Venography at insertion of tunnelled internal jugular vein dialysis catheters reveals significant occult stenosis

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Abstract

Background. Tunnelled catheters are widely used to provide vascular access for haemodialysis. Percutaneous insertion of these catheters requires large calibre tissue dilators with the potential to cause trauma to central veins, particularly if anatomical abnormalities are present.

Methods. We evaluated the use of venography to identify central vein anatomical abnormalities in 69 consecutive patients undergoing percutaneous placement of tunnelled right internal jugular vein catheters. The internal jugular vein was entered under ultrasound guidance and venography was performed prior to insertion of a guide-wire. Images were evaluated on-screen by the operator and a decision made regarding the need for additional fluoroscopy during insertion of the catheter.

Results. In 29 cases (42%), venography showed evidence of unexpected stenosis and/or angulation of the central veins of sufficient severity to warrant additional fluoroscopy during insertion of the dilators, or abandonment of the procedure. Patients who had previously had tunnelled internal jugular catheters had more than double the incidence of such abnormalities than those who had not [15/23 (65%) vs 14/46 (30%); \( P = 0.009 \)]. In two patients the procedure was abandoned due to severe stenosis. No patient suffered central vein trauma or pneumothorax. There were no adverse reactions to contrast injection.

Conclusions. Venography performed immediately prior to tunnelled internal jugular dialysis catheter insertion detects unexpected, clinically significant anatomical abnormalities of the central veins in a substantial proportion of patients, particularly those with a history of previous tunnelled catheter insertion. We suggest that the use of venography may help to minimize the risk of complications from this procedure.

Keywords: central venous catheterization; fluoroscopy; haemodialysis; internal jugular vein; tunnelled; venography

Introduction

Tunnelled cuffed internal jugular vein catheters are widely used to provide short-to-medium term temporary vascular access for haemodialysis and have been recommended as the method of choice in the NKF-K/DOQI guidelines [1]. Percutaneous insertion of these catheters requires the use of large calibre, rigid tissue dilators that have the potential to cause trauma to the central veins during the procedure. There are few published studies reporting the incidence or determinants of vascular trauma during insertion. Several studies have reported a zero incidence of complications resulting from central vein trauma during tunnelled catheter insertions by interventional radiologists [2–4]. Nevertheless, isolated case reports suggest that although rare, serious and sometimes fatal complications do occur [5,6]. It seems reasonable to expect that such complications would be more likely in the presence of anatomical abnormalities of the central veins. This is particularly relevant because the use of central venous catheters is associated with central vein stenosis [7]. Patients with a history of previous tunnelled catheter insertion may therefore have a higher prevalence of vascular abnormalities that would place them at greater risk for complications.

Debate continues as to what measures are required to minimize the risk of complications during tunnelled dialysis catheter insertion. Several studies support the use of ultrasound guidance to localize veins at the point of insertion [8,9], but this measure does nothing to reduce the risk of central vein trauma. Fluoroscopy has
Venography for insertion of tunnelled internal jugular vein catheters has been used to ensure correct catheter placement in some studies [2–4] and is considered mandatory in the NKF-K/DOQI guidelines [1]. The aim of our study was to evaluate the use of direct central venography, performed at the time of catheter insertion, to identify vascular abnormalities and facilitate safe catheter placement.

Subjects and methods

Sixty-nine consecutive patients (mean age 60.8 ± 16.2 years; 59% male) undergoing percutaneous placement of tunnelled right internal jugular vein catheters were included. Patients gave written informed consent for the procedure. All insertions were performed in a radiology suite with fluoroscopy available. Patients received conscious sedation and arterial oxygen saturation was monitored with pulse oximetry throughout the procedure. The internal jugular vein was entered under ultrasound guidance and venography was performed by injection of 10 ml of contrast material (iobitridol 300 mg/ml; Xenetix, Guerbet Laboratories Ltd, UK), prior to insertion of a guide-wire. Images were evaluated on-screen by the operator and a decision made regarding the need for additional fluoroscopy. Correct positioning of the guide-wire was confirmed with fluoroscopy. If indicated, insertion of the tissue dilators, peel-away sheath and catheter was performed under fluoroscopic guidance. A 14F × 28 cm silicone cuffed catheter was tunnelled under the skin on the right anterior chest wall after infiltration with local anaesthetic. The peel-away sheath and dilator were advanced into the superior vena cava (SVC) and the dilator was withdrawn. The catheter was then advanced through the sheath and the sheath peeled away. Correct placement of the catheter tip at the junction of the SVC and right atrium, or just in the right atrium, was confirmed by fluoroscopy. A post-procedure chest radiograph was obtained to exclude a pneumothorax. All immediate complications were recorded. Hard copies of the venography were subsequently examined by two investigators to assess the degree of any observed stenosis or angulation of the central veins. The location of each abnormality was classified as being above or below the inferior surface of the clavicle. Abnormalities above the clavicle were considered to involve the internal jugular vein whereas those below the clavicle would involve the brachiocephalic vein or SVC. Patient records were examined to determine whether or not they had previously had tunnelled internal jugular catheters inserted.

Data were analysed using SPSS version 11.0. A χ² test was used to compare the frequency of anatomical central vein abnormalities among patients with a history of tunnelled catheter insertion vs those without previous tunnelled catheters.

Results

In 29 patients (42%), venography showed evidence of stenosis and/or angulation of the central veins of sufficient severity to warrant additional fluoroscopy during insertion of the dilators, or abandonment of the procedure (Table 1). The frequency of different abnormalities is shown in Table 2. No patient had clinical signs of central vein stenosis (i.e. upper limb or facial oedema; superficial vein distention). Thus all the abnormalities identified were clinically unexpected. In two patients the procedure was abandoned due to severe stenosis or occlusion of central veins. Selected examples of the venograms are shown in Figure 1. Patients who had previously had tunnelled internal jugular catheters had more than double the incidence of significant central vein anatomical abnormalities than those who had not [15/23 (65%) vs 14/46 (30%); P = 0.009]. Evaluation of hard copies of the venography after the procedure showed that additional fluoroscopy was required significantly more often in patients with a history of previous tunnelled catheter (P = 0.009).

| Table 1. Cross tabulation showing frequency of patients in whom additional fluoroscopy was required during tunnelled dialysis catheter insertion due to anatomical abnormalities of the central veins and frequency of patients with a history of previous tunnelled catheter insertion |
|---|---|---|
| Previous tunnelled catheter? | No | Yes | Total |
| No | 32 | 14 | 46 |
| Yes | 8 | 15 | 23 |
| Total | 40 | 29 | 69 |
| Additional fluoroscopy was required significantly more often in patients with a history of previous tunnelled catheter (P = 0.009). |

| Table 2. Frequency of observed central vein abnormalities detected by venography prior to tunnelled dialysis catheter insertion |
|---|---|---|
| Frequency | Percentage |
| Normal | 40 | 58.0 |
| Angulation | 10 | 14.5 |
| Stenosis (>50%) | 10 | 14.5 |
| Angulation + stenosis | 9 | 13.0 |
| Total | 69 | 100 |

Discussion

To our knowledge this is the first published study of venography to evaluate potentially significant anatomical abnormalities of the central veins prior to insertion of haemodialysis catheters. We found unexpected, clinically significant anatomical abnormalities in a substantial proportion (42%) of patients. As anticipated, these abnormalities were significantly more common in patients with a history of previous
tunnelled catheter insertion. Our data therefore provide further evidence that the use of tunnelled haemodialysis catheters may be complicated by the development of central vein stenosis. This is relevant not only because of the potential for such stenoses to complicate future catheter insertions, but also because they may adversely affect the function of future arterio-venous fistulae due to impaired venous return. These findings therefore support the recommendation that an arterio-venous fistula should be formed as the primary means of vascular access, prior to initiation of dialysis, in the majority of patients [1].

Our data do not allow us to draw any direct conclusions regarding the effect of employing venography on the risk of central vein trauma during tunnelled dialysis catheter insertion. Given the apparently low incidence of such complications, it would require a large randomised study to achieve this. Our data also do not prove that anatomical abnormalities of the central veins are associated with an increased risk of vascular trauma, but it seems reasonable to expect that this would be the case [10]. In our series two procedures were abandoned after unexpected occlusion of the central veins was identified. It is easy to appreciate how attempting a catheter insertion in the presence of such an abnormality could result in serious complications. The unexpectedly high incidence of anatomical central vein abnormalities therefore does provide strong

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**Fig. 1.** Selected examples of venography performed immediately prior to tunnelled haemodialysis catheter insertion. (A) Normal venous anatomy in a patient without previous tunnelled catheter insertion. (B) Significant stenosis of the right brachiocephalic vein in a patient without previous tunnelled catheter insertion. (C) Significant angulation and stenosis of the right brachiocephalic vein in a patient with a history of previous tunnelled catheter insertion. (D) Complete occlusion of the right brachiocephalic vein in a patient with a history of previous tunnelled catheter insertion. Note multiple collaterals which resulted in this occlusion being clinically silent.
support for the notion that venography may reduce the incidence of complications. In this study two thirds of patients with a history of previous tunnelled catheter insertion had significant anatomical abnormalities on venography, suggesting that these patients in particular would benefit from venography. Nevertheless, as many as a third of patients with no previous tunnelled catheters had vascular abnormalities and are therefore also likely to benefit. In addition to improving safety, venography may also improve the success rate of catheter placement. In our patients with significant central vein abnormalities, catheters were successfully placed in all but two by using a combination of venography and fluoroscopy. Direct comparison of our results with previous studies that employed fluoroscopic guidance during catheter insertion is difficult because venography was not performed and no data were presented regarding the number of patients with a history of previous tunnelled catheter insertion [2–4].

There is a wide range of practice with regard to the measures taken to optimize the safety of tunnelled catheter insertion [11]. Catheters may be inserted by nephrologists without fluoroscopic guidance, interventional radiologists or surgeons. Clearly the use of venography for all tunnelled dialysis catheter insertions has significant resource implications as not all units currently have access to radiology facilities. It could be argued that the apparent low incidence of complications is insufficient to justify the use of venography in all cases. On the other hand, the serious and potentially fatal nature of these complications dictates that every effort should be made to minimize their incidence. Moreover, the method of venography that we have described is simple to perform and did not require the assistance of a radiologist. It is therefore easy to incorporate into the insertion procedure if fluoroscopy is available. Further research is required to better define the incidence of complications during tunnelled catheter insertion and to identify measures that are effective in reducing this.

Conflict of interest statement. None declared.

References
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