INTRODUCTION

Sir James Paget first described thrombosis of the subclavian veins in 1875. He coined the name gouty phlebitis to describe the spontaneous thrombosis of the veins draining the upper extremity. He observed that the syndrome was accompanied by pain and swelling of the affected extremity. However, he incorrectly attributed the syndrome to vasospasm. In 1884, Von Schrötter postulated that this syndrome resulted from occlusive thrombosis of the subclavian and axillary veins. In recognition of the work of these pioneers, in 1949, Hughes coined the term Paget-von Schrötter syndrome. At that time subclavian-axillary vein thrombosis was relatively rare; Hughes found only 320 cases of the disease ***(Hughes, 1949).***

By 1960s, it had been established that primary subclavian-axillary vein thromboses were seen after exertion of the affected upper extremity, and the term effort thrombosis came into use ***(Kommareddy et al., 2002).***

Virchow's triad (stasis, hypercoagulability , and intimal trauma) plays a major role in secondary subclavian-axillay vein thrombosis. From the time the central venous catheter is placed, there is ongoing injury to the vein ***(Kearns et al., 1996).***

The hallmarks of subclavian-axillary vein thrombosis are swelling and cyanosis of the involved extremity. The

oedema usually involves the entire arm and hand and is characteristically nonpitting. The patients develop venous engorgement of the superficial collaterals veins over the upper arm, base of the neck, and anterior chest. Most patients eventually complain aching or a stabbing pain in the affected extremity worsens with exertion. The pathophysiology underlying these characteristics is venous hypertension. The intensity of signs and symptoms is directly related to the length of the occlusion, the existence of prethrombotic venous collateral pathways, and the amount of activity of the involved extremity ***(Adams and De Weese, 1971).***

The underlying cause of primary subclavian-axillary vein thrombosis is compression of the subclavian vein at the costoclavicular space, the most medial aspect of the thoracic outlet. This dynamic compression leads to fibrosis, stasis of blood flow, and subsequent thrombosis ***(Aziz et al., 1996).***

A related condition is thrombosis of the subclavian vein that is induced by the presence of indwelling catheters. The incidence of this condition has increased remarkably since 1973, with the introduction of silicon-rubber catheter which was more flexible and easy to use ***(Broviac et al., 1973).***

The diagnosis of subclavian vein thrombosis is based on clinical presentation. Although Duplex Ultrasonography

is helpful in the diagnosis of acute subclavian-axillary vein thrombosis, it is operator dependent, and newer noninvasive imaging modalities may be used with expectation of higher senstivity and specificity. Magnetic resonance venography has become increasingly used to confirm the diagnosis noninvasively. Venography remains the gold standard in evaluating upper extremity vein thrombosis but is necessary only when an intervention is anticipated ***(Demondion et al., 2002).***

Historically the treatment of acute primary axillary-subclavian vein thrombosis relied on rest and elevation of the affected extremity along with systemic anticoagulation. The incidence of long term morbidity with conservative treatment was high because most patients are highly functional ***(AbuRahma et al., 1991).***

It is now accepted that optimal treatment of primary subclavian-axillary vein thrombosis requires restoration of luminal patency and removal of any extrinsic compression. Absent any contraindications, patients with acute thrombosis should undergo catheter directed thrombolysis without delay with correction of any underlying abnormality found in or around the vein at the level of costovertebral angle ***(Machleder, 1993).***

The treatment of catheter associated thrombosis depends primarily on the patient's symptoms and the need for further central venous access. The catheter does not to

be removed unless access is no longer required. In symptomatic patients who no longer need lines, catheter removal is usually adequate treatment for the thrombosis itself. If the patient still requires central venous access and if the catheter is functioning, anticoagulation agents are given until the catheter is no longer needed ***(Brismar et al., 1982).***

AIM OF THE STUDY

The aim of this study is to outline the etiology and new pathogensis of occurrence of subclavian vein thrombosis and to delineate new methods of diagnosis and of treatment.

EMBRYOLOGICAL DEVELOPMENT

Initial development of the vascular system:

The primitive vascular system forms initially from a clump of mesenchymal cells that separate and form channels. These channels eventually unite to form primitive endothelium-lined vessels that become a functioning vascular network by the end of the third week. This system then connects to the developing heart that, although it consists only of two tubes, is still capable of effectively circulating blood. ***(Joseph Giordano, 2005).***

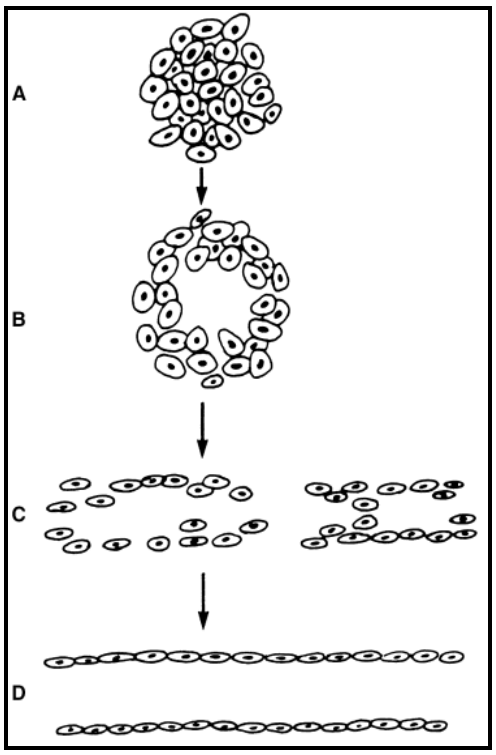

Figure (1): Initial development of vessels. A, Clumps of cells forms. B, Cavities develop. C, Channels form. D, Channels unite to form primitive endothelium-lined vessels ***(Joseph Giordano, 2005).***

Development of venous system:

During embryogenesis the earliest veins develop from capillary plexuses; these carry blood into the sinus venosus, the in-flow end of the forming heart ***(Geza and Peter, 2007).***

The right and left common cardinal veins drain directly into the sinus venosus. The common cardinal veins form at the junction of the anterior and posterior cardinal veins on both sides. Between this junction and the heart the common cardinal veins receive the vitelline and umbilical veins. ***(Carlson BM, 1988)***

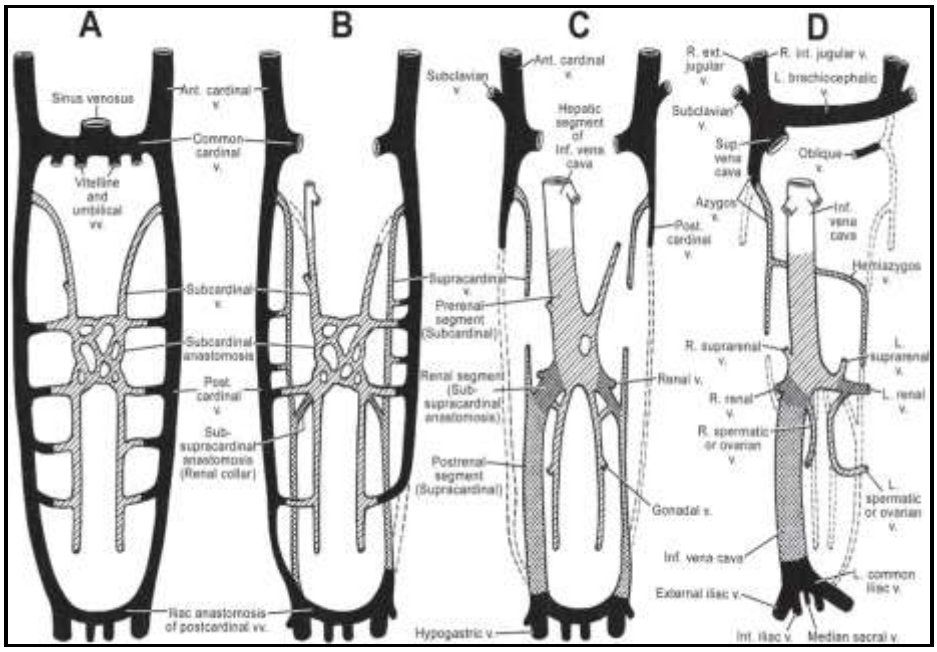

Figure (2): Embryology of the major veins (adopted from Avery LB. Developmental Anatomy, revised 7th ed. Philadelphia: WB Saunders, 1974). ***(The Vein Book, 2007)***

The **vitelline veins** initially drain the yolk sac and later the intestines ***(Nicholson and Gloviczki, 1994).***

The **right umbilical vein** regresses completely; the **left** drains the placenta ***(Nicholson and Gloviczki, 1994).***

The **anterior cardinal veins** drain the cranial part of the embryo and are connected to each other by a large central anastomosing channel. The segment of the left anterior cardinal vein located proximal to the anastomosis will regress ***(Carlson, 1988)***

The **oblique vein** of the left atrium and the coronary sinus develop from the regressed proximal segment of the left anterior cardinal vein. The remaining distal segment becomes the left internal jugular vein and the anastomosis between the anterior cardinal veins forms the left brachiocephalic vein ***(Geza and Peter, 2007).***

The right internal jugular and brachiocephalic veins develop from the proximal segment of the right anterior cardinal vein ***(Geza and Peter, 2007).***

The subclavian vein drains into the proximal anterior cardinal vein. The cephalic vein develops secondarily from segments of the radial marginal sinuses and attaches to the axillary vein later ***(Geza and Peter, 2007).***

Veins of the Limbs

At the tip of the early limb bud, blood in the terminal capillary plexus returns to the body via a marginal vein that develops along the pre- and postaxial borders of the limb. The marginal vein is separated from the overlying ectoderm by an avascular zone of mesenchyme.

As the limb enlarges the marginal vein can be subdivided into pre- and postaxial veins running along their respective borders. These latter vessels are the precursors of the superficial veins of the limb.

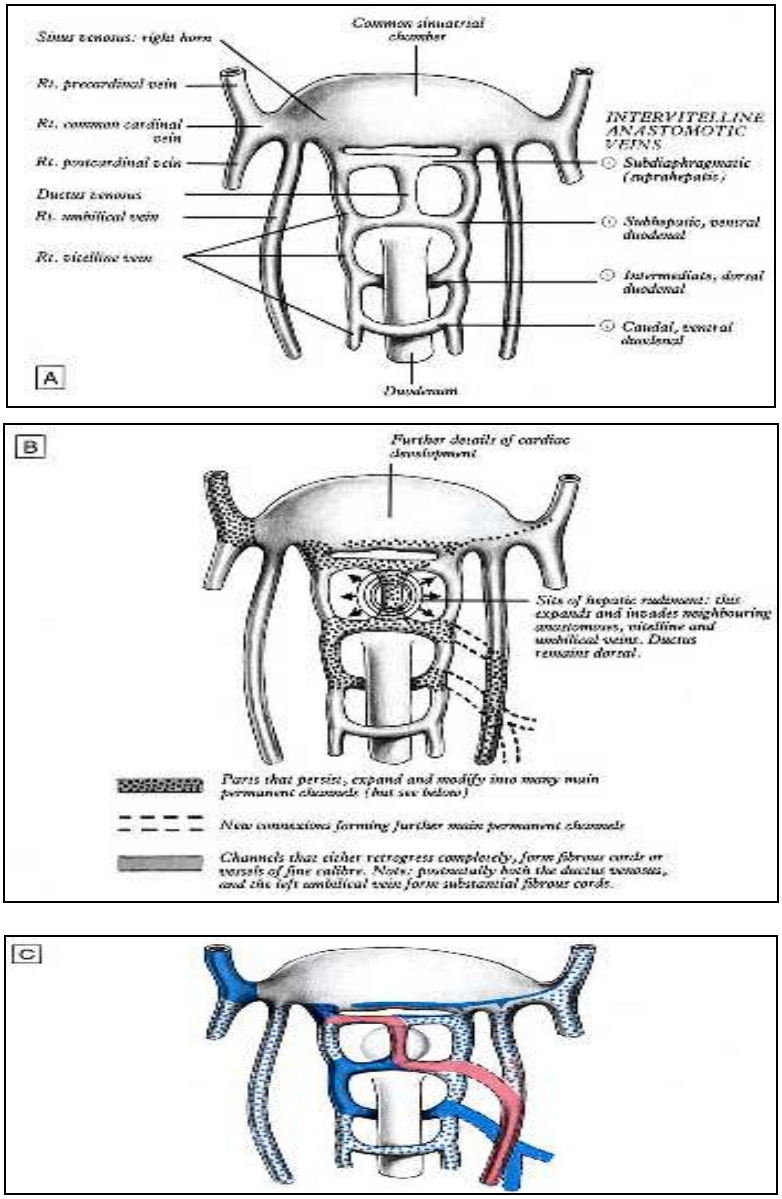

Figure (3): Development of the vitelline, umbilical and terminal cardinal vein complexes: the early symmetric condition. A. The topography and nomenclature of the veins forming the right and left sinual horns, the intervitelline anastomoses and the median ductus venosus. B. To assist understanding of later changes the symmetric pattern is used to indicate which segments persist or retrogress, the sites of formation of new channels and the intimately involved hepatic rudiment. C. A. simplified representation of the subsequent main flow paths of oxygenated and deoxygenated blood.

Generally the preaxial (superficial) veins join to deep veins at the proximal joint, and the postaxial (superficial) veins join to deep veins at the distal joint of the limb. Deep veins develop in situ alongside the arteries.

In the upper limb the preaxial vein becomes the cephalic vein; it drains at the shoulder into the axillary vein. The postaxial vein becomes the basilic vein, which passes deep in the arm to continue as the axillary vein.

In the arm the ulnar portion of the marginal sinuses dominate over the radial ones, and eventually form the basilic, axillary, and subclavian veins.

ANATOMICAL CONSIDERATIONS

Axillary Vein:

The axillary vein lies initially (distally) on the anteromedial side of the axillary artery, with its terminal part anteroinferior to the artery. This large vein is formed by the union of the brachial vein (the accompanying veins of the brachial artery) and the basilic vein at the inferior border of the teres major.

The axillary vein is described as having three parts that correspond to the three parts of the axillary artery. Thus the initial, distal end is the third part, whereas the terminal, proximal end is the first part.

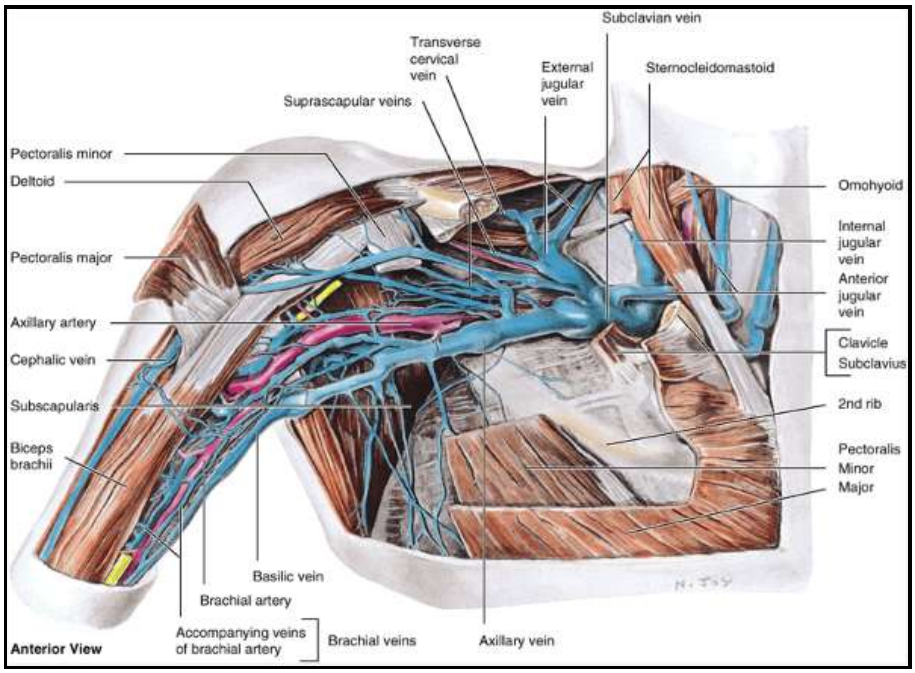

Figure (4): Veins of axilla. Observe that the basilic vein parallels the brachial artery to the axilla, where it merges with the accompanying veins (L. venae comitantes) of the axillary artery to form the axillary vein. Note the large number of highly variable veins in the axilla, which are also tributaries of the axillary vein.

The axillary vein (first part) ends at the lateral border of the 1st rib, where it becomes the subclavian vein. The veins of the axilla are more abundant than the arteries, are highly variable, and frequently anastomose.

The axillary vein receives tributaries that generally correspond to branches of the axillary artery with a few major exceptions:

- The veins corresponding to the branches of the thoracoacromial artery do not merge to enter by a common tributary; some enter independently into the axillary vein, but others empty into the cephalic vein, which then enters the axillary vein superior to the pectoralis minor, close to its transition into the subclavian vein.
- The axillary vein receives, directly or indirectly, the thoracoepigastric vein(s), which is (are) formed by the anastomoses of superficial veins from the inguinal region with tributaries of the axillary vein (usually the lateral thoracic vein). These veins constitute a collateral route that enables venous return in the presence of obstruction of the inferior vena cava.

SUBCLAVIAN VEIN

The subclavian vein is a continuation of the axillary vein. It extends from the outer border of the first rib to the medial border of scalenus anterior, where it joins the internal jugular to form the brachiocephalic vein. ***(Gray`s anatomy 39th ed, 2005)***

The clavicle and subclavius are anterior, and the subclavian artery is posterosuperior, separated by scalenus anterior and the phrenic nerve. The first rib and pleura are inferior. The vein usually has a pair of valves about 2 cm from its end. Its tributaries are the external jugular, dorsal scapular and (sometimes) anterior jugular veins, and occasionally a small branch from the cephalic vein which ascends anterior to the clavicle. ***(Gray`s anatomy 39th ed, 2005)***

The IJV ends posterior to the medial end of the clavicle by uniting with the subclavian vein to form the brachiocephalic vein (Fig. 8.17). This union is commonly referred to as the venous angle and is the site where the thoracic duct (left side) and the right lymphatic trunk (right side) drain lymph collected throughout the body into the venous circulation (Fig. 8.18) [easy chm].

Surface Anatomy

The vein can be projected as a broad band, convex upwards, from just medial to the midclavicular point to the medial edge of the clavicular attachment of sternocleidomastoid.

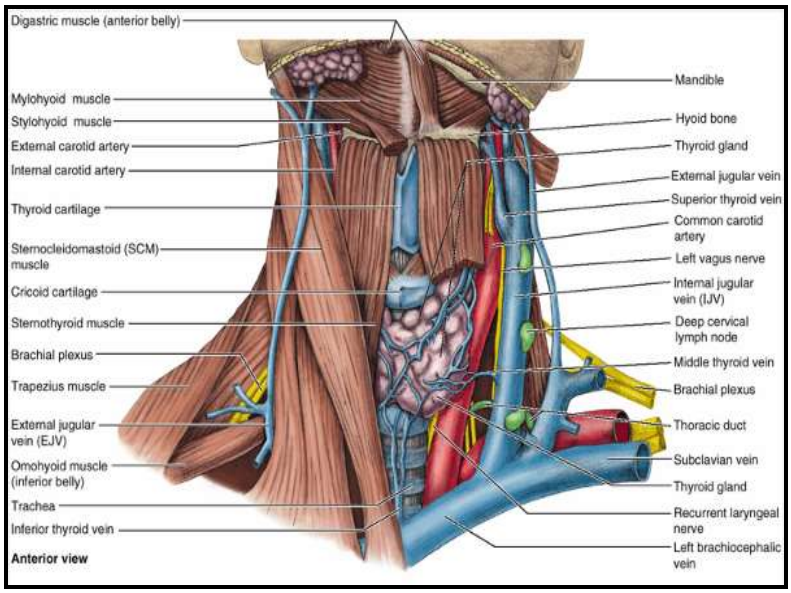

Figure (5): Dissection of anterior neck. The fascia has been removed and the muscles on the left side have been reflected to show the hyoid bone, thyroid gland, and structures related to the carotid sheath: carotid artery, internal jugular vein (IJV), vagus nerve (CN X), and deep cervical lymph nodes.

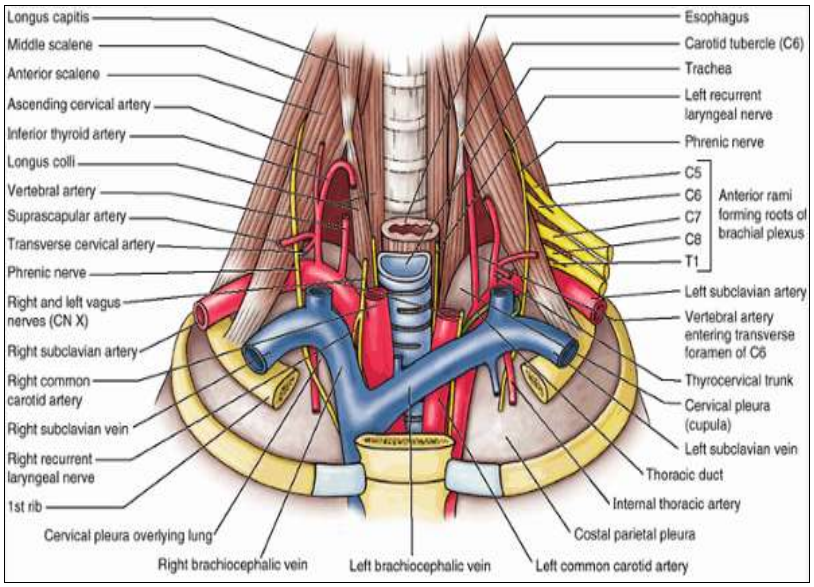

Figure (6): A dissection of the root of the neck is shown. The brachial plexus and the third part of the subclavian artery emerge between the anterior and the middle scalene muscles. The brachiocephalic veins, the first parts of the subclavian arteries, and the internal thoracic arteries arising from the subclavian arteries are closely related to the cervical pleura (cupula). The thoracic duct terminates in the root of the neck as it enters the left venous angle.

The anatomy of the thoracic outlet:

The superior opening of the bony thorax is now considered to be the thoracic outlet, sometimes termed the superior thoracic aperture.

The anatomic features of the thoracic outlet are descriptive in their own right in terms of explaining the varied clinical manifestations that encompass the thoracic outlet syndromes (TOS), namely the arterial, venous, and neurogenic TOS subtypes.

In a review in 1986, the neurologist WS Fields wrote: "All shoulder girdle compression syndromes have one common feature, namely, compression of the brachial plexus, the subclavian artery, and subclavian vein, usually between the first rib and the clavicle. With elevation of the upper limb, there is a scissor like approximation of the clavicle superiorly and the first rib inferiorly. Grouping the various conditions under the single heading of thoracic outlet syndrome has resulted in more correct diagnosis and improved therapy.

The anatomic feature underlying compression in the thoracic outlet is the presence of four spaces through which the neurovascular structures must traverse in their path from the neck to the axilla. These four spaces are the superior thoracic aperture, the interscalene triangle, the costoclavicular passage, and the subcoracoid space.