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SUBFASCIAL ENDOSCOPIC PERFORATORS SURGERY (SEPS) IN CHRONIC VENOUS INSUFFICIENCY (CVI) PATIENTS EVOLUTION OF A SIMPLER TECHNIQUE FOR OPTIMAL PERFORATOR LIGATION AND MIDTERM RESULTS

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Aim: *The main aim is to prospectively study the safety, feasibility and clinical outcome of SEPS performed by the technique of CO2 insufflation and use of regular laparoscopic instruments in patients with chronic venous insufficiency (CVI) suffering from advanced disease (Class IV to VI). Equally the study is meant to trace the evolution of steps and improvements introduced to the technique and whether the present proposed version of the procedure can achieve both completeness of perforator control with low cost and safety.*

Material: *Prospective collection of data from patients operated upon with SEPS starting form July 1997. 59 limbs in 52 patients fulfilled the inclusion criteria (A venous origin for the ulcer-presence of incompetent perforator veins (IPVs) with an average of 12 months follow up). Obesity, infected ulcers, extensive skin changes, large ulcers, lateral perforators or even previous SEPS were not considered as contraindications).*

Methods: *Demographic, physical examination and vascular laboratory data were prospectively collected for all patients. Preoperative duplex mapping of (IPVs) was done. A modified clinical severity score and clinical outcome score was given to each limb pre and post SEPS. Modification of the regular SEPS technique included the use of 5mm instruments and clip applier, use of endoretractors, use of mini-laparoscopy instruments, use of short hand instruments (24cm) especially bipolar scissors, use of Veress needle, percutanenous introduction of short small diametered metal instruments of ENT and arthroscopy and perforator control with ligation. Concomitant surgical procedures were dictated by duplex findings. Total ablation of perforators was done except a selective ligation of the Cockett group was practiced in post-thrombotic patients.*

Results: *60 procedures were performed in 59 limbs of 52 patients (mean age 37.5 years and male to female ratio of 7:1) Seven patients underwent bilateral SEPS (never simultaneously) and one patient underwent a second procedure on the same leg. Healed ulcers were found in 12 limbs (20%) class V, while active ulcers were found in 21 limbs (35%) class VI. Superficial system reflux was noted in 26 limbs (42%) combined superficial and deep reflux in 20 limbs (34%), isolated deep system reflux in 10 limbs (17%) while isolated (IPVs) was only seen in 4 limbs (7%) Number of perforators ligated per leg ranged from 1 to 12 perforators (mean of 3.6 perforators per leg). The average period of follow up was 12 months (ranging from 6 to 30 months). The duration of the procedure had a mean of 32 minutes with a learning curve. The clinical severity score dropped from 2.775 preoperatively to 1.183 post SEPS (statistically significant $P < 0.0001$). Clinical outcome scale showed that only 6% were unchanged but all the rest improved. No single patient had worsening of his condition. At the turn of a year follow up the cumulative ulcer healing rate was 95%. Ulcer recurred only in 2 limbs (6%) one of which was small and transient. Ulcers which did not heal or tended to recur had residual perforators (lateral perforators in one case and ankle perforators in the other case which had failure of tourniquet during its initial SEPS). The 3th ulcer which did not heal had no residual perforators it was a long-standing ulcer (28 years). No serious peri or post operative complications were noted like wound infection, hematoma, DVT, tibial nerve injury, only 2 cases with edema and cellulitis post SEPS. No ulcer recurrence in post-phlebitic limbs was recorded.*

Conclusion: *The collected data suggest that when used as a part of a treatment plan to correct deep and superficial*

venous insufficiency; SEPS results in a high rate of wound healing with practically no recurrent ulceration. The modifications and improvement that were evaluated in this study ended up into a simple, cost-effective, fast, safe, feasible and easy-to-learn way of comprehensively attack the (IPVs). Key points in the technique evolve around the prevention of air leak, prevention of cross-swording of the instrument and scope, the paratibial fasciotomy, the exploration of the intermuscular septum and the high manoeuverability offered by directly introducing short, small diametered ENT(Ear forceps), or arthroscopy curved shaft 3mm scissors or Veress needle.

Keywords: Endoscopic perforator surgery- SEPS – Chronic venous insufficiency and perforator incompetence – Video endoscopic vascular surgery.

INTRODUCTION

In spite of the fact that the symptoms of chronic venous insufficiency (CVI) such as edema and leg fatigue, discomfort, and heaviness are troublesome, the skin changes and their ulcerative sequelae are the most significant.

Annual health care costs for venous ulceration are estimated at 290million pounds in the United Kingdom, 14.7 billion Francs in France, 420 million deutsche marks in Germany and 1 billion dollars in the United States[1].

Although almost all venous ulcers can be treated by simple conservation means, in an extensive survey conducted in 600 patients, 66% had one or more recurrences of venous ulceration over a 5 year period[2].

Incompetent perforating veins were observed in patients with venous ulceration as early as the 1860s,[1] but surgical interruption of these veins to prevent ulceration was not suggested until 1938[3].

Despite abundant evidence of the pivotal role of incompetent perforating veins in symptomatic (CVI)[4] and refinements of the open technique[5], wound breakdown and patient disability have limited the acceptance of open perforator ligation[6].

Initial experience with endoscopic ablation of perforating veins achieved through a scope placed subfascially at a site distant to the skin changes and ulceration, was reported in 1985[1]. Since its introduction, two main techniques of SEPS have emerged. The first technique[2,7,8,9] which is now championed by Sattler[10] uses a special single scope with a working channel, with a bulky advancing head to open up in front of the advancing sheath the angle between the fascia and the muscle and which is specifically manufactured for this purpose[1]. The advantage of this technique is that it can reach down in the leg to the medial mallotus and ensure a more or less complete perforator ligation. The disadvantage is that it is expensive. The system is only used for this intervention.

The second technique, involving the regular laparascopic instrumentation was initiated and developed by Gloviczki's group at the Mayo Clinic and others[11,12,13].

The technique uses two, 10mm ports one for the optic in the upper medial aspect of the leg (a hand's breadth beneath the tibial tuberosity) and a second one 6 to 10cm infero-posterior through which are introduced the regular laparoscopic instrumentation.

The advantage of this system is that it does not add extra expenses and only make use of already available video-endoscopic basic set. The greatest disadvantage and limitation of this technique is that in the way the procedure is described and performed by its proponents it is exceedingly difficult to explore, dissect, control and sever lower medial leg perforators in the distal third of the leg (which are actually the most important to be attacked). The limitation is primarily due to the impingement of the working hand, the instrument handle and the camera head against the medial aspect of the knee or even the tourniquet above it (Fig.1).

The main aim of this study was to prospectively study the safety, feasibility and clinical effect of SEPS performed by the second technique on patients of (CVI) suffering from advanced disease.

A great task of this study was to trace the evolution steps and improvement of the technique and to probe whether the present proposed version of the procedure can achieve both completeness of perforator control together with low-profiled costs, easiness and feasibility especially that those patients usually pertain to already taxed socio-economic origin.

MATERIAL AND METHODS

This work was envisaged as a prospective study of SEPS outcome in patients with CVI with class IV to VI (lipodermatosclerosis-healed-active ulceration). The first case was done in July 1997 and till January 2000; 72 limbs in 63 patients were operated upon.

The inclusion criteria included:

(1) That the ulcer should be venous: This is to be demonstrated by an intact pedal pulse or an ankle- brachial index (ABI) more than 0.8.

(2) The presence of incompetent perforators in patients with advanced CVI (clinical classes 4 to 6).

(3) A follow up period of an average of 12 months so only 59 limbs in 52 patients were included in this study.

(4) A pilot study of 9 cases at the beginning of the study is not also included in this group. This pilot group was meant to test feasibility, safety completeness of set up and early improvements in the technique to get the optimum perforator ligation outcome.

The following were not considered as a contraindication for the technique: obesity, granulating or mildly infected ulcers (prepared for 10 days with antibiotic coverage), extensive skin changes, circumferential large ulcers, lateral perforators or even previous SEPS done elsewhere.

Demographic, physical examination and vascular laboratory data were prospectively collected for all patients. Preoperative evaluation included a detailed history and physical examination in all cases. These included a precise description of the symptoms (Pain-heaviness on climbing stairs – claudication – history of trauma – edema – relief on elevation-history of DVT-detailed history of previous treatment modalities whether compression, sclerotherapy or surgery).

The physical examination was directed to: arterial pulsations - Edema -pigmentation - skin changes - lipodermatosclerosis - healed ulcer - active ulcer - ulcer size, duration, number and recurrence - distribution of varicosities (long or short saph. territories – above or below knee - crossing to lower abdomen – back or lateral aspect of the thigh) – pattern of varicosities (system conforming – blow outs – bunches) fascial defects especially on medial aspect of the lower leg.

All patients were subjected to routine preoperative investigation for fitness assessment. Preoperative assessment of deep, superficial and perforator venous systems for competency, obstruction or reflux was done using duplex, ultrasonography. Perforating veins were defined as vessels that penetrate the fascia and constitute continuously traceable connections between the superficial and deep venous systems. The only criterion for insufficiency was reverse venous flow demonstrated on the Doppler spectral display during the relaxation phase after active dorsiflexion of the ankle or manual compression of the foot[14]. Insufficiency was determined to be present if reverse flow persisted for longer than 0.3 seconds. A sterile conductivity gel and transparent dressing were used for the duplex evaluation of the ulcer bed[15]. The number, localization, and presence or absence of insufficiency of the perforating veins at the medial and lateral side of the lower leg were noted. The distance of each perforating vein to the medial malleolus of the foot was measured in centimeters.

All the collected data were described through the CEAP, classification of the Consensus Committee of the American Venous Forum[16]. In brief, "C" relates to clinical signs. All our patients were class 4 to 6 "E" relates to etiologic factors, either primary or secondary. "A" relates to anatomical distribution either superficial, deep or perforators. "P" relates to pathophysiologic dysfunction, such as reflux, obstruction or a combination of both.

A modified clinical severity score was adopted in this series to be able to assess the impact of SEPS post-operatively (Table 1).

Table(1): ***Modified clinical severity score***

Lipodermatosclerosis	0 = none	1 = Localized	2 = extensive
Ulcer size	0 = none	1= < 2cm	2 => 2cm
Ulcer duration	0 = none	1= < 3 Months	2 => 3 months
Ulcer recurrence*	0 = none	1= once	2 = more than once
Ulcer number	0 = none	1= single	2 = multiple

* Ulcer recurrence in this scoring system is meant to describe the state of recurrence whether without treatment or after compression therapy or surgery but all prior to SEPS. Recurrence after SEPS during the period of follow up will be studied separately.

The SEPS procedure applied in this series is adopted from the work of Mayo clinic group championed by P.Gloviczki and mentioned in the introduction. This technique is rationally based on an earlier anatomic work of the same group[17]. This anatomic review is the basis for the whole technique and explains the basis of our improvements to the technique of Gloviczki. We believe that it is an essential portion of this section demonstrating the methods we used in this patient population. The study confirmed the presence of the Cockett II and III perforator veins and three groups of proximal paratibial perforating veins, including the famous "24-cm perforators". Two thirds of the medial direct perforator veins are accessible

for endoscopic division from the superficial posterior compartment. To divide the paratibial perforators, however, incision of the paratibial deep fascia is frequently required (Fig. 2). The technique described by Gloviczki and that we adopted in our pilot study is as follows:

After the induction of general or epidural anesthesia, the affected leg and the groin are prepared and draped in a sterile fashion. The pneumatic tourniquet is placed on the proximal third of the thigh, and the leg is exsanguinated with an Esmarch bandage. The tourniquet then is inflated to 300mm Hg and is continuously monitored during surgery with a pressure gauge. The time of the inflation is also monitored.

Two 15-mm longitudinal incisions are made about 5cm apart in the medial aspect of the calf 8 to 10cm distal to the level of the tibial tuberosity. The first incision is placed 3cm below the medial edge of the tibia. This incision is carried through the subcutaneous tissue under direct vision. Any varicose vein identified in this area is excised; the saphenous nerve, if encountered, is carefully preserve. With the assistance of small retractors the subcutaneous fascia is exposed and incised. The first 10mm laparoscopic port is inserted beneath the fascia, placing a blunt obturator through its lumen to facilitate passage. Once the port is beneath the fascia, carbon dioxide is insufflated to achieve a pressure of 30mm Hg; pressure is continuously monitored during the procedure. A staight-lens 10-mm scope is inserted to visually confirm proper positioning. Should the port be misplaced, emphysema in the subcutaneous tissue would be apparent, and the camera would visualize the subcutaneous fatty tissue.

After the scope is positioned properly, the second 10mm laparoscopic port is placed under direct vision through the second skin incision. This port is inserted over a trocar introducer, which can be visualized by the camera when it enters the subfascial space. The loose connective tissue that bridges the space between the muscle and the fascia can be bluntly dissected under videoscopic control with forceps or a grasper. Perforating veins are easily visualized as larger structures bridging the gap between the muscle and the fascia. Because the leg was exsanguinated, the veins have a whitish appearance, a 10-mm stapling device is used to clip the vein in two areas, between which the vessel is divided with endoscopic scissors. Dissection proceeds medially down to the edge of the tibia, laterally to the posterior midine, and distally to the level of the ankle. The most significant perforating veins are the Cockett perforators, which connect the posterior arch vein with the posterior tibial veins. Exploring the area close to the tibia and, if necessary, incising the paratibial fascia reveals the paratibial perforators, which should also be divided. Eventually the entire area between the medial malleolus and the laparoscopic port insertion site can be visualized, and all perforating veins can be interrupted.

After the procedure is complete, the instruments and ports are removed and the tourniquet is released. In patients with incompetent greater or lesser saphenous veins, striping is performed. The incision used for the first port can be used to introduce the stripper into the greater saphenous vein. Stab avulsion of the varicose tributaries is then performed in the usual fashion. At the completion of the procedure the skin ports are closed. The leg is wrapped with an elastic bandage. After surgery the legs are elevated to 30; ambulation is allowed after 3 hours.

From the very early cases in the pilot study we were obliged to change the technique in response to problems unsolved and goals unachieved by the standard technique. These changes could be grouped under the following points:

1. We preferred to use a roller up tourniquet rather than a pneumatic one as it offered 2 advantages. The first is that it works both as an Esmarch bandage and as a tourniquet. The second is that it can be sterilized and so can be rolled back on wounds especially when other interventions are needed as ex: phlebotomies in the thigh etc.

2. Due to an observed airleak around the optic trocar in the early cases we used a balloon tipped trocar, which prevented leakage but made the manipulation of the optic more difficult. Finally we used regular trocers but inserted a 2/0 vicryl purse string to the edges of the fascial defect a snagged it around the trocar and connected the free ends together around the hub of the CO_2 inlet in the trocar to prevent its slippage.

3. We don't dissect the space by an instrument introduced via the 2nd port but we use the advancing tip of the optic itself to produce the working space the moment we introduce the optic into the subfascial space. This is because it opens up the space and prevent the funneling of the view at the bottom the working space.

4. The 4th difference from the standard technique that we used a 2nd 5mm port rather than a 10mm one. The reason was not because we had a 5mm clip applier available only but the main cause is that introducing a 2nd 10mm port eats up the already small space and makes subsequent distal visualisation much encroached upon. The technique we used eventually evaluated through 4 phases to respond to special problems and fulfill certain tasks:

1. Phase I: We used an additional 5mm port more lower down than the first one to be able to dissect and clip perforators in the lower third of the leg. (Perforator control by Endoclips appliers 5mm or bipolar energy).

2. Phase II: We used a 5mm optic through the 1st 5mm working port and introduced an endoretractor via the initial 10mm optic trocar and used the 2nd 5mm lower down working port for dissection. (Perforator control by Endoclip applier 5mm, or bipolar energy).

3. Phase III: The use of mini-laparoscopy instruments (2mm diameter) in the lower ½ of the leg and even through the ulcer itself (Fig.3). (Perforator control by Endoclip applier 5mm or bipolar energy).

4. Phase IV: The use of Veress needle (pneumoperitoneum needle) to dissect the subfascial plane and the perforators. More than one could be inserted to dissect the whole space and the different perforators. By pulling back the spring loading mechanism the beveled sharp needle tip could be used to perform paratibial fasciotomy. Veress needle could also be used for retraction (Fig.4). An equidistant point is chosen in relation to all the perforators and a 5mm trocar is introduced and perforators are controlled by bipolar energy or 5mm endo-clip applier.

5. Phase V: Is the same as phase IV but during this phase a great breakthrough happened when we noticed that we can introduce 5 m instruments ex: scissors-bipolar graspers or 5mm endo-clip applier directly through the skin without the need of a trocar which saved a lot of space especially in the lower leg.

6. Phase VI: We started to use short hand-insruments (Fig. 5). As the regular length is 33cm we used 24cm length instruments which prevented hitting the other leg. During this phase we worked a lot with bipolar scissors which served both as a dissector and perforator vein controller.

7. Phase VII: This is the present phase where we are using only 2 metal instruments (short co-axial) one is straight ENT 2mm used for opening the space and dissecting the perforators. The 2nd which is an instrument of great advantage that was specially produced for us by Aesculap company which looks close to a curved right or left) arthroscopy scissors (Fig. 6). The curvature helps that the active portion i.e. the jaws would be co-axial with the long axis of the subfascial space but the handle outside would be away from the skin. It is of prime importance for severing the intermuscular septum harboring the Cockett group. Now the control of the perforators is effectuated by 2/0 or 3/0 prolene which is delivered around the vein (Fig. 7) and outside a Roeder sling knot is done and slidded down either by pulling the thread or using a knot pusher. Then the free end of the thread is grasped and snugged inside around the vein at the desired level (Fig. 8). Then between 2 ligatures the vein is severed and so are the threads. So as a matter of fact all what is needed to perform a thorough ligation of all perforators is a basic set of reusable low cost components as shown in (Fig 6).

By the technique described we ligate all perforator groups (paratibial-transmusclar and Cockett groups). Early in the study it was decided to have a special approach to the limbs having affection of the deep system. This was ushered by the occurence of early post SEPS leg edema which subsided with time. In "post-phlebitic" limbs especially with popliteal vein reflux we adopted a "selective SEPS technique" where we spared paratibial perforators even if incompetent and ligated all perforators in the ulcer bearing area.

Concomitant surgical procedures were done according to the clinical and duplex findings. Ex: Saphenofemoral disconnection ± stripping till the knee, saphenopopliteal disconnection, bunch varicosity excision, exploration of incompetent perforators in the thigh, multiple phlebectomies etc... Post-operative hospital course was dictated by the type of lesions. For patients with class IV and V (Lipodermatosclerosis and healed ulcers) were discharged within 48 hours after removal of the elastic bandage applied during surgery. They are advised to elevate their limbs and to be followed at time of suture removal and then on a monthly basis at least for the first year and then 3 monthly thereafter. For the group of active ulcers especially of large sizes (5cm or more) we kept the patients hospitalized to secure rest and elevation for a period enough to ensure sound and documented healing of the ulcer. No compression therapy was applied for those patients.

In this particular group we devised a way to assess the rate of ulcer healing by drawing with a black unerasable marker the ulcer contour on a transparent sterile paper (Fig. 9). This we simply got from the dressing sterile paper packing. There is one type of sterile packing, which is white paper on one side and transparent on the other. We used the inner surface of the latter (which is against the dressings and sterile) and put it directly on the ulcer and then mark the contour on the outer side together with marking where is up and down and the date. By putting those transparent sheets on apposition we can detect the change in the ulcer contour, the incidence of healing and where healing is starting. Also a clinical outcome scheme was adopted in the following manner:

+3 Asymptomatic
+2 Moderate improvement
+1 Mild improvement
0 Unchanged
- 1 Mild worsening
- 2 Significant worsening
- 3 Marked worsening

The singed rank test was used to calculate the clinical severity scores and surgical outcome scores

changes after SEPS. Statistical significance was confirmed if P was less than 0.05.

RESULTS

59 limbs in 52 patients were operated upon. The age of the patients ranged from 23 to 52 years with a mean age of 37.5 years. The majority of cases presented before the age of 45 [39] and 13 patients presented after the age of 45.

Males (46 cases) were affected more than females (6 cases) with a ratio of 7:1.

The left lower limb was affected alone in 32 patients (60%), the right side was involved alone in 14 patients (27%). Bilateral lower limb affection was found in 7 patients (14 limbs i.e. 13%).

The mean duration of patient's complaint before SEPS ranged between one and twenty eight years with a mean duration of 10 years.

Pain (whether on walking, during leg dependency or heaviness on climbing stairs was present in 54 limbs (92%).

Ankle or whole limb edema was found only in 16 limbs (26%).

Eczema and itching were found in 10 limbs (17%). Brown or blackish pigmentation, localized to the supramalleolar region or involving the whole leg was present in 53 limbs (90%).

Apparent varicosities were found in 30 limbs (52%) Lipodermatosclerosis per se was only met with in 6 limbs (10%) but was a common denominator with ulcers whether healed or active.

Healed ulcers were found in 12 limbs (20%), while active leg ulcers were present in 21 limbs (35%).

Only 5 patients (9%) underwent previous surgeries for their veins. 3 had Trendelenburg procedures, one Trendelenburg and whole length long saphenons vein (LSV) stripping and one with Trendelenburg and SEPS performed elsewhere.

The 21 limbs having active ulcers had a duration ranging from one to 28 years, 19 ulcers where located on the medial aspect of the lower portion of the leg (the gaiter ara). The lower extent in the 19 ulcer reached to the level of the medial malleolus. One ulcer was situated laterally on the outer side of the lower leg but was continuous along the chin of the tibia with a medial component. One ulcer was situated on the back of the lower leg with features of healed ulcer on the medial aspect together with scarring of an old burn. The size of the ulcers viand from 1x 1.5cm to 13 x 7cm. The longer dimension was always present along the long axis of the limb.

Active ulcers were bilateral in 2 patients (4 limbs) and in both were practically of the same magnitude. In this series we did not meet a single case of multiple active ulcers. Only in 2 limbs were found both healed and active ulcers. Some sort of periodicity in ulcer recurrence was present especially in long lasting ulcers with recrudescence and activation of the ulcer in summer times. This pattern was recorded in a least 8 patients having ulcers for 4 to 28 years of duration.

Duplex examination revealed the presence of reflux at the level of the deep system in 29 limbs (49%). Reflux was detected in the superficial system in 39 limbs (67%) In competent perforators were mapped in every limb. (Table 2 to Table 4) shows the duplex findings).

Table (2): ***Incidence and sites of reflux in 59 limbs***

Location	*Nº of limbs*	*Percent*
Superficial (without deep reflux)	26	42%
Perforators (Alone)	4	7%
Deep (without superficial reflux)	10	17%
Superficial and Deep reflux	20	34%

Table (3): ***Incidence and sites of reflux in 29 limbs with deep venous incompetence***

Location	*Nº of limbs*	*Percent*
Common and superficial femoral	3	10%
Common femoral and popliteal	1	3%
Common femoral-popliteal-post. Tibial	1	3%
Popliteal alone	5	19%
Popliteal-post. tibial	12	44%
Poptiteal-gastrocnemial veins	1	3%
Poptiteal-peroneal	2	6%
Post. Tibial veins	4	12%
	29 limbs	100%

Table (4): ***Incidence of reflux at different sites in 40 limbs with superficial venous incompetence***

Location	*Nº of limbs*	*Percent*
Sapheno-femoral jct.	33	56%
Long saphenous vein (LSV)	35	60%
Sapheno-popliteal jct.	17	29%
Short saphenous vein (SSV).	3	5%
N.B.: These are combinations of affection		

All 59 limbs had incompetent perforators ranging from 1 to 12 perforators per leg with a mean of 3.6 perforators per leg. 33 limbs had up to 5 perforators per limb, 16 limbs had between 6 and 10 perforators per limb

and only 6 limbs had more than 10 perforators. The modified clinical severity score was marked for each limb it ranged between 1 and 6 with a median of 2.775.

Tourniquet was used in every case except in one instance where routine pre-tourniquet checking of pulse revealed absent pedal pulses inspite of being checked as present in the preoperative sheet list. The procedure was uneventful but needed extra-care for hemostasis, time factor was not against us. The problem we met in 3 extremely obese patients that the roller type tourniquet could not go around the thigh. A pneumatic tourniquet was always the solution.

We had 3 instances of tourniquet failure after entering the subfascial space and this is the worst situation. Re-exanguination of the limb with an Esmarch tourniquet after covering the wound and application of a pneumatic tourniquet was the solution. However in all these 3 cases visualization was encroached upon. All 3 cases had initially pneumatic trourniquet.

A key point we found is that the back of the thigh and heel should be supported leaving the calf unsupported. Any support of the calf either by hand or against the table will end up by closing the subfascial space of the superficial posterior compartment (Fig.1). Apart from one case in the early phases where we used a balloon tipped trocar to prevent air leak but proved combursome for the camera movement we always applied 2/0 vicryl purse string snugging the deep fascia around the optic trocar.

It is to be noticed that air leak around the optic trocar was the main reason in this series of events of compromised visualization (exposure).

In the early phases we used to put an extra 5mm ports more and more lower down. We used endo-retraction either by endo-peanut or 5mm expandable retractor in 4 cases in the early part of the series They are no more needed.

We resorted to different kinds of perforator control with no evidence of any subfascial hematoma formation.

Table (5): ***Methods of Perforators Control and Outcome***

Type of Control	Number %	Incidence of hematoma
1- 10mm clip applier (medium – large clip)	2 / 3%	None
2- 5mm clip applier (medium – large clip)	20 / 35%	None
3- Bipolar grasper and then scissors	12 / 20%	None
4- Bipolar scissors	15 / 25%	None
5- Thread ligature	7 / 12%	None
6- No control	3 / 5%	None
	59 limbs / 100%	None

So still the 5mm clip applier was the most commonly used modality of perforator control. SEPS was never done as a sole procedure except in 2 limbs were sapheno-femoral junctions were previously ligated. Concomitantly sapheno-femoral disconnection with or without (LSV) stripping till the knee was done in 31 limbs. Sapheno-popliteal disconnection with or without (SSV) stripping was resorted to in 8 limbs. A mid-thigh perforator was ligated in 7 limbs. Bunch excisions, multiple phlebotomies were done in 12 limbs.

In the bilateral cases we never did SEPS bilaterally in the same sitting. 1 case was a redo procedure for one of our early cases. The duration, of the procedure was easily monitored because we had to use a stop watch for the tourniquet time. The longest time was 85 minutes and the shortest was 28 minutes with a mean of 32 minutes. A learning curve is quiet apparent, which reached its plateau around 30 minutes after 20 cases. A small rise was noticed when we started perforator knotting instead of clipping. However the mean operative time in the 7 limbs we used thread ligature was 38 minutes.

The hospital length of stay was 3 days on the average (range of 1 to 6 days). Patients with active ulcers were kept longer for at least 10 days with elevation but no compression dressings applied. There was a definite improvement of the patients complaints especially pain and sense of heaviness on climbing stairs. This was reflected on the modified clinical severity score which decreased from preoperative of 2.775 (range 1 to 6) to postoperative of 1.183 (range 0 to 4); $P < 0.0001$.

The clinical outcome scale for the patients whose average follow-up periods extended to 1 year and were

kept in contact with the department showed in the most recent follow-ups that (76%) were asymptomatic, (12%) had moderate improvements (6%) had mild improvement (6%) were unchanged (0%) worsened after SEPS. The mean clinical outcome score 2.542 (range +3 to -3 shows a significant overall improvement.

Of the 21 limbs presenting with ulcers, total healing occurred in 19 limbs (90%). 2 limbs showed initial improvement but with time the ulcer reached a fixed size and persisted as such.

It is surprising to note that both cases had only superficial system affection (not post-thrombotic). On repeating the duplex one case showed 1 missing medial leg perforator but many lateral incompetent perforators. A redo SEPS was done to ligated the medial perforator and the lateral perforators were equally attacked endoscopically. This case had a medial and lateral component of the ulcer connected across to chin of the tibia. Post-redo SEPS the patient did marvellously and had a complete healing of his ulcer with no recurrence after one year of follow up (he was operated upon in 11/1/1999). The second case was not shown to have residual leg perforators on duplex scanning. This was the case of her ulcer being persistent and recurrent for 28 years. So the cumulative ulcer healing rate would be (19+1 = 20 limbs) which mounts up to 95%.

There were some findings we noted on the pattern of ulcer healing the rate ulcer healing ranged between 12 and 51 days with an average of 38 days.

Out of the limbs presenting with healed ulcers (12 limbs and the 20 limbs with active ulcers that healed after SEPS (a total of 32 limbs) ulcer recurred only in 2 limbs (6%). One of them persisted and needed further intervention and the other was very small recurrence (?? Like a breach of skin) that healed with some rest and elevation. The duplex follow up with the persistent ulcer recurrence case showed definitive residual perforators in the ulcer bearing area. By reviewing the patient's sheet he was one of the 3 cases of failed tourniquet and re-application of pneumatic tourniquet. Still the deep system was normal in this case. Operative and post-operative complications are depicted in (Table 6).

Table (6): ***Operative and post-operative complications after SEPS***

Complications	*No*	*%*	*Special remarks*
Trocar site infection	0%	0%	Antibiotic prophylaxis
Trocar wound dehiscence	1/59	1.6%	A very fatty lady
Lower leg trocar wound infection	0	0%	Too small incisions (2-3mm)
Lower leg trocar wound dehiscence	0	0%	Too small incisions (2-3mm)
Saphenous neuralgia	0	0%	Supragenicular stripping only
Tibial neuralgia	0	0%	Always sticking to underneath the fascia
Subfascial hematoma	0	0%	Control of perforators Application of crepe bandage at end of procedure.
Superficial thrombophlebitis	2/59	3.3%	Late in post operative course. Both had deep system affection
DVT (perioperative)	0/59	0%	◆ Short time procdure ◆ Early Ambulation
DVT (late in follow up)	1/59	1.6%	Patient with hypercoagulability state.
Early leg edema ± cellulitis	2/59	3.3%	SEPS in post-phlebitic limbs with complete perforator ligation in early cases of the series.

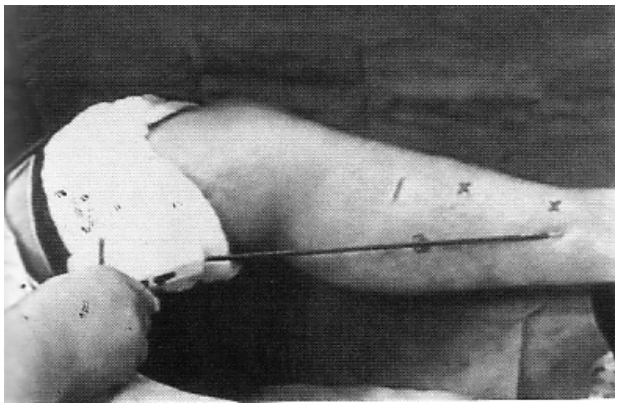

Fig (1) - Positioning of the leg (thigh heel support)

- *Pneumatic tourniquet applied*
- *This is to show the trajectoir of the intrument and if we want to go for the lower third the handle will impinge against the medial aspect of the lower thigh.*
- *Calf is suspended and unsupported.*

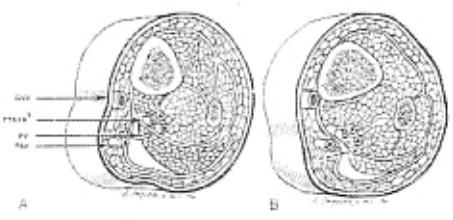

Fig (2) Cross-section of calf demonstrates the SEPS dissection plane in the superficial posterior compartment. The posterior tibial neurovascular bundle (PTA + V^S) is depicted, as are the greater saphenous vein (GSV), the posterior arch vein (PAV), and the perforating veins (PV). A, Anatomy typically found in midcalf, with upper Cockett perforating veins crossing superficial posterior compartment. B, Anatomy of lower calf demonstrates a lower Cockett perforating vein that does not cross the superficial posterior compartment and therefore requires a paratibial fasciotomy (dashed line) for endoscopic exposure. Adapted from Wittens, CHA Subfascial dissection and perforating vein ablation. In: Gloviczki P, Bergan JJ, editors. Atlas of endoscopic perforator vein surgery[9].

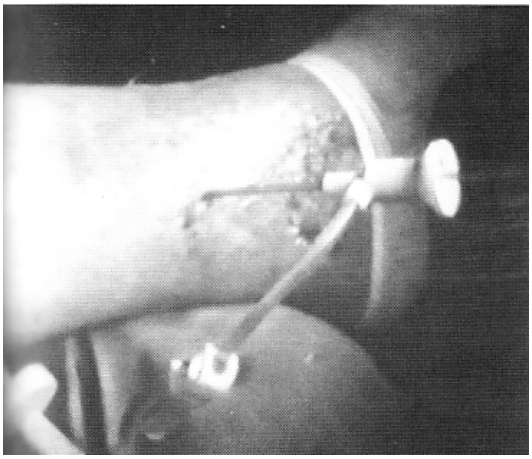

Fig (3) The use of mini-laparoscopic instruments. A 2mm scissor going through a mini-trocar in the gaiter area.

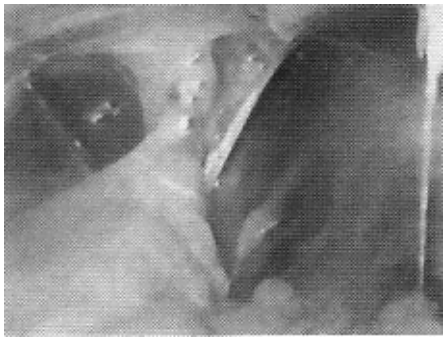

Fig (4) Another view of a Cockett III perforator showing the definite fascial defect through which the vein connects to the superficial system . Also this view shows the importance of retraction by a Veress needle which helps in elongating the perforator making its clipping and severing much more easier.

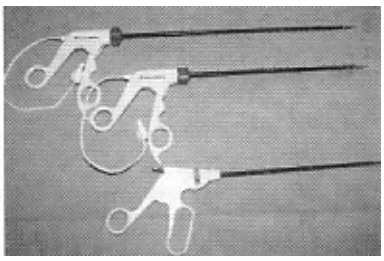

Fig (5) Short hand instruments. Top is regular bipolar instrument (33cm) Bottom and middle are mono and bipolar short instruments (24cm).

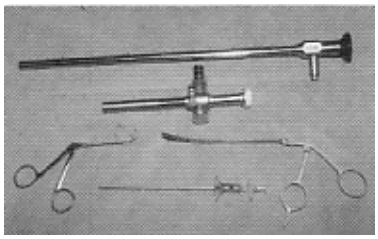

Fig (6) All that is needed to perform the present version of the procedure. A 10mm O^0 scope-A 10mm metal trumpet valve non beveled tip trocar- A curved shaft 3mm arthroscopy scissors- A straight 2mm ENT Ear froceps – A Veress needle.

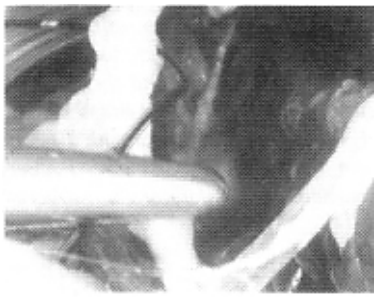

Fig (7) Use of 2mm Ent instrument (ear foceps) going though the skin directly (no trocar) and passing a 2/0 polypropylene thread around the perforator.

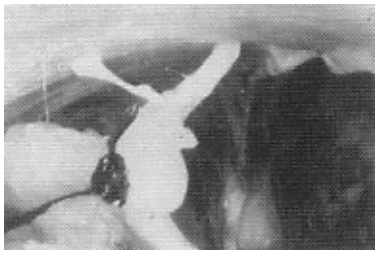

Fig (8) After performing a sling knot (Roeder knot) outside the leg it is slidded down either by pulling on the long end or using a knot slider.

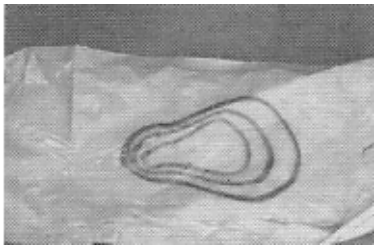

Fig (9) The simple way to trace the data of an ulcer. On the transparent portion we mark the periphery of the ulcer, where is up and down, and date

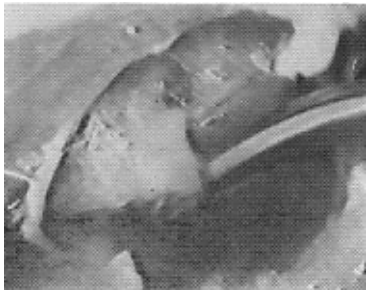

Fig (10) A gigantic paratibial perforator. Some degree of preparation (severing of soleal attachments to the tibia) is needed to disclose the vein Note the fascial defect.

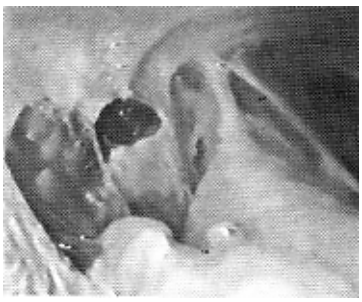

Fig (11) Importance of paratibial fasciotomy in increasing the working space and leading to the Cockett III perforator here starting to appear occupying the free proximal border of the intermusular septum.

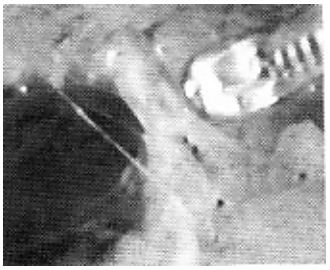

Fig (12) After full paratibial fasciotomy control of Cockett III perforator is easier.

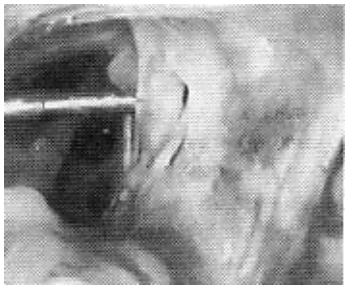

Fig (13) An improtant view showing how Cockett II perforator is usually hidden in the intermuscular septum. Here being dissected by Veress needle.

Fig (14) Control of paratibial perforator using medium-large clips from a 5mm clip appplier. Here shown after severing.

DISCUSSION

" If you do what I say and follow it closely, your ulcer will heal". Robert Linton

To provide level 1 evidence on the efficacy of perforator interruption in the treatment of patients with advanced chronic venous disease, prospective, randomized, multicenter trials are needed[18]. However based on the data of multiple studies, SEPS achieves ulcer healing up to 4 times faster than medical therapy alone. Subfascial endoscopic perforator surgery (SEPS) has become popular in the recent years. This minimally invasive technique achieves the same hemodynamic results as those obtained with the classic Linton operation, but wound complications were reported to be significantly less and the duration of hospitalization was much shorter. Because conservative estimates indicated that more than 1% of the population have chronic venous insufficiency and that at least 25% of them have venous ulcers at some point of their life, it can be expected that the number of patients who undergo SEPS will increase markedly in the future[19]. The patients demographics, the side affected the most and clinical presentations in this series is conforming to the findings of other workers[2,6,22]. Of special interest is the sense of heaviness on exertion especially on climbing stairs. This is constant feature of pain complaint and could be used as an indicator for clinical outcome score improvement post-SEPS. According to the CEAP classification, 45% were class IV 20% class V, and 35%, class VI. The use of this system to describe venous disease is quiet helpful in following cases and comparing different studies. Venous ulcers whether healed or active were met with in 55% of the patients. We had two unusual sites for the venous ulcer, a case of lateral ulcer and

another a posterior one. The lateral one was found to have lateral incompetent perforators, while the posterior one showed incompetent sapheno-popliteal junction and refluxing short saphenous vein. A recent study[21] demonstrated that reflux from the short saphenous system may affect the lateral side of the ankle in the same way as greater saphenous vein insufficiency causes CVI on the medial aspect. However others[22] differed a little bit with this view. They have shown that the concept of calf muscle pump failure also helps to explain the finding that roughly one-quarter of patients with long saphenous incompetence had lateral venous ulcers and one-half of patients with short saphenous incompetence had lateral venous ulcers and one-half of patients with short saphenous incompetence had medial venous. ulcers. This is contrary to the commonly held belief that long saphenous incompetence causes medial ulcers and short saphenous incompetence causes lateral ulcers. If ulceration is a consequence of calf muscle pump failure and subsequent venous hypertension, there is no reason that either long or short saphenous incompetence should produce ulcers specifically in the anatomical distribution of the incompetent vein. The finding of a high healing rate after short saphenous surgery is in agreement with the previous study.

The second point of interest while studying ulcers in this series is the issue of periodicity. There is definite preponderance of ulcer activation in hot climate. This could be caused by some speculations such as: intolerance to elastic stockings in hot weather, more active life more standing or bad skin hygiene. Few of our cases typically presented with ulcer activation after ulcer exposure to sea water. No literature back up could help us in this respect.

The pattern of venous incompetence showed by duplex scanning in our study demonstrated reflux in the superficial system in 39 limbs (67%) out of which 26 limbs were without concomitant deep system affection, and reflux in the deep system in 29 limbs (49%) out of which 10 limbs were without concomitant superficial system affection. Isolated perforator reflux was only detected in 4 limbs (7%). Combined superficial and deep system affection was seen in 20 limbs (34%). The incidence of deep system alone was only 10 limbs (17%). This pattern of reflux where there is preponderance of superficial reflux alone or with deep reflux and a low incidence of isolated perforator incompetence has been emphasized in many of the recent studies focusing on the hemodynamic patterns in venous ulceration patients[4,23,24]. The high incidence in this study of lower down reflux: popliteal and post-tibial vein reflux accounted for 53% of all instances of deep system reflux giving a notion on the importnace of the outward flow in the ankle perforators rather than the paratibial ones. In our study sapheno-femoral incompetence was going hand in hand with LSV incompetence. While out of 17 limbs having sapheno-popliteal regurge only 3 limbs had reflux along the SSV. This would infere upon the place of stripping of LSV together with sapheno-femoral disconnection in this study. While for SSV territory we did not perform any saphenectomy with the S/P junction ligation. Perforator incompentence is seen in 100% of patients with ulceration usually in combination with superficial or deep system abnormalities. The low isolated perforator reflux (only 7%) is in accordance with many other studies[24]. There is more consensus of opinion about the role played by the superficial system reflux in comparison to the role played by the deep one. A revolutionary study[4] stated that conventional teaching is that lipodermatosclerosis or ulceration most often result from past deep venous thrombosis followed by deep and perforator vein recanalization with loss of their valves or from chronic congestion in deep veins connected to the perforators, which causes secondary valvular incompetence. Terms such as the postthrombotic syndrome, deep venous insufficiency, and perforator incompetence have become synonymous with the complications. These problems have led to the use of treatment to interrupt perforators or to repair or replace valves in the deep veins.

These beliefs are now being questioned. Recent studies show that extensive deep venous reflux is not common, deep venous reflux alone is very uncommon, and superficial venous reflux is frequently present in limbs with complications. It is difficult to see how deep reflux can cause the chronic congestion held to be the basis for complications, if any competent deep valves exist. It can be calculated that the deep veins below the groin would need to almost double their diameter during calf muscle contraction to hold such a volume and provide a reservoir for reflux, and this occurrence has not been observed by duplex scanning. However that dilated superficial veins could be the reservoir for reflux causing complications. Blood is not adequately expelled from the leg because of impaired calf muscle function in limbs with complications, this problem could lead to superficial stasis just as much as deep stasis, if the predominant disease is in the superficial veins. It may be that blood is expelled out by muscle contraction from deep veins or the calf muscle plexuses into superficial varicose veins through the saphenous junctions or perforator veins to then return into the muscle plexuses through perforator veins during calf muscle relaxation.

This section of the discussion will be addressed to critically evaluate the evolution of a new version of the technique we first adopted from P. Gloviczki and co-workers[12] and whether it had an impact on cost-effectiveness and clinical outcome as ulcer healing and symptoms improvement. The first trigger to the need of improving the original technique is that when we adopted the operation to our early cases we clearly noticed that we will not be able to control the perforators in the lower third and partially in the middle third of the leg. This is displayed

in (Fig. 1) where the handle of the instrument and the hand of the operator impinge on the medial aspect of the knee in the situation where it is desired to shift the handle of the instrument more laterally to alligne the shaft of the instrument with long axis of the leg in order to explore more and more distal portions the leg.

It was discovered that we were not the only having this concern. Others workers[2,12] stated that, potential limitations of the endoscopic technique include the inability to reach the first Cockett perforator behind the malleolus in some patients.

A meticulous study and understanding of the "endoscopic anatomy" and the sites of perforator groups to be attacked is of prime importance to give a higher yield of perforator control. The value of each component of the improved procedure is discussed in function of optimizing the perforators control.

The lower limb position with suspended unsupported calf between fixed and supported thigh back and heel optimized the visualization, and gave the maximum room for space expansion (Fig. 1). Contrary to the comment of some groups[2,12] that severe lipodermatosclerosis many resist optimal expansion of the subfascial space, we don't believe that this is a limiting factor because we believe the main brunt of expansion is on the muscle side and not on the fascial side with overlying tough skin and this position gives the maximum compliance for the muscles for full excursion away form the fascia.

The issue of the tourniquet is of central importance in successful SEPS produce. A failing tourniquet is worse than working without a tourniquet. Because what actually happens is that tourniquet pressure (most instances happened with pneumatic tourniquet) goes down to allow arterial inflow and prevent venous drainage. This will end up by swelling of the muscle and obliteration of the space. Re-exanguination and reapplication of the tourniquet is not always successful because one of the failures in this series was a delayed ulcer recurrence with left over perforators in one of the cases we faced failure of the tourniquet. Needless to say is the bloody field contributing to damping of the visualization.

We believe that air leak around the optic trocar is one of the main causes of failure of this technique. We always apply a 2/0 vicryl purse string suture snugging the deep fascia around the optic trocar. With air leak around the optic trocar starts rythmic muscle contraction which close up the space. We thought at the start that this was due to muscle contraction which made us abandon regional anaesthesia at the beginning but we found out that those rythmic encroachment upon the space were nothing but the rythmic pumping of the gas from the insufflator due to the leak around the optic cannula.

The use of 5mm trocars and 5mm hand instruments instead of the original 10mm ones contributed in improving the working space. The main disadvantage was that the regular length 33cm laparoscopic instruments tended to hit the other leg at their handles and make their manoeuverability more difficult.

The actual first move towards the solution of the handle of instruments hitting the knee or inner aspect of the lower thigh and sometimes the tourniquet itself was the lower down placement of trocars in the lower half of the leg. This allowed us more to hunt more and more perforators but offered 2 disadvantages the first was that it encroached upon an already small working space and second that instrument handles tended to hit the other leg. The use of mini-laparoscopic instruments of 2mm diameter through 2mm ports constituted the start for the chain of coming technical evolution. We needed something small to go through small trocars to be placed in the lower leg and not encroaching upon the working space. This allowed us to dissect the space really down to the medial malleolus and form 5mm trocar placed more proximally we could control the perforators. The main disadvantage we faced was that the instruments were of regular length (33cm) and relatively delicate where we are going through tough skin and manipulating tough tissues (fascia and intermuscular septum).

In parallel with this advance, we could purchase short lengthed instruments (22-24cm) like mini-endoshear either with mono-polar or bipolar energy connected. The use of these instruments was of great value in increasing the manoeuverability and prevented encroaching upon the opposite leg.

For a good number of cases we prefered using the short bipolar scissors that we used for dissection, cutting and perforator control by bipolar energy. The drawbacks were the fact that this is a single-use instruments, which costs about 550 pounds and its shaft cannot sustain the shearing forces when the instrument is levered with its site of entry as a fulcrum due to the tough nature of skin.

The great value of using the minilaparoscopy instruments was the generation of the idea of using the Veress pneumoperitoneum needle. This came from the fact that the main trocar for the mini-laparscopy instument is a large Veress needle of 2mm diameter having an outer working sheath. Then the idea of using the regular Veress needle for initial dissection of the subfascial space and preparation of the perforators to be controlled. That was the initial intention, but this step offered us many advantages:

1- The use of an already available, low cost instrument.

2- We can introduce more than one to open up and dissect the whole space and all perforators.

3- It is short and stout so it resists bending even when levering tough skin and does not hit against the other leg.

4- It gives an idea for the "trajectoir" of the coming instrument whether the site of its entry on the skin is suitable or not.

5- It could be used for retraction (for exposure) but mainly for retracting the muscle down at the inferior end of the perforator so as to elongate and to give extra-length of perforator for easier clipping and enough spacing of clips for severing the perforator.

6- While retracting the blunt tip, the pointed beveled end of the needle can even be used to make paratibial fasciotomy and diconnect the soleus form the tibia hunfing for perforators.

But as a matter of fact the main value of using the Veress needle was that it gave the idea of introducing instruments 5mm or less directly through the skin. This happened when a Veress needle accidentally came of the skin and inspite of the air leak yet the space was practically unchanged (High inflow of gas-small space- small rent). This encouaged us at the beginning to extend the hole of entry of the Veress for couple of more millimeters and then introduce all sorts of 5mm short instruments and clip applier. The value of eliminating the use of 5mm trocar is obvious in view of giving more room and another advantage is that those trocars were easy to slip out with collapse of the cavity. We were even encouraged to introduce fine tipped regular instruments where the criss-crossing of the shaft and handle produce an X-shaped relation of the parts of the instrument around the point of crossing. The staight 2mm diameter ENT ear forceps works beautifully in dissection of perforators and passing threads around then (Fig. 7). However the more these instruments are directed more and more up or down from the point of skin entry the hand of the operator will hit the side of the leg. From this came the idea of using the same type of instruments but with curved shaft axis so as the working portion which is inside will be co-axial with the long axis of the leg while the handle will be away from the side of the leg. This scissor was initially for arthorscopy and it was procured to us by Aesculap for the purpose of improving the outcome of SEPS.

We consider paratibial fasciotomy as an integral part of the procedure. May be controlled prospective randomized studies would be essential to disclose the actual role of this component of the technique. This part of the procedure offered us the following advantages which collaborated at the end to give the highest control of perforators:

1- Paratibial fasciotomy starting in the proximal portion of the leg by disconnecting the attachment of the soleus muscle from the tibia, disclosed the presence of paratibial perforators (Fig. 10).

2- It widens the working space considerably.

3- The main value of paratibial fasciotomy is that it leads to the Cockett group of ankle perforator. The lower extent of paratibial fasciotomy opens up the seal which connects the free border of the intermuscular septum to the sides of underneath the fascia and medially to the muscles (Fig. 11). This brings into view two tunnels on both sides of the intermuscular septum harboring flexor digitorum longus muscle close to tibia and the complex of gastrocnemius and soleus away and more superficial. The proximal free edge of this internuscular septum harbor the Cockett III and further distally Cockett II.(Fig.12 and Fig.13). These findings are of paramount importance for controlling the Cockett group of perforators which constitute the mainstay of ulcer healing. These findings are in accordance with the anatomical findings[17] which demonstrated that sixty-three percent of the perforators (including all indirect muscle PVs) were accessible from the superficial posterior compartment. They also confirmed that 68% of the Cockett II and 16% of the Cockett III perforators were not accessible from this compartment. These PVs were located either in the deep posterior compartment or within a duplication of the deep fascia between the superficial and deep posterior compartments. Sevently-five percent of the paratibial perforators were not accessible from the superficial posterior compartment. These veins were hidden from view by the insertion of the soleus on the tibia. Even paratibial fasciotomy is taking now a new dimension[25] concerning the biomechanics of leg ulceration where it was demonstrated that patients with venous disease showed high compartmental pressures which were posturally related and that the relationship between capillary pressure and tissue pressure is such that these forces can cause capillary closure, reduced flow or shunting of skin perfusion. This intermittent closure is almost certainly associated with a reperfusion injury, white cell trapping and (in a reparative way) fibrin cuffs.

Of final but not least concern of the points related to the technique and that increased the yield of perforator ligation is related to the camera and optic. The use of "parafocal zoom lens" cameras (where we can get close ups without the need to advance the camera and the scope) proved very helpful to eliminate the incidence of "cross-swording" between the scope and the working instrument. This is due to the fact that inspite of the skin entry of the two which is distenced of about 6-8cm, at the end of the working

space both the scope and the instrument meet and each is encroaching upon the movement of the other. The second point of concern in this respect is that we found it very helpful to sling around the optic trocar and elevate it so as to displace the axis of the scope up to a higher parallel axis which increases the view and prevent the impingement of the scope viewing end against the leg muscles.

We clipped all perforators except in cases of "post-thrombotic" syndrome were we adoptted a selective attitude. Many groups[25,26] advocate complete irradication of perforating veins regardless of the state of their competency on the assumption that those that were still competent might become incompetent later in life, particularly if deep venous reflux was present with potential recurrence of ulceration.

To control perforators we used medium-large titanium clips (Fig. 14), bipolar cautery and cutting, knotting using mofilament non-absorbable suture to slid knots inside. Our quest for simpler and less expensive way of controlling perforators is due to the cost of a 5mm clip applier (about 700 pounds in best prices). We never used unipolar energy for fear of un-anticipated sequelae on the adjacent deep venous system and close-by neuro-vascular bundle. Some surgeons[26] prefer clipping than electrocoagulating. The concomittant procedure with SEPS was dictated by the duplex findings. With preponderance of superficial system reflux most of the cases under-went either sapheno-femoral or sapheno-popltial disconnection ± stripping either of LSV or SSV. The place of superficial system surgery even alone is now much advocated by many workers in the field. It was shown[27] that saphenoous vein disconnection improves venous function and heals venous ulcers without compression bandaging if the deep veins are normal. This procedure under local anaesthetic may be particularly suitable for elderly patients, but long saphenous vein stripping should be added in young patients. Another study[28] also pointed to the fact that eradication of main stem saphenous reflux corrects incompetent perforator vein reflux in most cases in which reflux is confined to the superficial system. However, in patients with superficial reflux that presists postoperatively, or when there is coexistent deep venous reflux, saphenous surgery alone fails to correct IPVs reflux. In these circumstances, the only way of reliably correcting pathologic outward flow in medial calf perforating veins is to perform SEPS.

Owing to the growing trend of limiting intervention to treat the reflux in the superifcial system rather than addressing (IVPs), Perrin[29] in an editorial on the subject, has paraphrased Shakespeare by saying, "to ligate or not to ligate, that is the question".

To clearly describe the place of SEPS in today's venous surgery the Edinburgh classification was put forwards [28]:

A perforator classification based on the distribution of venous reflux associated with the IPVs and the type of venous surgery required to correct pathological outward perforator flow:

Type I IPVs: fed by a refluxing saphenous vein (long and /or short) in the presence of a normal deep system. In most (80%) of these cases, saphenous surgery alone will correct outward perforator flow.

Type II IPVs: found in association with isolated deep venous reflux. That is, there is no significant saphenous reflux. In these circumstances, IPVs may require direct surgical interruption.

Type III IPVs: found in association with mixed superficial and deep venous reflux. In these circumstances, saphenous surgery alone is inadequate, and on the basis of present data, SEPS appears to be required to correct outward flow.

Type IV IPVs: act as part of a collateral circulation bypassing an ocduded deep venous system. Such IPVs must be clearly identified, because perforator interruption, with or without saphenous extirpation, could be detrimental to the patient.

Type V IPVs: occur in the apparent absence of other venous reflux or obstruction. These constitute a small group.

In accordance with this classification we never performed SEPS as a sole procedure (only when saph-femoral junction was previously ligated).

It is worse mentioning that we did 2 SEPS procedures as redo-operation. This is just to signal its feasibility when needed with adequate visualization and excellent clinical outcome. This in accordance to the work of others[30].

The last portion of the discussion will be dedicated to discuss whether the improvements in SEPS technique and the version of the procedure we adopted had effectively an impact on the clinical outcome and patient's improvement. There was definite, statistically significant, improvement of the clincal severity score and we noticed that improvement of the sense of heaviness on climbing stairs was a near constant feature.

In our study we found that large ulcers tend to heal slower but not in function of surface area but the absolute rate of healing is slower than smaller ones. This is in accordance to the findings of Bello et al,[22] who found the cumulative healing rate for the largest ulcers to be 80% and they concluded that larger ulcers are not more resistant to healing but simply take longer.

Another finding related to the pattern of ulcer healing after SEPS and that was documented by the method of drawing the ulcer on a transparent sterile paper is that the initial rate of surface area reduction is higher. From this we advised our patients to be hospitalized with leg elevation and rest (but no compression dressing) to make use of this tide in achieving a faster rate of healing. Yet we started to question whether this improved rate of healing was secondary to rest and elevation and not as a sequelae of SEPS. However we got the answer, at least partially, when we studied the rate of ulcer healing in cases of simultaneous bilateral active ulcers in this series (2 cases).

As our policy was not to perform SEPS simultaneously on both sides so it was a very convenient opportunity to compare the rate of ulcer healing in the side operated upon compared to the pending side. And in both cases it was definitely proved that the ulcer healing rate was higher on the side where SEPS was performed and when the 2nd side was subsequently performed it showed an enhanced rate of ulcer healing.

At the turn of one year follow up, cumulative ulcer healing rate was 95%. Also ulcers recurred only in 2 limbs (6%) as matter of fact one of them was like a small breach of skin that resolved but we considered it as a recurrence.

By analyzing the failures (2 non-healing ulcers one of which was treated by a redo-SEPS and the other persisted and the one case of recurrent ulceration that persisted) the duplex scanning in the 3 cases showed a normal deep system, remaining perforators in a lateral position in one case, no perforators in the 2nd and persistence of some perforators in the 3th). The latter case was due to failure of tourniquet during the procedure which jeopardized the view. So as a matter of fact this testify that the technique we are using encompass practically all the perforators but on condition of good visualization.

These results are considered to be an excellent outcome for the modified technique we are using if compared with the results of the biggest series in the world. This is the mid-term result of the North American SEPS (NASEPS) registry[31]. In their results registered from 16 centers from the USA and Canada and 33 surgeons; the cumulative ulcer healing at 1 year was 88% (median time to healing 54 days). Cumulative ulcer recurrence at 1 year was 16% and at 2 years 28%. Post-thrombotic limbs had a higher 2 years cumulative recurrence rate of 46%.

Our appreciation to the prohibitively high recurrence rate and the ulcer healing rate which is at least 8% less than ours to the following reasons.

1 - Limitations of their technique that we stressed upon which is the inability to control perforators fully in the distal 1/3 of the leg.

2 - They attributed the failure more to the presence of "post-phlebitic" state and deep system affection. We did not have a single case from this group suffering any post – SEPS failure of healing or recurrence. But we relate this findings to the extra difficulties to control the distal perforators in those limbs which are known to have more pronounced skin changes and incompliant subfascial space due to heavy lipodermatosclerosis. It was shown[2] that there is a direct relation between delayed ulcer healing and residual incompetent perforators. Another group[6] stressed that the missing perforating veins in their series were all located on the distal calf near the ulcer. In each case visualization was limited in the tight subfascial plane.

3- The authors in this registry blamed the contribution of operative experience of the sharing surgeons.

4- One of the reasons of high recurrence in their series would be inability to explore the intermuscular septum harboring the Cockett II and III perforators a reason of recurrence in 8 out of 10 of the redo operations that were analyzed for recurrent cases in a recent study[30].

5- What also points to the presence of a defect in their technique that needs to be addressed is the accumulating reports showing that the results of single port technique are better than those with CO_2 isufflation and regular laparoscopic instrument[2,32].

We could not explain the reason for ulcer persistence in the patient who had her ulcer for 28 years inspite of normal deep system and no residual perforators after, SEPS until we found proof in the litterature that long lasting ulcers tend to persist even after SEPS[2,30]. The explanation as advanced by those workers may be the ensuing of a special type of pathology (ex: malignancy) or tissue fibrosis preventing healing which would necessitate excision and grafting. Generally speaking, the factors which are responsible for ulcer failure to heal or recurrence include: venous outflow obstruction, multilevel deep venous reflux and ulcer size > 2cm[33] popliteal vein reflux[34].

The incidence of peri and post-operative complications was low in this series. We did not face any problems concerning the percutaneous instrument insertion through holes of 2-3mm diameter that we make in the gaiter area and mostly left without skin closure.

We did not have cases of tibial nerve injuries in this series. This was mostly due to the fact that we depended on two criterion while dissecting perforators and these are first that we should follow the structure we have dissected as perforator until it will lead us into a fascial defect (Fig. 4 and Fig. 10). Second is the issue to stick always to the underneath surface of the fascia especially while dissecting the intermuscular septum in the quest for the Cockett

groups, because the neuro-vascular bundle tend to pop up more superficially in the space between flexor digitorum longus and gastrocnemius – soleus complex. One of the manoeuvres to help keeping along the underneath of the fascia is the upward displacement of the optic axis by slinging up the optic trocar.

Tibial nerve injury underneath the flexor retinaculum was reported[35]. Other workers[26] advise to perform the paratibial fasciotomy as close to the tibia to avoid any injury to the posterior tibial vessels and the tibial nerve.

We had a couple of cases of post SEPS edema and superficial cellulitis in "post thrombotic" patients. These instances and the different patterns of deep system reflux we met; lead to some concern about being very strict in ligating all perforators. We thought that even though that some would be incompetent yet they play a role in drainage of the limb which was proven by the occurence of edema when we meticulously ligated all the perforators. From our belief that perforators in the ulcer bearing area are the most crucial for ulcer healing we followed a "selective attitude" in post-thrombobic cases where we spared the para-tibial perforators and ligated specifically Cockett II and III. Non of these cases showed so far failure of healing or recurrence of ulceration in contra-distinction to the findings of NASEPS registry which found rates up to 46% after 2 years in this group of limbs. Our explanation to the difference again is stemmed from a defective technique which fails to secure the Cockett group of perforators especially in heavily lipodermatosclerotic limbs famous to be more vivid with post-thrombotic limbs. Our view is supported by the work of others[37] who demonstrated that local venous hemodynamic abnormalities in the ulcerated area may play an important role in the development of the ulcer, because 86% of the ulcers had some degree of reflux in that area

CONCLUSION

Perforator incompetence, caused by primary valvular incompetence or by previous deep venous thrombosis, contributes to ambulatory venous hypertension and the development of chronic venous disease. Although the exact role and contribution of perforators to the development of ulcers are still debated, poor results of nonoperative management to prevent ulcer recurrence justify surgical attempts at perforator ligation, in addition to ablation of superficial reflux. The endoscopic technique of perforator interruption has significantly fewer wound complications than the open technique and is the preferred method for ablation of medial perforating veins. The technical aspects we presented in this study ended up into a form of SEPS which is easy, safe, simple, feasible, reproducible, cost-oriented, could be easily taught to junior surgeons and above all yielded a very high incidence of perforator control, ulcer healing and lower ulcer recurrence compared with honoured centers still adopting the initial technique with limited ability to attack the perforators especially in the ulcer bearing area. The marked decrease of clinical severity score and marked clinical outcome improvement index are the objective parameters of the efficacy of the technique. The study showed also the success of a "selective type of SEPS" addressed to the perforators in the ulcer bearing area with practically no failure of healing or ulcer recurrence. The possibility of doing the technique as a redone procedure is signaled. A prospective randomized tial is needed to define the long-term benefits of perforator interruption whether total or selective in order to suite different hemo-dynamically different patterns of CVI.

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