Jugular vein catheterization for hemodialysis: correct positioning control using real-time ultrasound guidance

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ABSTRACT: The jugular vein catheterism (JVC) is adopted for blood access in patients with acute renal failure, in chronic renal failure and when patients show failure of traditional vascular access. The technique of catheter insertion in the jugular vein is quick and easy. Usually correct catheter positioning, before starting the dialytic procedure, is controlled by chest X-ray or by intra-cavitary electrocardiogram. The aim of this work is to evaluate the feasibility of the real-time ultrasound guidance to control the correct positioning of the catheter instead of the usual chest X-ray control. We have studied 158 patients with JVC insertion before the hemodialytic procedure; 54 patients have undergone both ultrasound and a chest X-ray control while 104 were only submitted to ultrasound control. The ultrasound procedure includes an under xifoid scanning, with a convex 3.5 Mhz drill to evaluate the four heart cavities. When the right atrium is identified a second operator rapidly infuses in the venous catheter 15 ml of physiological solution thus creating a blood turbolence easily observed in real time as a light jet inside the atrium. This turbolence appears to be the main evidence for good catheter positioning and we were able to show the light jet in 156 (98%) patients. All light jet positive patients were submitted to the hemodialytic procedure without any complications during and after dialysis. We concluded that the intraoperative ultrasound control technique is an alternative to the chest X-ray evaluation because it offers the possibility for safe intraoperative immediate control thus reducing the total costs of the procedure.

KEY WORDS: *Ultrasound, Jugular vein catheter, Light jet control*

INTRODUCTION

The jugular vein catheter (JVC) positioning is a valid approach for hemodialytic procedure in patients with acute renal failure and in a subset of patients affected by chronic renal failure, when the usual vascular access is not available and dialysis is an urgent need. The JVC is also recommended in very old patients with short life expectations (as for neoplastic patients). For these particular patients we recommend this method because of easier venous access, lower number of complications during the insertion procedure, and reduced incidence of infections (1-5). The technique is based on a preliminary ultraosund control of the neck veins or, whenever possible, on the ultrasound guided insertion, as recommended by guideline 6, point E, DOQI. – NKF 1997 (6-10). Our experience is based mostly on the preliminary ultrasound control of the neck veins, followed by an ultrasound guided catheter insertion in the most complicated cases. The control of the appropriate position of the catheter was done mostly by chest X-ray (Fig. 1) (11, 13, 14) or by intracavitary electrocardiogram after catheter positioning (12).

The aim of our work is to evaluate the role of real time ultrasound control to check the correct intravenous positioning of the JVC after its insertion.

MATERIALS AND METHODS

One hundred and fifty-eight consecutive patients were evaluated and included in the study from 01/01/1995 to 31/12/1999 (Tab. I) (82 males and 76 females); 123 were affected by acute renal fail-

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ure and 35 by chronic renal failure. We inserted 123 double-lumen catheters, mostly Mahurkar (16 cm and 19 cm in length) and 35 double-lumen permanent catheters (19 cm in length). The vein puncture, near the Sedillot triangle, was identified by an ultrasound of the neck blood-vessels in 136 patients; in 8 cases the catheter was inserted directly under ultrasound guidance and in 11 cases simply by anatomical identification. A Siemens SI 450 with a 7.5 MHz linear drill for the insertion phase and 3.5 MHz convex drill for positioning control was used in this study.

The first group of 54 patients was submitted, after the insertion, to both chest X-ray evaluation and ultrasound control. Another selected group of 104 patients underwent only ultrasound control. The ultrasound investigation needed an under-xiphoid heart scanning to evaluate the four heart cavities in a single section (Fig. 2). The drill (convex 3.5 MHz) was placed at the xiphoidal dimple while the patient was lying in bed in the dorsal position with legs slightly flexed. When the right atrium was identified a second operator rapidly infused 15 ml of physiological solution in the catheter thus creating an artificial turbulence easily observable in real time as a light jet inside the right atrium. This turbulence was considered as the main indication for correct catheter positioning (Fig. 2).

RESULTS

One hundred and fifty-six (98%) out of the 158 patients submitted to venous catheter insertion showed the light jet under the ultrasound control (Tab. II). Of these 54 patients were examinated by both chest X-ray and ultrasound only one patient, in whom no light jet was detected, had the catheter in the pleural cavity. The other 104 patients were controlled only with ultrasound and the light jet was clearly evidenced in 103 patients (99%) in this case too, where no light jet was detected, a radiological control showed that the catheter was in the pleural cavity. All the light jet positive patients were submitted to the hemodialytic procedure without any clinical problems during and after the procedure (Tab. II).

In conclusion, our results lead us to conclude that the ultrasound technique with intra-operative control is an effective strategy to demonstrate the correct positioning of the jugular vein catheter. The radiological technique is also a very important screening method for evaluating any possible complication (11, 13, 14) of venous catheter positioning (hemotorax, pneumothorax, and mediastinal

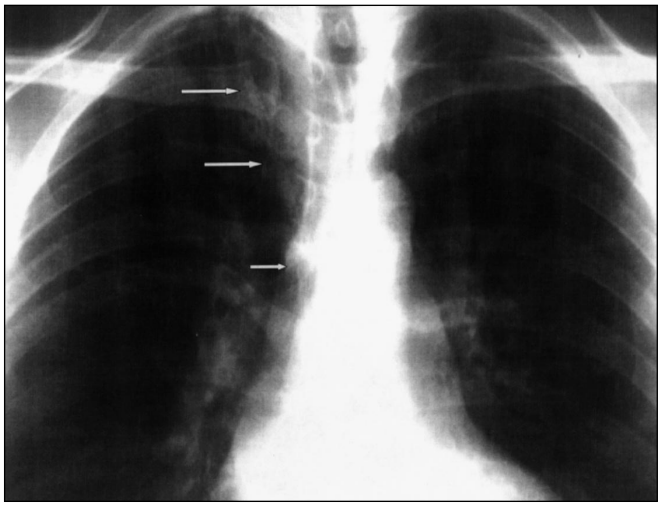

Fig. 1 - *Chest X-ray in a patient after jugular vein catheter insertion.*

TABLE I - JVC: PATIENTS EVALUATED FROM 1995 TO 1999 IN A SINGLE DIALYSIS UNIT

	No.
Total number of	
• Catheter insertions	158
• Male/Female	82/76
• ARF/CRF	123/35
• Temporary catheters	123
• Permanent catheters	35
• Insertions under ultrasound	8
• Insertions after preliminary ultrasound evaluation	136
• Insertions without any ultrasound support	11

TABLE II - JVC: NUMBER OF PATIENTS WITH LIGHT JET EVIDENCE

	No.	%
Total number of patients examinated	158	
First Group:		
Patients submitted to ultrasound and chest X-ray control	54/158	
- Evidence of light jet	53	(99%)
Second Group:		
Patients submitted to ultrasound control	104/158	
- Evidence of light jet	103	(99%)

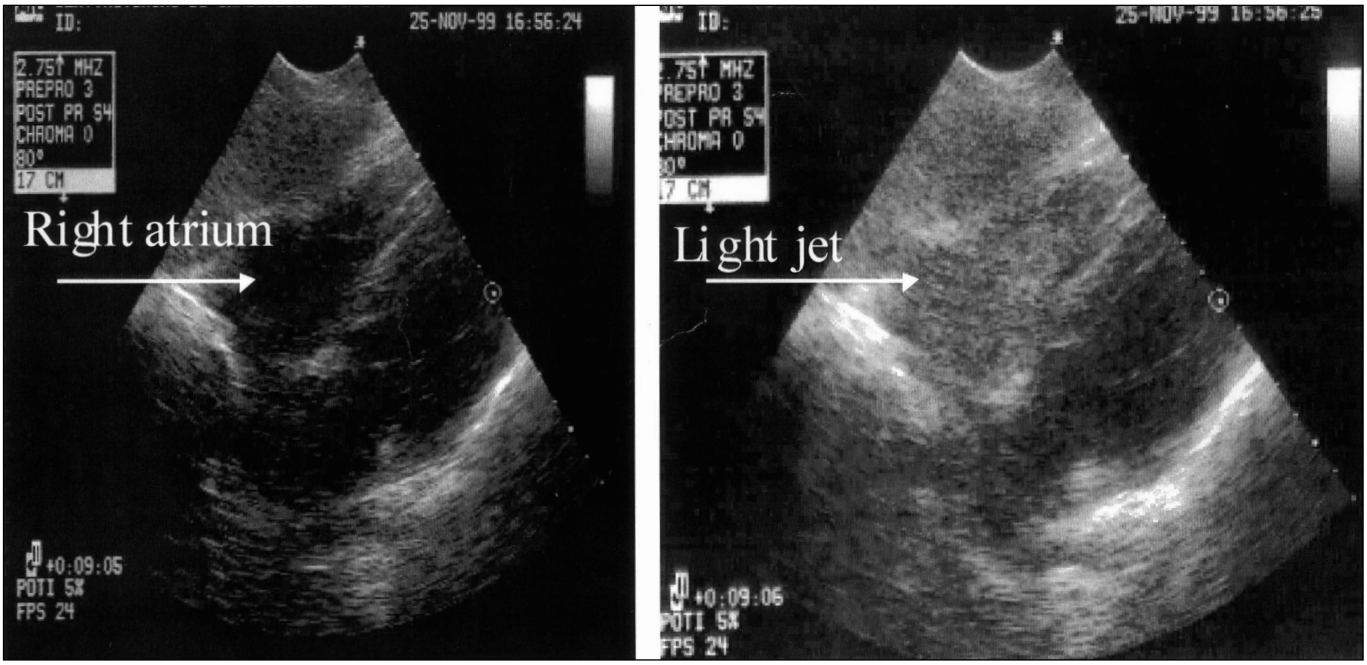

Fig. 2 - ***Right atrium identification and "Light Jet" evidence.***

hemorrhages). However, it does not allow the direct evaluation of the correct catheter positioning in the blood vessel and does not enable a functional evaluation.

The real-time ultrasound guidance is a useful tool for immediate intraoperative evaluation of the correct catheter tip positioning in the atrium. Additionally, the light jet created by the rapid infusion of 15 ml of physiological solution clearly shows the presence of the catheter in the upper vena cava and its patency. Ultrasound control of the i.v. catheters also offers the possibility of reducing patient discomfort reducing his share of radiation and of minimizing costs. Chest X-ray should, therefore, be confined only to those cases that present difficulties during catheter insertion and when real-time ultrasound could not reveal a proper trial light jet.

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