Endovascular laser ablation: minimally invasive intervention for klippel trenaunay syndrome

I G A M A Putra1, N A Hidayat1, and P A N K Permatananda2

1 Department of Thoracic and Cardiovascular Surgery, Faculty of Medicine Universitas Airlangga/General Hospital of Soetomo, Surabaya, Indonesia
2 Faculty of Medicine and Health Science, Universitas Warmadewa, Indonesia

*igusti.agung.map@gmail.com

Abstract. Klippel Trenaunay syndrome (KTS) is a complex congenital malformation that may affect the lower or upper extremities or, less commonly, involve the trunk, head, or neck. The three main components of KTS are varicosities and venous malformations (VMs), capillary malformations (port-wine stains), and hypertrophy of the soft tissue and bone. Management of varicosities in KTS patients is generally conservative. The role of endovascular therapy and minimally invasive intervention has not been widely practiced due to the low prevalence of the disease, but is preferred over open surgery, especially when non operative management is refractory. This case report is aimed to describe our minimally invasive procedure, Endovascular Laser Ablation for treatment of Klippel Trenaunay Syndrome. A female, 24 years old came to hospital with chief complaint of swelling and pain on her leg. She was diagnosed with Klippel Trenaunay Syndrome and we performed Endovascular Laser Ablation to manage her varicosities. Endovascular laser ablation is one of the semi-invasive interventions of persistent embryonic vein or great saphenous vein that is currently popular with high success rate.

1. Introduction
Klippel-Trénaunay syndrome (KTS) is a complex congenital malformation that may affect the lower or upper extremities or, less commonly, involve the trunk, head, or neck. The three main components of KTS are varicosities and venous malformations (VMs), capillary malformations (port-wine stains), and hypertrophy of the soft tissue and bone [1]. After the first mention of KTS by Klippel and Trenaunay, Parkes Weber detected patients in whom the three clinical features specific to KTS and arteriovenous fistula were found concurrently. Some medical scholars termed it the Klippel-Trenaunay-Weber syndrome. However, the recent trend is in favor of treating these patients as cases of KTS plus arteriovenous fistula as a separate disease, calling it the Parkes Weber syndrome [2].

The etiology of the disease is still under investigation, but it is well accepted that venous abnormalities are not the causative insult. Embryonic mesodermal changes resulting in increased angiogenesis lead to increased vascular flow causing tissue hypertrophy and vascular changes. Most experts agree that the majority of cases of KTS are due to sporadic polygenic mutations [3]. This syndrome has no racial predilection. Vascular malformations on the skin surface may be visible from birth, but venous velocity and limb hypertrophy are usually not seen early. The average age of children detected in health facilities is 4 years [4].
Imaging studies like contrast enhanced Magnetic Resonance Imaging (MRI), Ultrasonography (US) and Doppler study may be needed for diagnosis and to find out the extent of lesion that helps in planning the interventions if indicated. Treatment is indicated to reduce the symptoms and the risk of complications. Management for KTS is generally conservative with compression therapy. Active intervention needs to be attempted only for localized lesion or in presence of serious complications like bleeding or cardiac failure [5]. The role of endovascular therapy and minimally invasive intervention has not been widely practiced due to the low prevalence of the disease, but is preferred over open surgery, especially when non operative management is refractory. This study is aimed to report our endovenous laser ablation (EVLA) as semi invasive therapy for Klippel Trenaunay Syndrome.

2. Case Presentation
A 24 years old single female came to our department with chief complaint of pain and swelling on her right leg since child. She also had multiple purple colour lesions which were increasing in size with age. Tenderness was minimal. Pain was felt as being tied up, exacerbated by activity and decreased at rest. She denied any hereditary disease. History of diabetic mellitus, hypertension, allergy, and trauma were also denied. She has never run a treatment for her disease. She has no family with same complaint or disease. She works as a private employee in a company with daily activities sitting in front of computer. She didn’t smoke and drink any alcohol.

On physical examination, we found general status was good, compos mentis, blood pressure 120/80 mmHg, pulse 80 x/min, respiratory 20 x/min, temperature 36.5oC, Body weight 60 kg, Height 156 cm. We found no abnormalities in heart and pulmonary examination. On her right inferior extremity, we found there were multiple lumps which is varied in size, numular and lenticular, spider vein (+), hyperemia (-), and port wine stain (+). The lumps were supple and fixed, tenderness (-). Examination with vascular ultrasound along right inferior extremity (figure 1), we found varying Great Saphenous Vein (GSV) sizes ranging from 3.7 mm to 9.5 mm, flow (+), turbulence (+). Small Saphenous Vein size also varies from 2.7 mm to 5.3 mm, at half cruris there is venous displacement in the medial direction and followed by branching into 5.6 tributary vein. No visible deep vein thrombosis. MRI results (figure 2) lead to varicose vein medial cutaneous-subcutaneous distal femur that is related to varicose vein sign in GSV thigh-calf dextra. There is apresimation of m. sembrimembranosus dextra. Varicose vein signs are lighter on SSV and intramuscular vein on m. sembrimenosus and m. achilis dextra. She was diagnosed with Klippel Trenaunay Syndrome. We choose Endovenous Laser Ablation as therapy, followed by vein compression. After 7 days follow up, we found the varicosities appear to be reduced (figure 3).
3. Case Discussion

Klippel–Trénaunay syndrome (KTS or KT) is an unusually seen syndrome with typical combinations of delicate tissue or bony overgrowth, dermatological vessel abnormalities, and associated venous capillary or lymphatic malformations. KTS is now termed capillary-lymphatic-venous malformation (CLVM). This is a low-flow vascular malformation and not an arteriovenous malformation, which is a high flow condition. The latter is termed Klippel–Trénaunay–Weber syndrome and is a separate syndrome. The vascular abnormalities are usually seen in a single limb, but in rare cases, multiple limbs can be involved. This syndrome should be diagnosed properly and early and differentiated from similar-looking conditions such as Parkes–Weber syndrome (PWS), lymphatic filariasis, Beckwith–Wiedemann syndrome, Proteus syndrome, Russell–Silver syndrome, Maffucci syndrome, CHILD syndrome (congenital hemidysplasia with ichthyosiform erythroderma and limb defects), neurofibromatosis type 1 (NF1), and triploid syndrome [6][7]. In our case, we found the three main components of KTS, such as varicosities, port-wine stain, and soft tissue hyperthropy. At least two of three main symptoms must be present for diagnosis of KTS. Other systemic involvement in patients of KTS, include central nervous system abnormalities may include microcephaly, macrocephaly, cerebral arteriovenous malformations, and orbito-frontal varices, patients may present with neurological symptoms due to compression of spinal cord by hemangiomas, gastrointestinal bleeding and genitourinary lesions like hematuria and vascular malformations of scrotum, penis, vulva, vagina and bladder may also occur [8].

Non operative medical management is the main modality in the treatment of symptomatic KTS patients. Rarely, and only in patients refractory to medical management, should operative intervention be considered. For example, in a series of 19 KTS patients described by Sung et al. only 4 underwent operative intervention during a mean follow-up of 4.1 years with no major adverse outcomes regardless of management style. Patients with KTS should be managed similarly to those with more common varieties of chronic venous disorders with appropriate consideration of potentially extenuating circumstances, such as deep venous agenesis, which may make the remaining superficial veins an important egress for lower extremity outflow [9]. The conservative management is sufficient in mild form of KTS but in female patients of reproductive age group like in our case, KTS will increase obstetric risk and can exacerbate complications mainly thromboembolism and hemorrhagic. Probably risk is ten time higher than normal population. The other factors which exacerbate this risk are oral contraceptives, surgery and pregnancy [8].

The role of endovascular therapy and minimally invasive intervention in KTS is not well established secondary to the low prevalence of the disease; however, it should be offered over open surgery after failed non operative management. Using the CEAP classification, operative vascular intervention should be considered when the severity of disease progresses to greater than class 3 or potentially class 2 in some symptomatic cases. The largest experience of vascular malformations intervened on is reported by the Mayo Clinic. In their practice, absolute indications for intervention consist of continuing hemorrhage, refractory ulcerations, and acute thromboembolism. Relative indications consist of pain, functional impairment, swelling secondary to venous insufficiency, limb asymmetry, and cosmesis [10][11]. The basis of the success of sclerotherapy, embolization, ablation, and laser treatments in KTS is built from the parallel experience in chronic venous and capillary disease. Endovascular treatment is considered to be safe and effective and offers the significant advantage of rapid recovery than other choice of treatment [12].

In the era of minimally invasive surgery, new techniques in the treatment of varicose veins, such as the endovenous laser ablation (EVLA), have been introduced. In 1999, the first report on EVLA appeared in the literature. Using an 810 – nm diode laser, Boné first reported the delivery of endoluminal laser energy for the treatment of the insufficient GSV. The EVLA method of venous closure acts by heat – induced collagen shrinkage, followed by fibrotic sealing of the vein lumen. In order to destroy a vein with laser, the vein wall must absorb enough energy to result in generating so much heat as to damage all layers of the vein [13].
Figure 3. Seven days after EVLA procedure, we found the varicosities appeared to be reduced

Prior to decide management option, the diagnostic evaluation is performed by taking a careful history, performing a physical exam, and obtaining noninvasive vascular laboratory studies. A venous duplex ultrasound of the affected lower extremity should evaluate the deep veins, great saphenous vein (GSV), accessory saphenous veins (ASVs), if present, and small small saphenous vein (SSV) for patency as well as the presence of reflux. Great Saphenous Vein (GSV) reflux is the most common underlying cause of significant varicose veins. When the GSV reflux is the principal underlying problem, treatment should involve eliminating this source of reflux with ablation of any associated incompetent venous segment [14].

The importance of the intraoperative ultrasonographic (US) guidance during the EVLA procedure must be underlined. The vein mapping, as in figure 5, is important at the initial puncture of the saphenous vein, the advance and the right positioning of the laser catheter within the vein lumen and at the end, for the evaluation of the success of the procedure. Access to the saphenous vein is obtained by a needle puncture. The preferred point of the puncture is just below the knee, because at this point the diameter of the vein is large and the risk of thermal injury of the saphenous nerve is low. Sometimes, the vein goes to spasm and puncture may be difficult. In order to avoid that, many authors recommend puncturing the vein without local anaesthesia, which can cause the spasm. It is important to put the patient into the reverse Trendelenburg position previously in order to have a vein full of blood and make the puncture easier. Once the access has been obtained under US guidance, J-tip guidewire of 0.035 inch. passes through the hollow needle into the vein lumen. Then, the needle is withdrawn and a small incision is made at the entry point of the guidewire to permit the passage of the introducer sheath of 5 or 6Fr and the dilator over the wire. Subsequently, the guidewire and the dilator are removed and the sheath remains in position. Then, the laser fiber, which usually has a diameter of 600 mm is passed through the sheath and under US guidance is advanced at the SFJ. The correct position of the tip of the laser fiber is at a distance of 2 cm from the junction or just below the inferior superficial epigastric vein. This vein is an important landmark for the positioning of the fiber tip in order to have a safety distance from the femoral vein, avoiding major complications, such as deep vein thrombosis (DVT). Additionally, the blood flows from the abdominal wall through the superficial inferior epigastric vein towards the femoral vein. Thus, maintaining this vein patent is important for the maintenance of the patency of the femoral vein [13].

The procedure can be performed under tumescent anaesthesia which is administered under US guidance with multiple syringe hand injections or with the use of a foot pump system. Marking the vein course with a skin marker could be helpful in the tumescent solution administration, see figure 6. The solution includes 500 mL saline, 25 mL 2% lidocaine and 10 mL sodium bicarbonate. Temperature set at 4°C to cause local anaesthesia and significant spasm of the vein. Tumescence is delivered in a circumferential manner in the perivenous sheath with the use of an 18 - G needle. The administration of tumescent anaesthesia is of paramount importance in order to achieve an external compression of the vein, posing in strict contact the vein wall with the fiber tip located within the lumen and having a direct transmission of the laser energy to the vein wall. This procedure can also increase the distance between
the vein and the skin, isolating it from the perivenous structures and avoiding skin burns. Finally, a painless procedure is achieved with this kind of anaesthesia, because tumescence acts as a local anaesthetic. Tumescent solution excludes blood from the vein by squeezing it out and therefore it is useful to have the patient in Trendelenburg position during the administration and start the tumescence distally and proceeding proximally so that blood does not get trapped. It is useful to increase the quantity of tumescent solution injected at the level of the SFJ in order to achieve a better compression of the junction and avoid a possible extension of a thrombotic phenomenon into the femoral vein or the passage of bubbles toward the heart [13].

After setting of the parameters the patient is positioned into the Trendelenburg position in order to achieve a bloodless vein. The parameters of the laser is adjusted in accordance with the type of wavelength and the type of fiber. This maneuver in association with the tumescent administration helps to increase the surface area contact between laser tip and vein wall and to reduce the amount of blood that can absorb even a small part of the energy inducing clot formation. Then the laser fiber is pulled back constantly in the case of continuous mode. After complete withdrawal of the catheter a US examination must be performed to reveal absence of flow and lack of compression in the treated vein.

At the end of the operation elastic stockings are used in the treated limbs for two weeks. Patients are mobilized immediately after the operation and discharged from the hospital or the ambulatory office a few hours later. The US and clinical examinations can be performed within the first week, at 1, 3, 6 months and then yearly. The patients must be assessed for lack of flow in the treated vein, recanalization, DVT and nerve injury [13]. In this case, our patient come for routine follow up one week after EVLA procedure, and we see great reduction of varicosities with minimal postoperative pain. Some published studies reported a high success rate of EVLA procedure, however recanalization of a treated vein has been reported 2 and 3 years after EVLA procedure [15].

If we compare between EVLA and stripping or ligation, EVLA is performed in local-tumescent anaesthesia and the patient is mobilized immediately after procedure. The patient is discharged from hospital after a few hours. Thus, the procedure can be easily performed in an outpatient setting. Patient can return to normal activities in 2 or 3 days. Stripping and high ligation of the saphenous vein requires a groin incision, that is avoided in the EVLA. Even a short groin incision presupposes taking care of the wound until it heals. With EVLA the groin is not dissected, and the stimulus for neovascularization is lacking. The dissection of the groin with ligation of the tributaries and dissection of the saphenofemoral junction may be sufficient to trigger the phenomenon of neovascularization. With EVLA, wound infections in the groin incision, especially in obese patients, can be avoided. Ablating the vein to just below the knee abolishes the possibility of saphenous nerve injury, which is relatively common during stripping (at the level of the ankle), because of the position of the nerve in close proximity to the vein mainly in the area of medial malleolus. Additionally, EVLA in expert hands seems to be a less time consuming procedure. In terms of health related quality of life, EVLA has a significantly superior short and long term effect [13].

4. Conclusion
Because of the rarity and complexity of KTS, early referral to specialist centers should be considered. The varying presentations and severity of disease necessitate that each treatment plan be individualized for the specific KTS patient. A multidisciplinary team should be involved with the patient’s care so that all needs are addressed as they are manifested. Patient should be educated about the nature of the disease as compliance to any proposed treatment is essential to ultimate success and only increases with education. Open surgical intervention has drastically decreased to be done for varicosities management due to wound complication and persistent bleeding. EVLA is one of semi invasive intervention for treating KTS and must be considered open surgical intervention.

References
[1] Noel A A, Gloviczki P, Cherry K J, Rooke TW, Stanson A W, Driscoll D J 2000 J. Vasc. Surg. 32 840
[2] Sung H M, Chung H Y, Lee S J, Lee J M, Huh S, Lee J W, Choi K Y, Yang J D, Choo B C 2015 APS 552
[3] Billington A R, Shah J, Elston J B, Payne W G 2013 J. Plast. Surg. Hand Surg. 1-5
[4] Cha S H, Romeo M A, Neutze J A 2005 RadioGraphics 25 1941
[5] Kapoor A, Sarkar D, Rai G J, Anand S 2012 PJSR 5 51
[6] Sharma D, Lamba S, Pandita A, Shastri S 2015 Clin. Med. Insights Circ. Respir. Pulm. Med. 9 1-4
[7] KTS Working Group 2016 Clinical Practic Guidelines for Klippel-Trenaunay Syndrome (Boston – Boston Children’s Hospital)
[8] Wang S K, Drucker N A, Gupta A K, Marshall F E, Dalsing M C 2017 J. Vasc. Surg. 5 587
[9] Agale S A, Bharame B M, Pawar R, Valand A G 2012 JEMDS 1 693
[10] Gloviczki P, Driscoll D J 2007 Phlebology J. 22 291
[11] Eklof B, Rutherford R B, Bergan J J, Carpentier P H, Gloviczki P, Kistner R L 2004 J. Vasc. Surg. 40 1248
[12] King K, Landrigan-Ossar M, Clemens R, Chaudty G, Alomari A I 2013 J. Vasc. Interv. Radiol. 24 855
[13] Galanopoulous G, Lambidis C 2012 Int. J. Surg. 10 134
[14] Eissaway M G, Abd-Elgawad E A, El-Shereif M A E 2016 EJN 47 179
[15] Proebstre TM 2005 Recanalization of the Great Saphenous Vein Can be Observed at 2 and 3 Years after Endovenous Laser Treatment (San Fransisco-ACP 19th Annual Conference)