

血管通路介紹

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104年6月14日

課程大綱

1. 了解哪些病人需要血管通路
2. 血管通路的歷史故事
3. 血管通路的種類
4. 人工血管的材料
5. 血管通路的合併症及暢通率
6. 血管通路的圖片欣賞

Reference

- Sabiston Textbook of Surgery, 18th ed. Copyright ©
- www.google.com.tw 找了幾張圖片

哪些病人需要血管通路 (Vascular access)

- 靜脈營養 (parenteral nutrition)
- 化學治療 (chemotherapy for malignant disease)
- 血漿交換 (plasmapheresis)
- 血液透析 (short-term and long-term dialysis)

說歷史故事時間 - 1

- Thomas Graham, 19th世紀
 - 第一個研究透析
- George Haas, in 1924
 - 進行第一次人類的透析, 透析量不足夠, 死翹翹,
- Willem Johan Kolff, in the early 1940s
 - 設計洗腎機器, 使用heparin, 透析了26天, 死翹翹
 - 因為當年沒有所謂的血管通路, 一直重複做血管切開 (surgical cut-downs).
- 沒有好的血管通路 (vascular access), 就沒有今天血液透析的大量發展

說歷史故事時間 - 2

- Quinton and colleagues in 1960
 - 第一個外在的血管通路 (Teflon conduit 連結在動靜脈之間).
- Brescia and associates in 1966
 - 第一個 native arteriovenous fistula (AVF), 在 the radial artery 及 the cephalic vein 之間
 - **The Brescia-Cimino fistula is still considered the gold standard for dialysis. (B-C fistula)**
- The cephalic vein不理想
 - 也有人使用 the saphenous vein, 但不能令人滿意的
- 人工血管的出現
 - 目前 standard 材質是 **polytetrafluoroethylene (PTFE)**

外在的血管通路 (Teflon conduit 連結在動靜脈之間)



The Early History of Dialysis for Chronic Renal Failure in the United States:
A View From Seattle
American Journal of Kidney Diseases, Volume 49, Issue 3, March 2007, Pages 482-496

Left Brescia-Cimino fistula



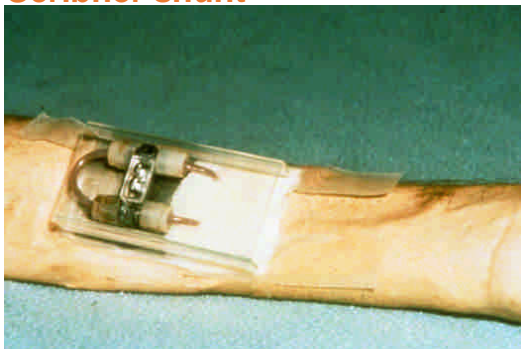
血管通路的種類

- 外在的血管通路 (External access)
 - Scribner shunt
 - Temporary Hemodialysis catheter (Hemocath)
 - Permanent Catheter (PermCath)
- 內在的血管通路 (Internal access), 通稱為 AV Shunt
 - 自體的瘻管 Natural Fistulas, (AVF)
 - 人工的血管 Prosthetic Grafts, (AVG)

外在的血管通路 - 1

- The first successful shunt for repeated hemodialysis was the **Scribner shunt**
 - a Teflon tip 分別插入動脈及靜脈
 - Silastic tubing (矽橡膠管), 連接 Teflon tip, 穿過皮膚在體外連結, 造成連續的血流。
 - Hemodialysis時, 將連結處打開, 兩端分別接上洗腎機器
- 和現在比起來, 就是不必puncture 血管啦!!
- But, 自殺 比較方便

Scribner shunt



外在的血管通路 - 2

- Temporary Hemodialysis Catheters : non-tunneled catheter, short term used. 簡稱 **Hemocath**
- Subclavian, internal jugular or femoral vein.
- 可能導致 central venous stenosis.
- Low incidence of re-circulation (2%~5%) But, 18% ~40% at higher blood flows of 400 mL/min

Temporary Hemodialysis Catheter

(Short Term Hemodialysis Catheter)

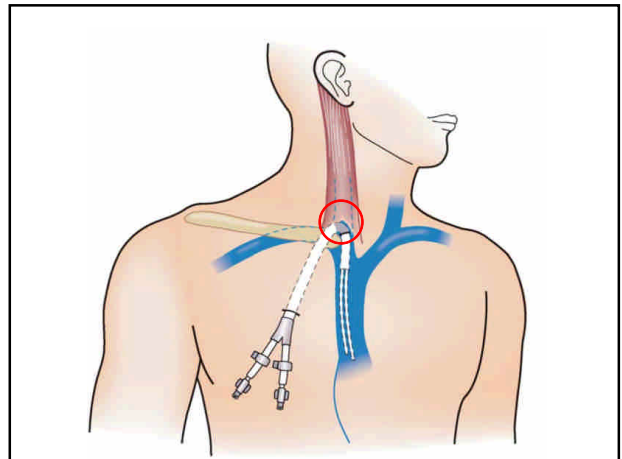
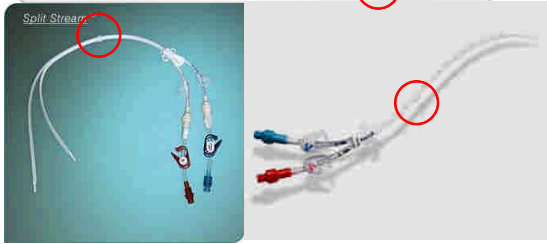


外在的血管通路 – 3.1

- Permanent Catheter : long-term 的外在血管通路, 是 tunneled catheter, 又稱為 **PermCath**.
- Catheter 有 the Dacron cuff 可以讓 **組織生長** 進去, 跟 noncuffed catheters 比起來, 有助於 **抵抗感染**.
- 大多 catheters 有 both lumens in a single unit. However, blood flows of up to **400 mL/min**

Dialysis Outcomes Quality Initiative (DOQI) guidelines state that **internal access** needs to be attempted first.

Hemo-Cath® LT



外在的血管通路 – 3.2

- 一般建議, Catheter tip 要放在 **the right atrium (RA)**, 避免 **recirculation** 及減少 **clot** 形成
- 如果是 Stiff (硬的) catheters, 建議放在 **RA 及 SVC 的 junction**, 避免 **arrhythmias**
- 可能造成 **central vein stenosis**
- 如果病患不合適 **internal access**, (**poor venous condition, unclear cons.**) or **severe CHF** 才會做此選擇
- PermCath survival rate
 - 74% at 1 year
 - 43% at 2 years

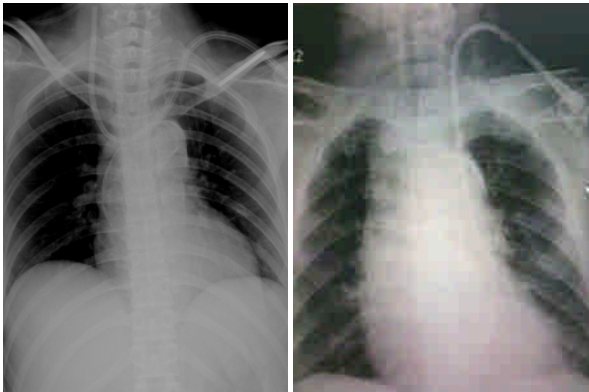


PermCath 的 Complication

- 手術時, 可會: **pneumothorax, hemothorax, arterial injury, thoracic duct injury, air embolus, inability to pass the catheter, bleeding, nerve injury, and great vessel injury.**
- 手術後要 F/U Chest radiograph, 確認catheter位置, 排除 pneumothorax 及是否有 great vessels 損傷
- **The incidence of pneumothorax is 1% to 4%,**
- **The incidence of injury to the great vessels is less than 1%.**
- **Mechanical complications :**
 - catheter malposition (移位),
 - flow不順 (the clavicle and the first rib 夾住啦)

PermCath 的 Complication

- **Clot or fibrin sheath formation and thrombotic complications : occur in 4%~10%**
 - Tissue plasminogen activator (tPA)
 - Mechanical or pharmacologic thrombectomy
 - Be treated for the deep venous thrombosis
- **The second most common catheter problem is infection.**
 - 手術後 3-5 days
 - Catheter-related sepsis
 - Infection, 可能演變成大災難 : epidural abscess, osteomyelitis, bacterial endocarditis, or septic arthritis.....



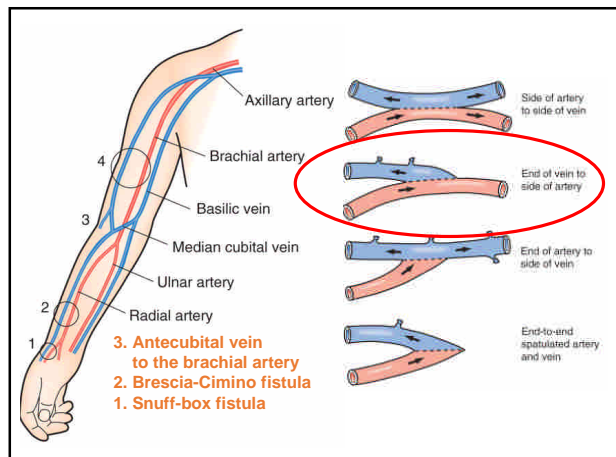
跑到 right internal jugular vein Left side SVC→coronary sinus

內在的血管通路 – 1 自體的瘻管 Natural Fistulas

- **The fistula most frequently used, the standard : is the Brescia-Cimino fistula.**
- **Allen test** is performed before operation
- **Non-dominant** arm is used first
- Start **as distal** in the arm **as possible**
- 動靜脈的吻合方法有四種, including from side artery to side vein, from end artery to side vein, **from side artery to end vein**, or from end artery to end vein
- A **side-to-side** anastomosis can cause **venous hypertension** in the hand, which can be corrected by ligation of the vein distal to the anastomosis.
- The **end-to-end** anastomosis appears to be accompanied by a **higher initial thrombosis rate** because fewer collateral channels are present.

內在的血管通路 – 1 自體的瘻管 Natural Fistulas

- **Snuff-box fistula** : the autogenous posterior radial branch- cephalic direct access
- **Brescia-Cimino fistula** : the autogenous radial-cephalic direct wrist access
- **Feinberg** : the autogenous ulnar-cephalic forearm transposition, autogenous forearm radial-basilic transposition fistula
- **Antecubital vein to the brachial artery** : autogenous brachial-cephalic upper arm direct access
- **Basilic vein transposition** : the autogenous brachial-basilic upper arm transposition. The last fistula calls for dissection of the basilic vein and transfer to a superficial position on the medial portion of the upper extremity
- **Basilic vein superficialization**



Snuff-box fistula



Brescia-Cimino fistula



Antecubital vein to the brachial artery



Basilic vein superficialization



R Basilic vein transposition L



內在的血管通路 – 1 自體的瘻管 Natural Fistulas

- **Transposing saphenous vein** to upper arm as a conduit or transposing a loop in the thigh to create natural fistula access
- **Superficial femoral vein transfer** has also been reported but carries a high rate of initial as well as late complications and is reserved for limited cases
- **Acquired immunodeficiency syndrome (AIDS)** : **natural vein** is the preferred conduit for construction of vascular access for hemodialysis.

內在的血管通路 – 1 自體的瘻管 Natural Fistulas

- The National Kidney Foundation's **Dialysis Outcome Quality Initiative (DOQI)** Guidelines :
 - **Doppler mapping** of vessels has been done to determine what vessels can be used for the construction of a natural fistula.
- An **artery** had to be **2 mm** or more in diameter and a **vein** had to be **2.5 mm** or more in diameter to be useful for a fistula.

Mapping



內在的血管通路 – 1 自體的瘻管 Natural Fistulas

- **Brescia-Cimino fistula**
 - 65% at 1 year
 - 55% to 89% at 2 years.
- **Brachiocephalic fistulas**
 - 80% at 1 year.
- **Basilic vein transposition**
 - 73% at 2 years
- 自體瘻管 failure 的原因 : aging, stenosis and poor venous outflow, excessive dehydration or hypotension, thrombus

內在的血管通路 – 1 自體瘻管的 complications

- The most common is **failure to mature** (size and flow) → Mature?? 要多久??
- **Stenosis at the proximal venous site (48%)** → PTA
- **Aneurysms (7%)** : repeated needle punctures → **excision of aneurysm or ligation of the fistula**
- **Thrombosis (9%)** : the next most common complications.. → **thrombectomy or/and PTA**
- **Heart failure** : a marginal cardiac reserve and a fistula **flow rate of more than 500 mL/min.** → **a Teflon band for banding or ligation of the fistula**

內在的血管通路 – 1 自體瘻管的 complications

- **The arterial steal syndrome** : about 1.6%, pain, weakness, paresthesia, muscle atrophy, gangrene
 - wrist fistulas (0.25%), more proximal fistulas (~30%)
 - be reversed by **banding or ligation** of the fistula.
- **Venous hypertension** : distal tissue swelling, hyperpigmentation, skin induration, skin ulceration.
 - A side-to-side anastomosis (steal syndrome and distal venous hypertension) → Ligation of the distal limb
 - This proximal partial vein occlusion or stenosis → **PTA, bypass or ligation of the fistula**
- **Infection** : rare (<3%)

Aneurysms (repeated punctures +)



**Aneurysm + Infection
+ Stenosis**



Aneurysm (traumatic)



The arterial steal syndrome
→ a Teflon band for banding

Venous hypertension



**Venous hypertension +
Stenosis**



Venous HTN post ligation



內在的血管通路 – 2 人工的血管 Prosthetic Grafts

• 隨著poor peripheral veins及AVF failure的病患增加, 需要找到一種 prosthetic material(人工血管), 放置在皮下, 用來嫁接在動靜脈之間, 需要:

- easy to handle and to suture
- allows graft-host biocompatibility
- minimally thrombogenic
- resists infection
- Inexpensive
- repeated needle punctures
- allow tissue ingrowth.

好縫
生物相容
少栓塞
抗菌
不貴
常打針
組織長進去

內在的血管通路 – 2 人工的血管 Prosthetic Grafts

- Dacron, bovine graft, and PTFE
- PTFE is the most popular material
 - ingrowth of tissue
 - neointima formed
 - lessens thrombosis and infection.
 - lower incidence of aneurysm formation than do bovine grafts
 - Heparin-bonded PTFE has recently
 - the patency rates
 - a vein cuff or a precuffed prosthetic graft

Polytetrafluoroethylene (PTFE)

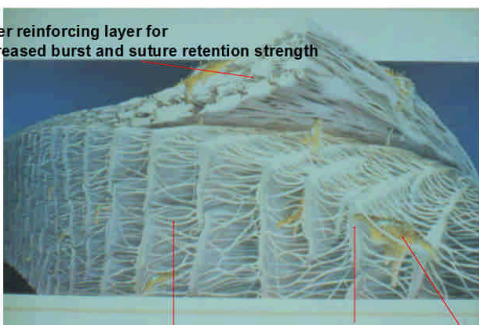
- 聚四氟乙烯 (Polytetrafluoroethene), 英文縮寫為PTFE, 商標名Teflon®, 台灣譯為鐵氟龍®
- 具耐熱、耐低溫、耐蝕性、異優的非粘著性、自潤性及低磨擦係數等等。鐵氟龍除了常被應用在烹飪器具上外, 還被廣泛應用於訊號管線的絕緣體、防水和防塵塗料等等之處。
- 聚四氟乙烯在常態下是無毒的, 但當聚四氟乙烯烹調器具在溫度達到500 °F(260 °C)之後便開始變質, 並且在660 °F(350 °C)之上開始分解。

洗腎用的人工血管

- 材料: 膨脹聚合四氟乙烯 簡稱 ePTFE
 - 是由氟分子及碳分子組合而成, 是最具惰性之合成材料之一
 - 具生物相容性: 具多孔性, 使其在植入人體後, 能與組織相容。
 - 且孔隙的大小不同, 組織會生長進入孔隙, 符合人體組織在臨床上的不同要求
 - 孔隙的大小為 22-25 微米, 最適合人體組織生長
- 各個品牌, 產品內容豐富, 在此不能介紹

Microstructure

outer reinforcing layer for increased burst and suture retention strength



fibril length of 25 microns (nominal) Nodes Fibroblasts

內在的血管通路 – 2 人工的血管 Prosthetic Grafts

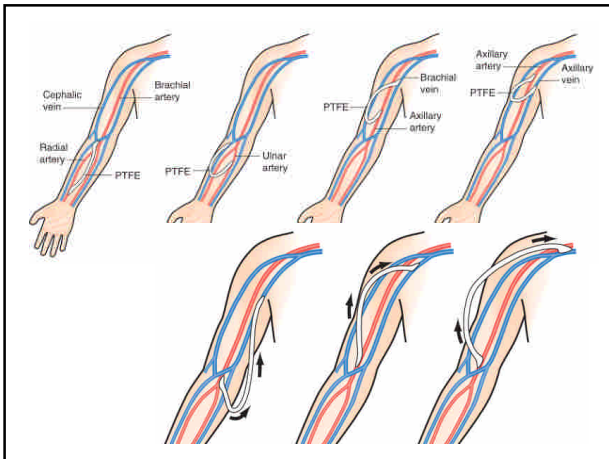
- Successful creation 的要件: good arterial inflow and venous outflow.
- Duplex scanning
- Rotation or pinching of the graft in the tunnel: avoided.
- a 6-mm graft and a rapid-taper 4- to 7-mm graft: size permit needle puncture readily.
- 4- to 7-mm taper and 6-mm straight: patency or flow rates 沒差
- 6- to 8-mm taper and 6-mm straight: patency and flow rates 有差,
- Hematoma formation / bleeding at the puncture site, infection and pressure occlusion → 成熟期 1 to 2 weeks, tissue ingrowth, for the needle puncture

a rapid-taper 4- to 7-mm graft



內在的血管通路 – 2 人工的血管 Prosthetic Grafts

- **Non-dominant** arm is used first,
- Start **as distal** in the arm **as possible**
- **The forearm, straight graft** : the radial artery at the wrist → the cephalic vein just below the elbow.
- **The forearm, loop graft** : the brachial artery at the elbow → the antecubital / cephalic / basilic / brachial vein
- **The upper arm, straight graft** : the brachial artery at the elbow → the axillary / brachial / basilic vein
- **The upper arm, loop graft** : the axillary / brachial artery → the ipsilateral axillary brachial vein



內在的血管通路 – 2 人工的血管 Prosthetic Grafts

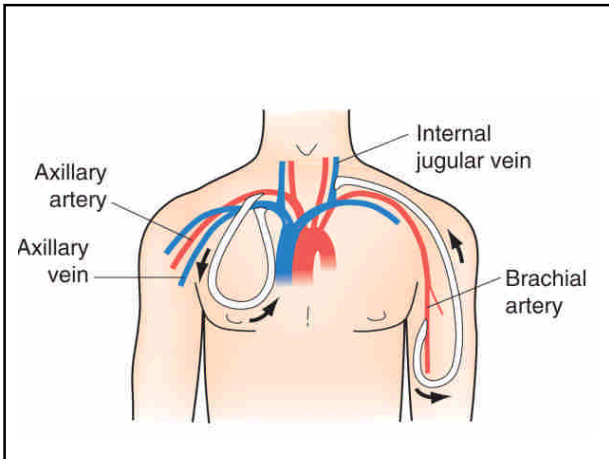
- These upper arm grafts
 - a high flow rate
 - a low incidence of thrombosis
 - a higher incidence of ischemia in the hand
- After graft placement, swelling is frequently
 - secondary to surgical trauma
 - changes in venous outflow.
 - **resolve with arm elevation and time.**

內在的血管通路 – 2 人工的血管 Prosthetic Grafts

- Interposition grafts in the lower extremity : 上臂做完了
- **A loop graft in the thigh** (superficial femoral artery to saphenous vein; prosthetic femoral-saphenous looped inguinal access
- **A jump graft between the popliteal artery and the femoral vein** are the two most common configurations.
- 最好不要使用在 **diabetes** and **elderly** patients, who frequently have peripheral arterial insufficiency (PAOD)

內在的血管通路 – 2 人工的血管 Prosthetic Grafts

- 如果上下肢都做完了
→ other arteriovenous jump graft
 - from the axillary artery to the axillary vein across the chest, creating a loop on the anterior chest,
 - grafting from the axillary artery to the iliac vein,
 - grafting from artery to artery
 - requires narrowing the artery between the graft anastomoses
 - potentially result in acute limb-threatening ischemia.



Forearm loop graft



Forearm loop graft + previous Brescia-cimino



Upper Arm AVG, 7 years



Basilic vein stenosis post 6mm graft bypass



內在的血管通路 – 2 人工血管的 complications

- **Hemorrhage**
 - Early hemorrhage : anastomotic site
 - Late hemorrhage : needle puncture → bleeding into the peri-graft space.
- **Thrombosis**
 - Early thrombosis : technical reasons
 - Later thrombosis : intimal hyperplasia
- **Outflow stenosis / intimal hyperplasia / occlusion**
 - repaired by a patch graft
 - balloon dilation of the strictured area / PTA
 - graft bypass of the obstruction.

內在的血管通路 – 2 人工血管的 complications

- 造成 graft thrombosis 的原因, 多數為
 - Low blood pressure
 - Excessive external pressure
 - Intimal hyperplasia
- Thrombosis 不一定有 narrowing of either inflow or outflow, 可能只需要 simple thrombectomy of the graft 或 simple thrombolytic injection into the graft.
- 有些病患 recurrent episodes of thrombosis, 可能是 hypercoagulability, 想要藉由藥物 prevention of thrombosis, 往往是 unsuccessful.

內在的血管通路 – 2 人工血管的 complications

- 研究顯示, aspirin increased secondary graft patency by 30%;
- 但是, both aspirin and clopidogrel 會有 unacceptable bleeding complications
- 有人做 coagulation evaluation, 包括 protein S, protein C, antithrombin III, plasminogen, factor V Leiden, and antiphospholipid antibodies. 但沒有任何藥物可以減少 intimal hyperplasia
- Cilostazol (Pletal) and clopidogrel (Plavix) 在動物實驗中, 有證實可減少 intimal hyperplasia

內在的血管通路 – 2 人工血管的 complications

- Infection 是人工血管的一個很大問題
- 如果 suture line 沒 involved,
 - 可以考慮先 local drainage and wound care
 - Bypassed with a short graft
 - Covered with a skin flap.
- 如果 suture line 有 involved, tunnel infection, clotting of the graft, or lack of success with local wound therapy,
 - 可能要拆掉人工血管
 - Infected grafts 救援成功的機會是低的, 只有 25%-50%

Graft infection



內在的血管通路 – 2 人工血管的 complications

- Old clotted prosthetic grafts 可能導致 infection, 尤其是病患 low serum albumin concentration.
- In patients infected with human immunodeficiency virus (HIV), the leading complication is infection; 32% of grafts in these patients become infected within 30 days.
- The organisms are *S. aureus* or coagulase-negative staphylococcal species.
- Patients with a history of IV drug use and those with AIDS have an infection rate with PTFE grafts in place of about 40%.

內在的血管通路 – 2 人工血管的 complications

- False aneurysms, 是因為 puncture 導致 laceration of the graft material
 - Bypassed
 - Endovascular technique using covered stents.

Upper arm straight graft + pseudoaneurysm with rupture



**內在的血管通路 – 2
人工血管的 complications**

- **Venous hypertension, congestive heart failure, vascular steal**, and vascular access neuropathy.....這些都有可能發生在人工血管
- A rapid-taper 4- to 7-mm graft : decreases the flow rate, 一般使用在老年人或糖尿病病患
- The steal syndrome 較常發生在 upper arm fistulas
- Proximal artery ligation, bypass to the distal artery by saphenous vein, resolved the steal syndrome in more than 85% of patients in the studies.
- Most of the studies showed patency of the access to be more than 80%.

Forearm loop graft + arterial steal syndrome



Upper arm straight graft + venous hypertension



Upper arm straight graft + graft failure and exposure



**內在的血管通路 – 2
人工血管的暢通率 (patency rate)**

- PTFE grafts 的 patency rate : the 1-year rate is 80% and the 2-year rate is 69%. 其實和 natural fistulas 沒差很多
- Raju reported a 93% patency of PTFE at 1 year and a 77% patency at 2 years.
- Munda and associates :
 - an upper arm location : 60% patency rate at 12 months
 - a forearm straight graft : 35% patency rate at 12 months
 - a forearm loop graft : 78% patency rate at 12 months
- Thigh grafts : 80% patency rate at 12 months

Ring-graft + paper skin



烏青



生仙



好的動靜脈瘻管之三要件

Flow要夠
血管淺, 打針打得到
要有足夠打兩針的長度

好的動靜脈瘻管之三要件

~~Flow要夠
血管淺, 打針打得到
要有足夠打兩針的長度~~

用一句話來說明

好的動靜脈瘻管之三要件

~~Flow要夠
血管淺, 打針打得到
要有足夠打兩針的長度~~

用一句話來說明
動脈血流表面化

Thank You