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Unusual Vascular Access for Hemodialysis Therapies

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1. Introduction

For many years, the arteriovenous (AV) fistula has been demonstrated to be the best vascular access for patients requiring chronical hemodialysis therapy.

The morbidity and mortality statistics for patients with AV fistula is significantly lower compared to patients with central venous catheters (1). However, many patients are found in which performing an arteriovenous fistula or implanting an AV graft is not a possibility. For these patients the usual protocol is the use of an indwelling catheter for chronic hemodialysis therapy practice.

The appearance of patients incompatible with AV fistula is due to the repetitive venous punctures in classical blood vessels, performed in the intensive care unit or for patients with chronic renal failure. These patients develop venous fibrosis making subsequent cannulations impossible.

The use of central venous catheters for initial hemodialysis therapy is also a common practice, this situation is repeated in all countries so that in the United States 60% of incident patients and 17 to 30% of prevalent patients depend on it as the only vascular access catheter despite the recommendation of the K/DOQI guides (Kidney Disease Outcomes Quality Initiative). (2)

In the year 2010, 100% of incident hemodialysis patients in our renal unit were treated with a central venous catheter. This reflects a late referral of doctors to the nephrology clinic, preventing the early practice of AV fistula.

In the same year 259 central venous catheters were implanted in our Renal Unit, 34% of them were transient in acute renal failure patients, 56% transient in patients with chronic renal failure and 10% tunneled catheters. Additionally our statistics showed that at the end of the year 2010 tunneled catheters represented 25% of vascular accesses and that in 94% of the patients using these catheters, arteriovenous fistula or AV graft implant were impossible, thus constituting the catheter tunneled the only access for the practice of chronical hemodialysis.

Traditionally, the most used vascular access is the internal jugular venous, but it can fail due to permanent thrombosis or agenesis. In these situations the usage of even more unusual routes is necessary. Routine practice of procedures through these routes can make them much more available; the purpose of this article is to familiarize physicians with these routes and the correct techniques for accomplishing safe alternative vascular accesses.

2. Vascular access variant

2.1 Upper hemithorax

Several blood vessels can be punctured in this area for the implantation of central venous catheters (Figure 1).

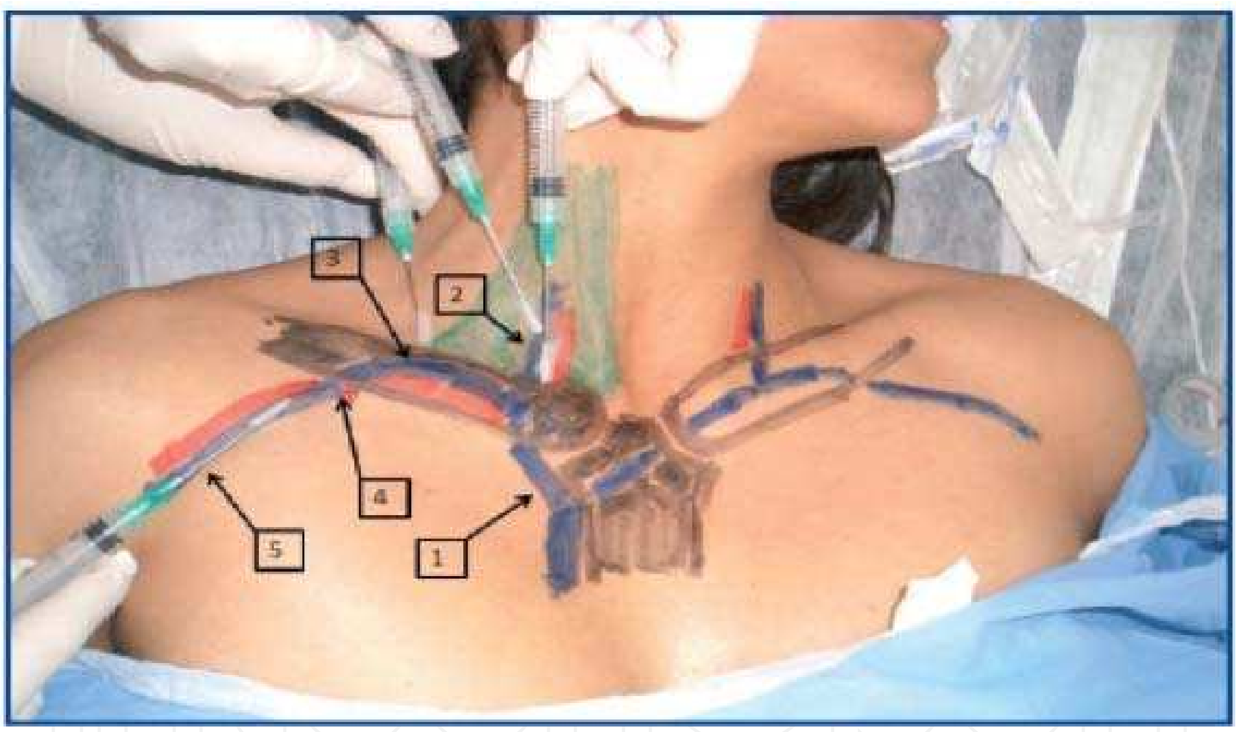

Fig. 1. 1- Innominate Vein, 2- Internal Jugular Vein, 3- Supraclavicular Vein,
4- Infraclavicular Vein, 5- Axillary Vein.

The **internal jugular** access is the most commonly used by nephrologists, but surgeons and intensive care units prefer **Infraclavicular (subclavian)** access. Subclavian access has a disadvantage; it produces subclavian vein stenosis that leads to arm edema when AV fistula is later practiced on the same side (Figure 2).

Fig. 2. Edema in left arm by subclavian vein stenosis and brachiocephalic fistula.

Catheters in the internal jugular vein kept for prolonged periods can also cause stenosis, in this case the superior vena cava (Figure 3).

Fig. 3. Cava superior syndrome.

For patients in which the implantation of catheters in the internal jugular vein is not possible, and those in which puncturing this vein or the subclavian vein would not be convenient (for example patients with tracheostomy), an alternative not commonly used is the implantation of catheters in the **axillary vein**. (3)

This vein extends from the clavicle to the axilla (figure 4). The segment in the axillary fossa has been used for decades by pediatric surgeons especially in children with extended burns in whom this is the only preserved area. Unfortunately there are severe infectious complications due to the bacterial flora that lives in this area. (4)

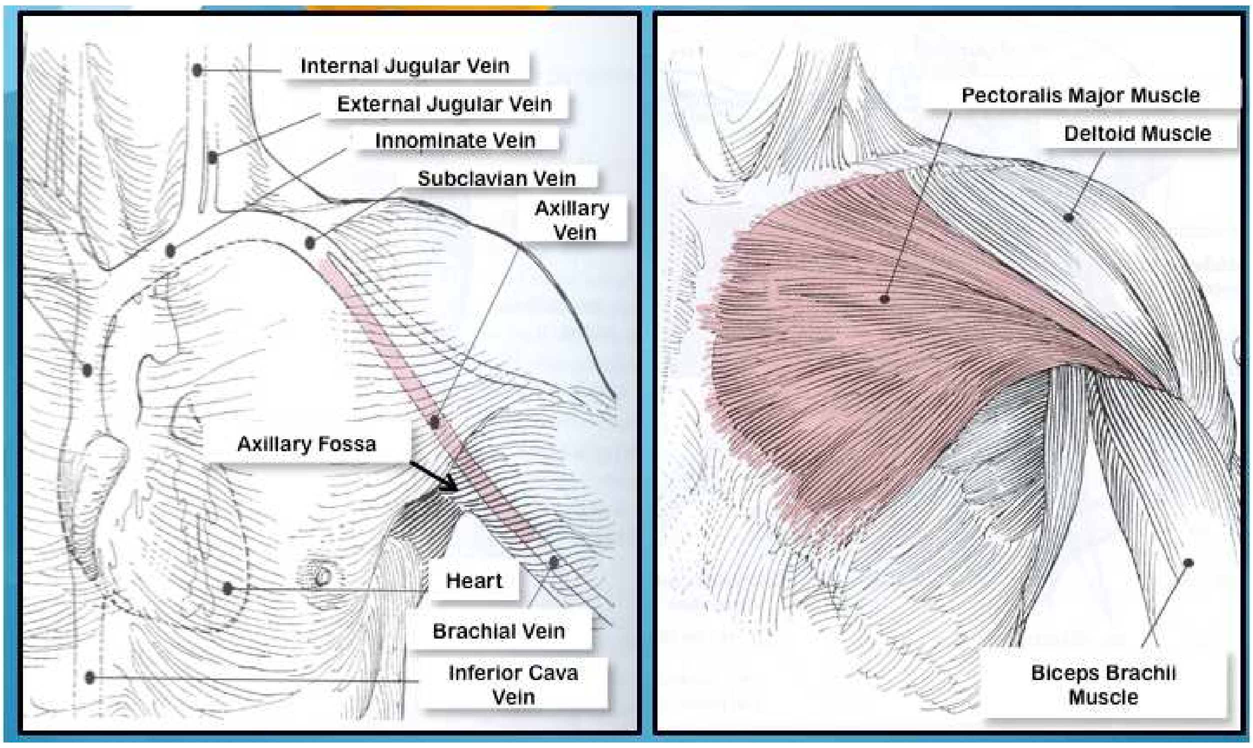

Fig. 4. Axillary Vein and muscle of anatomic area.

Other segments of the axillary vein, from the axillary fold to the clavicle have minimal risk of infection. Classically it is recommended puncturing two finger widths below the site where the coracoid process is found. (5) (Figure 5).

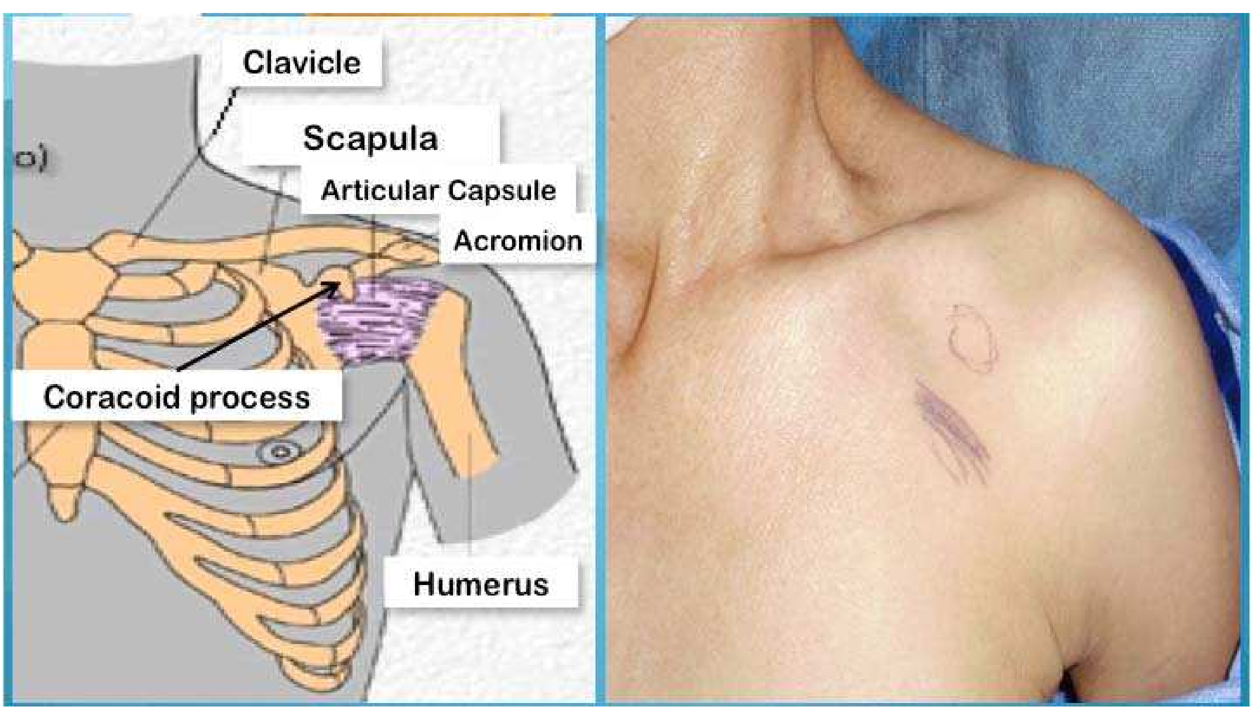

Fig. 5. Recommended place to insert axillary catheter.

In our experience and with patience it is possible to palpate the axillary artery and immediately under it puncture the axillary vein for catheter implantation. It is important to remember that in order to get to the axillary vein both pectoralis major and minor must be penetrated and hence this vessel is located in deep layers (Figure 6).

In our experience also this catheter have utility in patients in intensive care unit in which is common the presence of tracheostomy (Figure 7).

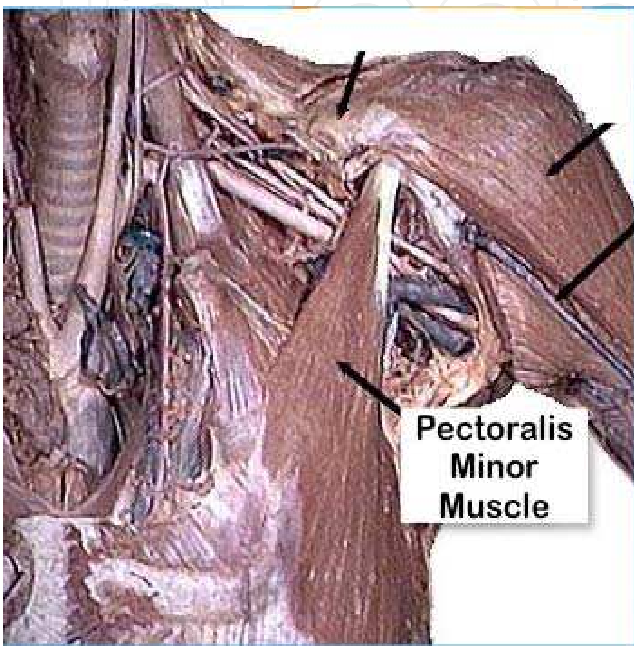

Fig. 6. Pectoralis Minor Muscle.

Fig. 7. Patient with tracheostomy and axillary catheter.

The use of ultrasound guidance is a very good alternative, since it allows for an easy and clear view of the vessels of the axillary region, reducing the number of punctures (Figure 8).

Fig. 8. Ultrasound guidance for axillary catheter implantation.

The **innominate vein** is another blood vessel rarely used for the implantation of central catheters. It is a resource most commonly used by anesthesiologists and its use has not been spread due to fear of puncturing the pleural dome. To access this vessel percutaneously an aspiration needle is introduced holding it immediately above the clavicle between the sternal and clavicular bundles of the sternocleidomastoid muscle. It is directed to the mediastinum and parallel to the anterior chest wall to obtain an abundant blood return. The vein is easily punctured and only 2 to 4 centimeters from the skin. (6) Radiologically the catheters implanted in this blood vessel can be seen riding on top of the clavicle. (Figure 9).

Fig. 9. Catheter inserted into the innominate vein, riding on top of the clavicle.

Innominate vein thrombosis is a rare event, but it can be seen as a complication of the extended use of catheters in this blood vessel. (Figure 10).

Fig. 10. Innominate vein thrombosis.

There are two final vascular accesses in the upper hemithorax for the implantation of central catheters: intracardiac and superior vena cava access. For the first, anterior thoracotomy is performed in the fifth intercostal space and the catheter is inserted into the right atrium (7). For the second, proceed with anterior right mediastonomy, incision through the third intercostal space and resecting the condrosternal union. Under direct vision puncture the superior vena cava and introduce the catheter. (8) (Figure 11) The appearance of hemothorax, pneumothorax and pneumopericardium is common in these patients, so a routine chest tube implantation is recommended during the procedure and kept for several days.

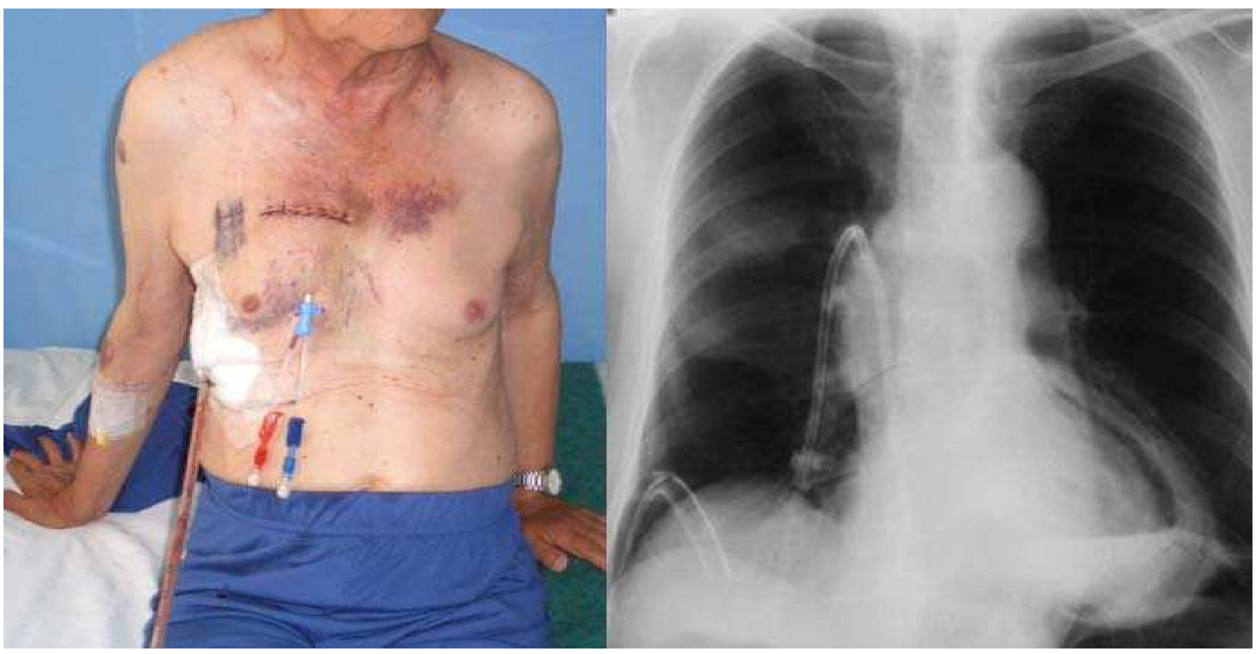

Fig. 11. Patient with catheter in superior vena cava and pneumopericardium.

2.2 Lower hemithorax

After exhausting the vessels of the upper hemithorax is necessary to use the lower hemithorax to continue chronic hemodialysis therapy. An alternative is to divert patients to peritoneal dialysis, but when this is not possible for various reasons it is essential to use different approaches.

In our renal unit, the first access we use is the **femoral vein** option. They are classically canalized and then tunneled either to the anterior abdominal wall or into the thigh on the same side. In our experience, this access produces complications such as frequent infections in the exiting orifice for the catheter and also thrombosis (comment pending publication). In one of our patients we managed to keep this catheter for one year only to be withdrawn when the patient received a renal transplant. (Figure 12)

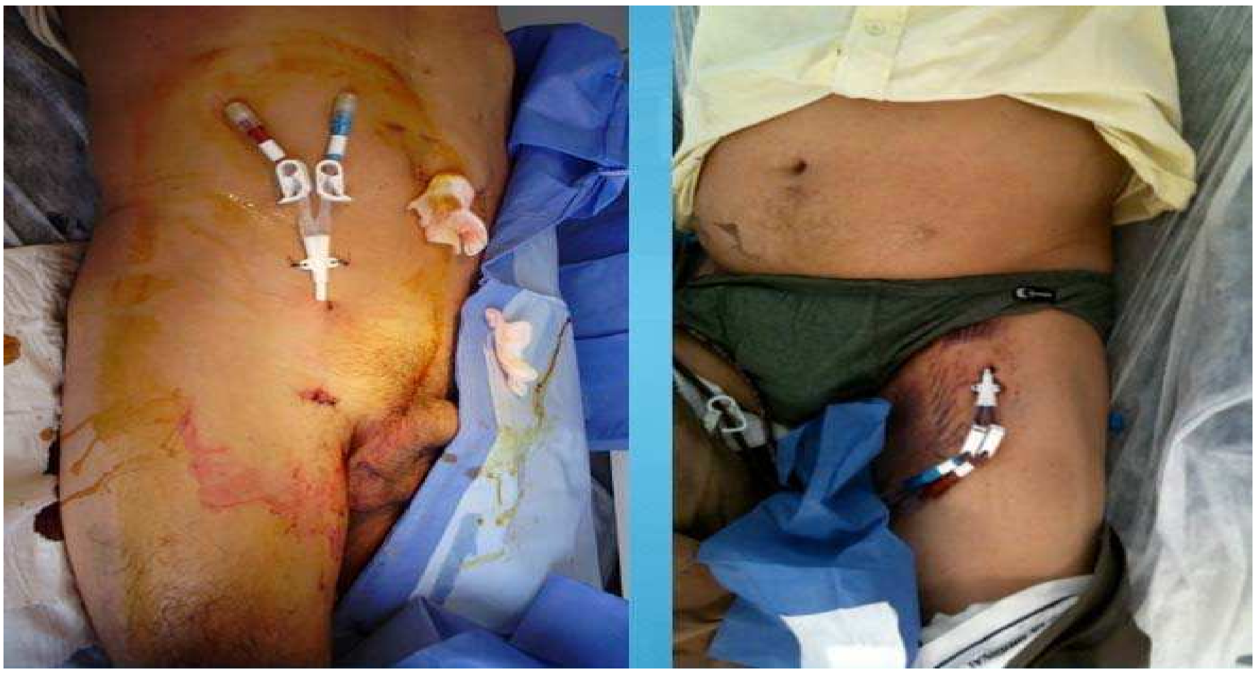

Fig. 12. Tunneled femoral catheter to anterior abdominal wall or into the thigh.

The **iliac vein** can also be used, but requires the participation of a vascular surgeon to achieve safe punctures once the ilioinguinal region has been dissected and the blood vessel exposed (Figure 13).

Fig. 13. Tunneled iliac catheter and radiological control.

We then proceed to channel the **inferior vena cava**; we perform this procedure using fluoroscopy or angiography. First we implant a transient catheter in femoral vein, then place the patient in left lateral position with knees flexed and produce a lumbar puncture at the level of the iliac crest, 10 cm from the midline in an upward direction, close to the vertebral body to avoid puncturing the ureter (Figure 14).

Fig. 14. Position of patient for implantation ideal of catheter in inferior vena cava, and angiography guide.

It is necessary to use a needle with a minimum length of 18 cm. The infusion of contrast medium allows the inferior vena cava location, then directing the needle toward her, and once punctured proceed to catheter implantation in technique like any tunneled catheter. (Figure 15 and 16).

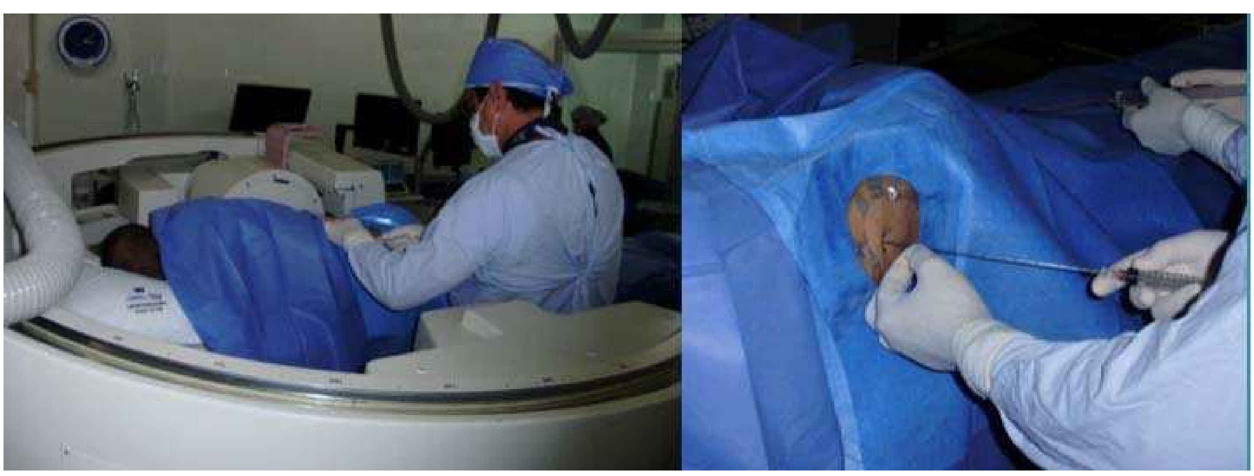

Fig. 15. Angiography guide, and needle with a minimum length of 18 cm. Procedure performed by the author of the chapter.

Fig. 16. Tunneled inferior vena cava catheter in use.

Other vascular access used by other groups, and with which we have not experience is transhepatic access.

3. Preventive antibiotic intervention before the implantation of catheters

For many years the recommended procedure for every patient scheduled for the implantation of a central venous catheter was to receive antibiotics that covered both Gram (+) and Gram (-) bacteria 30 minutes before the procedure.

In the year 2007 we presented our work in this subject. We performed two periods of experimentation. First, we administered the combination of first generation cephalosporin and amino glycoside 30 minutes before the catheter's implantation and second we suspended the antibiotics and practiced universal techniques for avoiding infection.

Our results showed that in the first period, 1,93% of 156 procedures had infectious complications. In the second period 2,29% of 304 procedures had complications, concluding then that the practices of preventive antibiotics don´t have any benefices and was abandoned in our unit. (9) (Figure 17).

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TRABAJO ORIGINAL

¿ES ÚTIL LA PROFILAXIS ANTIBIOTICA PARA PREVENIR INFECCIONES RELACIONADAS CON LA INSERCION DE CATETERES TRANSITORIOS PARA HEMODIÁLISIS?

CESAR A RESTREPO V. ARNOVY CHACON CARDONA, CARLOS E ARCOS SANZ.

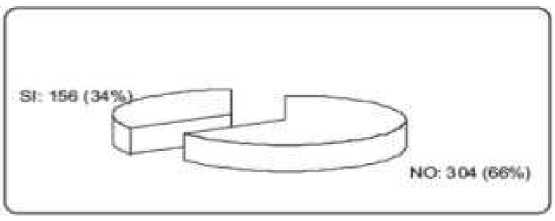


Figura 1. Profilaxis antibiótica endovenosa previa a la inserción del catéter transitorio para hemodiálisis.

AGENTE ETIOLOGICO	No. CASOS	%
S. aureus	5	62.5
E.cloacae	1	12.5
E. coli	1	12.5
K. pneumoniae	1	12.5
TOTAL	8	100
n = 10 infecciones entre 460 procedimientos		

Tabla 5. Distribución de agentes etiológicos en infección temprana, post inserción de catéter transitorio de hemodiálisis. STR de Caldas, Enero de 1998 a Noviembre de 2006.

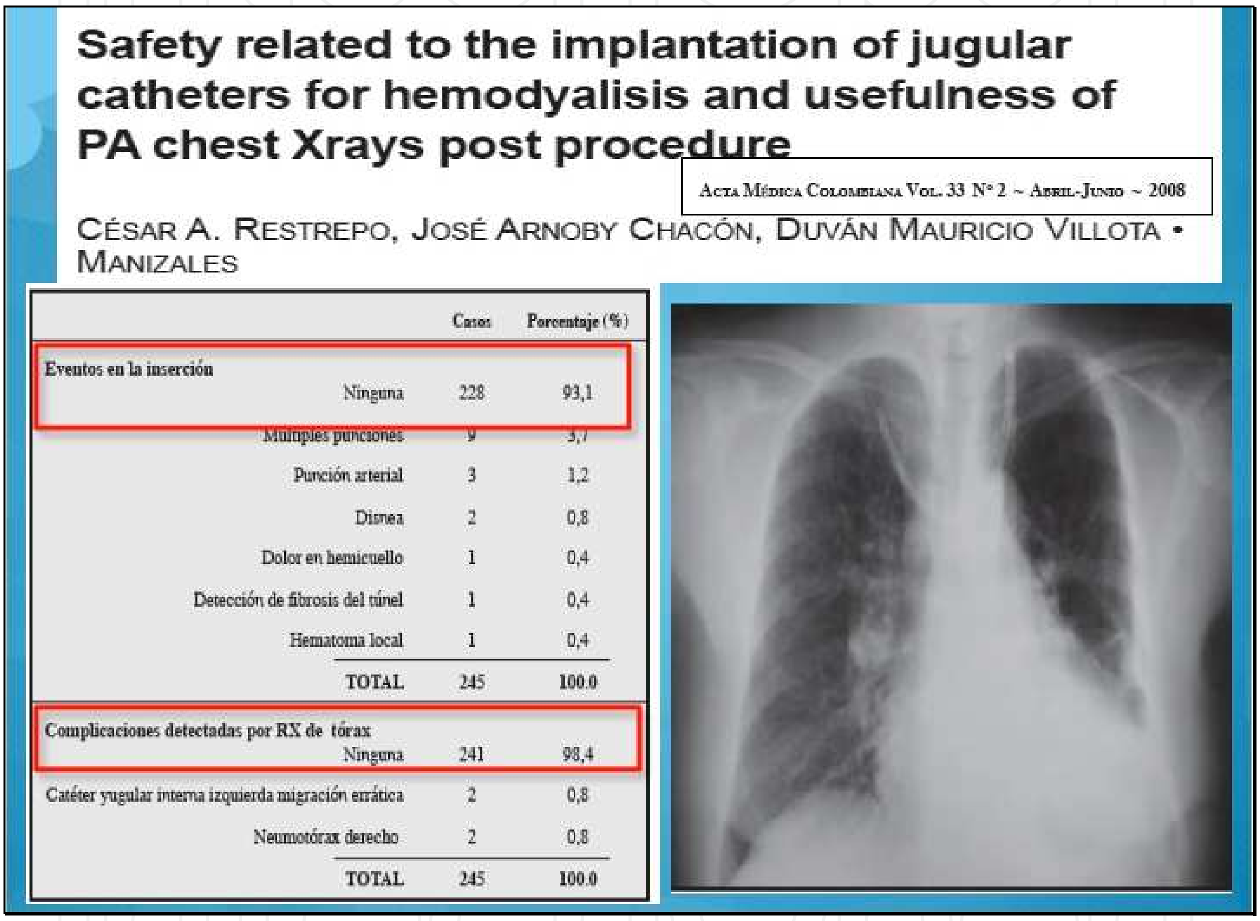
ETIOLOGIA DE LA INSUFICIENCIA RENAL	INFECCIÓN SI	INFECCIÓN NO	TOTAL
Nefropatia diabética	2	141	143
GMN Crónica	2	116	118
Nefritis intersticial Crónica	2	61	63
Nefroesclerosis hipertensiva	1	41	42
Uropatía obstructiva	1	18	19
Nefropatía lupica	1	21	22
Post Preeclampsia	1	17	18
Desconocida	0	18	18
Otras	0	9	9
GMN rápidamente progresiva	0	2	2
Necrosis cortical	0	3	3
Riñón poliquístico	0	2	2
Post medio de contraste	0	1	1
TOTAL	10	450	460

Tabla 7. Etiología de la Insuficiencia renal entre los pacientes que presentaron complicación infecciosa temprana post inserción de catéter transitorio de hemodiálisis. STR de Caldas enero de 1998, a noviembre de 2006.

Fig. 17. No benefit with antibiotic prophylaxis for prevention of central venous catheters infections.

4. Radiological control after the implantation of jugular catheters

It has been suggested that every patient with a central venous catheter implanted on his or her superior hemithorax, must have PA chest radiography before actually using the catheter to confirm a correct placement. In occasions it is necessary to take the patient to hemodialysis therapy immediately after implanting the catheter and the radiological control can delay this process. In the year 2008 we published our experience with 245 jugular catheters implanted in the past years, all of them had PA chest radiography performed after the implantation. Only 4 cases (1,6%) had a significant complication (10). Based on this and if the implantation of the catheter was easy, we avoid soliciting the radiography and immediately proceed to the hemodialysis practice. (Figure 18).



	Casos	Porcentaje (%)
Eventos en la inserción		
Ninguna	228	93,1
Múltiples punciones	9	3,7
Punción arterial	3	1,2
Disnea	2	0,8
Dolor en hemicuello	1	0,4
Detección de fibrosis del túnel	1	0,4
Hematoma local	1	0,4
TOTAL	245	100.0
Complicaciones detectadas por RX de tórax		
Ninguna	241	98,4
Catéter yugular interna izquierda migración errática	2	0,8
Neumotórax derecho	2	0,8
TOTAL	245	100.0

Fig. 18. PA chest radiograph post insertion of central catheter is unnecessary.

Interestingly in 4 patients with insertion of catheters in left jugular vein we observed abnormal catheter course, corresponding to persistent left superior vena cava, anatomical abnormality confirmed by radiological or echocardiographic studies. (11) (Figure 19).

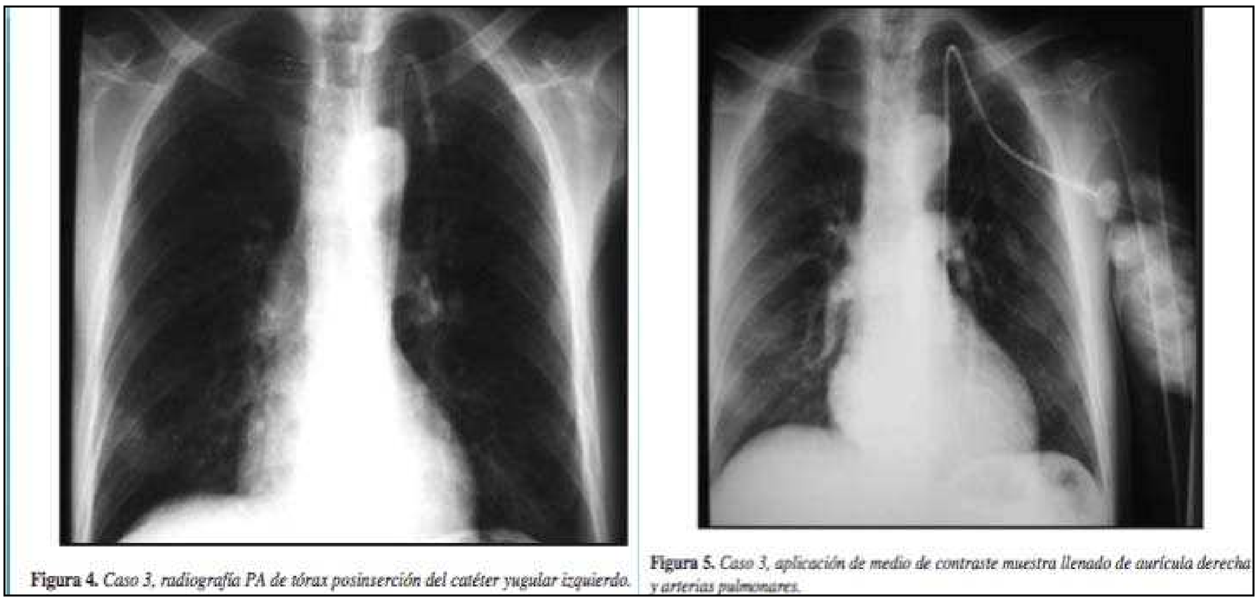


Fig. 19. Catheter in left persistent superior vena cava, confirm by Radiological studies.

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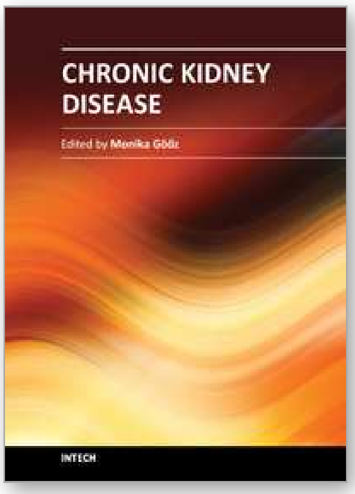

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Chronic kidney disease is an increasing health and economical problem in our world. Obesity and diabetes mellitus, the two most common cause of CKD, are becoming epidemic in our societies. Education on healthy lifestyle and diet is becoming more and more important for reducing the number of type 2 diabetics and patients with hypertension. Education of our patients is also crucial for successful maintenance therapy. There are, however, certain other factors leading to CKD, for instance the genetic predisposition in the case of polycystic kidney disease or type 1 diabetes, where education alone is not enough.