicians are not familiar with the management of this disease, treating it without proper anicoagulation therapy. This kind of treatment inevitably leads to residual dysfunction in the upper limbs and frequent recurrent thrombosis. Effort thrombosis is ideally managed using anticoagulation therapy, combined with upper extremity elevation and rest. Alternatively, a multimodal approach consisting of catheter thrombolysis and anticoagulation therapy can be undertaken. Surgery remains the 'last resort' in the therapy of PSS in athletes, performed usually in relatively rare cases linked with post-thrombotic syndrome. Future studies should be focused on the cost-benefit analysis of various treatments and the use of thrombolytic therapy in patients presenting late.

Most important is an early recognition of PSS and immediate referral to a medical facility. This is the only way of ensuring that the best management results can be achieved.

**Effort thrombosis is ideally managed using anticoagulation therapy, combined with upper extremity elevation and rest. Alternatively, a multimodal approach consisting of catheter thrombolysis and anticoagulation therapy can be undertaken**

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