
ORIGINAL ARTICLE

Complication Rates after Radiological Versus Surgical Placement of Central Venous Catheters

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ABSTRACT

Objective: To retrospectively compare the complication rates of radiologically and surgically placed central venous catheters in a single tertiary centre over a four-year period.

Methods: All long-term central venous catheters placed over a two-year period by radiological and surgical methods were retrospectively reviewed. For each group of patients, the placement problems, short- and long-term complications, sepsis rates, and catheter lifespan were assessed.

Results: A total of 199 central venous catheters were inserted in 170 patients; 108 catheters were inserted radiologically in 91 patients and 91 catheters were inserted surgically in 79 patients. The indication was chemotherapy in all radiological cases and in 73% of surgical cases. Only one patient had an early complication associated with catheter malpositioning in the surgical group but there was no such complication in the radiological group. The overall rate of infection per 1000 catheter days showed no significant difference between the groups, with the rates being 2.24 in the radiological group and 2.75 in the surgical group. The mean catheter lifespans in the two groups were 246 and 234 days, respectively.

Conclusion: Overall early and late complication rates were low and were similar after both radiologically and surgically placed central venous catheters. We postulate that central catheter insertion is safe in patients requiring long-term vascular access.

Key Words: Catheterization, central venous; Catheters, indwelling; Postoperative complications; Radiography, interventional; Treatment outcome

中文摘要

比較放射及手術中央靜脈置管術的併發症發生率的研究

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目的：回顧性比較在一所轉介中心兩年內進行放射及手術中央靜脈置管術的併發率。

方法：回顧研究期內所有利用放射及手術的方法長期放置的中心靜脈導管。評估兩組病人置管遇到的問題、長期及短期併發症、敗血病率和導管使用壽命。

結果：研究期間170名病人放置了199根中心靜脈導管，其中91名病人利用放射學方法放置了108根中心靜脈導管，另79名病人利用手術方法放置了91根中心靜脈導管。所有利用放射學方法置管及73%利用手術方法置管的原因皆為化療。利用手術方法置管的組別中只有一宗錯誤置位的早期併發症，

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而利用放射學方法置管的則無併發。兩組的感染率無顯著分別：放射組為每日每1000根導管發生2.24次，手術組為每日每1000根導管發生2.75次。導管平均壽命為放射組246天，手術組234天。

結論：放射組和手術組的早期及晚期併發率類似，均屬於低水平。我們認為中央靜脈置管術對於長期需要血管通路的病人來說是一個安全的方法。

INTRODUCTION

Long-term central venous catheter insertion nowadays has become a common clinical practice for a variety of indications, including antibiotic / chemotherapy administration, haemodialysis, total parenteral nutrition (TPN), and pain control.

Traditionally, insertion was performed by surgeons in an operating theatre and under fluoroscopic guidance. The trend now is to perform the procedure radiologically, with ultrasound and fluoroscopy guidance. This study aimed to assess the early and late complications after radiologically versus surgically inserted central venous catheters at a single institution.

METHODS

Medical records from patients who had surgically inserted central venous catheters during the period from January 2007 to December 2010 (four years) were retrospectively reviewed. In all, 91 catheters were inserted in 79 patients; nine individuals had two catheters inserted at different times and one had four insertions. The indication of central venous catheter was chemotherapy administration in 58 cases (64%), and the rest (33 cases, 36%; with 2 patients having 2 insertions) was TPN administration. In the chemotherapy patient group, there were 40 cases with underlying haematological and 18 cases with underlying non-haematological conditions.

Radiologically, a total of 108 catheters were inserted in 91 patients during the two years (from January 2009 to December 2010); 13 patients had insertions twice and two had three insertions. All these insertions were for chemotherapy administration. Regarding these cases, 85 had haematological malignancies and 23 had non-haematological conditions. Although 56 patients had central venous catheter insertions for haemodialysis during this period, such insertions were excluded as the majority were for the short term (Table 1).

Haematological diagnoses included acute and chronic leukaemia and lymphoma, myelodysplastic

anaemia, aplastic anaemia, myeloma, and idiopathic thrombocytopenic purpura. The non-haematological conditions included carcinoma of breast and colon, germinoma, teratoma, as well as single cases of a synovial sarcoma, a medulloblastoma, a Wilm's tumour, and a yolk sac tumour.

The radiological procedure entailed ultrasound-guided (Philips HDI 5000) puncture of a distal internal jugular vein with a Seldinger technique. Confirmation of catheter position was by fluoroscopy (Siemens AXIOM ARTIS DBA).

The surgical procedure included a cut-down technique via the cephalic vein in the operating theatre. The majority of patients also had anaesthetic care with sedation. Confirmation of the catheter position was by C arm fluoroscopy (Philips Pulsera 12).

The outcomes of the catheters were reviewed. A procedure-related complication was defined as any complication within 24 hours. Catheter infection was defined as: (i) catheter tip culture being positive, (ii) positive blood culture from the catheter, and (iii) septicemia resolving only after catheter removal.

The number of total infections in the two groups were compared by Z test (Microsoft excel 2003). For chemotherapy administration, infection rates in

Table 1. Number and indication for central venous catheter insertion in each group.

Parameter	Radiologically inserted	Surgically inserted
No. of patients	91	79
Placements	108	91
2 Catheters per patient	13	9
3 Catheters per patient	2	-
4 Catheters per patient	-	1
Indication for placement		
Chemotherapy	108	58
Haematological	85	40
Non-haematological	23	18
Total parenteral nutrition	-	33

haematological and non-haematological patients were also compared by the Z test.

RESULTS

There was one surgical case of malpositioning into the right ventricle for which reposition was carried out. One surgically introduced catheter thrombosed for unknown reason that was noted on day 3, and was subsequently removed.

Regarding radiologically introduced catheters, none was misplaced and one raised a suspicion of thrombosis. In the latter case, the suture line was actually too tight; the catheter was blocked. After release of the suture, the catheter was freed and not removed.

Neither group endured a pneumothorax, nor was there any localised bleeding for which an intervention was carried out.

The total numbers of septic events are summarised in Table 2. The overall sepsis rate was 2.24 and 2.14 per 1000 catheter days ($p = 0.85$) for the radiological and surgical group patients, respectively. The TPN patients were excluded from this comparison, because of a much higher infection rate.

There appeared to be a difference in infection rates between non-haematological and haematological malignancy patients in both the radiological and surgical groups (Tables 3 and 4). However, these differences were not statistically significant ($p = 0.0529$ and 0.657 in the radiology and surgery groups, respectively).

Table 5 summarises the lifespan of the catheters; the mean being 246 and 234 days in the radiological and surgical groups, respectively. Early removals were mainly due to infection and misplacement, with the rates of 39% and 41% in the radiological and surgical

Table 2. Infection and sepsis rate per 1000 days.

	Overall		Excluding TPN	TPN
	Radiological	Surgical	Surgical	Surgical
Catheter infection	19	8	6	2
Blood culture positive	31	31	18	13
Catheter days	22,353	14,198	11,228	2970
Sepsis rate per 1000 days				
Catheter	0.85	0.56	0.53	0.67
Overall	2.24	2.75	2.14	5.05

Abbreviation: TPN = total parenteral nutrition.

Table 3. Haematological and non-haematological infection and sepsis rates per 1000 days.

	Haematological case		Non-haematological case	
	Radiological	Surgical	Radiological	Surgical
Catheter infection	17	4	2	2
Blood culture positive	29	15	2	3
Catheter days	18,182	8451	4168	2777
Sepsis rate per 1000 days				
Catheter	0.93	0.47	0.48	0.72
Overall	2.53	2.25	0.96	1.8

Table 4. Catheter use in haematological and non-haematological malignancy patients.

	Radiological				Surgical			
	Haematological patients		Non-haematological patients		Haematological patients		Non-haematological patients	
	No. of catheter insertions	Days	No. of catheter insertions	Days	No. of catheter insertions	Days	No. of catheter insertions	Days
Early removal	36 (42%)	5695	6 (26%)	848	18 (45%)	2157	6 (33%)	960
Treatment completion	6 (7%)	1876	5 (22%)	677	12 (30%)	3342	7 (39%)	863
In-situ patient's death	16 (19%)	3494	4 (17%)	786	6 (15%)	1444	2 (11%)	397
Currently in situ	27 (32%)	7117	8 (35%)	1860	4 (10%)	1508	3 (17%)	557
Total	85	18,182	23	4171	40	8451	18	2777

Table 5. Mean duration of central venous catheters.

	Radiologically inserted		Surgically inserted (excluding TPN)	
	No. of catheter insertions	Days	No. of catheter insertions	Days
Early removal	42 (39%)	6543	24 (41%)	3117
Treatment completion	11 (10%)	2553	19 (33%)	4205
In-situ patient's death	20 (19%)	4280	8 (14%)	1841
Currently in situ	35 (32%)	8977	7 (12%)	2065
Total	108	22,353	58	11,228

Abbreviation: TPN = total parenteral nutrition.

groups, respectively. Respective in-situ patient death rates were 19% and 14%, both being comparable.

DISCUSSION

In the modern era of oncology, intravenous chemotherapy regimens have become a common practice. Consequently, requests for central venous line insertion have been shown a steadily growing trend. Therefore there is a need to review the complication and lifespan of catheters.¹

The most important and life-threatening early complication is pneumothorax. Most insertions nowadays entail ultrasound guidance. The operator can therefore make a precise puncture at the internal jugular vein, and consequently a very low pneumothorax rate can be achieved. Actually, pneumothorax as a complication of such procedures was not encountered during the last two years. Notably, pneumothorax has also been associated with cachexia (patients with body mass index of < 19 kg/m²).^{2,3}

The major late complication of these procedures is catheter sepsis. Both groups yielded a low sepsis rate, which is in keeping with other published studies³⁻⁵ (Table 6^{2,3,6-9}). Moreover, there was no statistically significant difference between sepsis rates in the two groups. This series of sepsis patients included subjects with positive catheter tip cultures, positive peripheral blood cultures, and clinical sepsis without biological confirmation. This may explain our higher sepsis rate in comparison to others, who applied stricter criteria to make such a diagnosis, both for positive peripheral blood and line cultures.

One surgical case resulted in malpositioning of the catheter into right ventricle. In our experience, the length of catheter was usually underestimated. The right hilum can be used as the landmark for the tip, at which point it is approximately at the junction of superior vena

Table 6. Summary on published series about central venous catheter-associated complications.

Study	No. of catheters	Catheter days	Sepsis per 1000 catheter days
Cockburn et al ²	69	4015	3.24
O'Neill et al ³	110	9670	1.55
Mueller et al ⁶	46	10,592	1.79
Harrington et al ⁷	71	7981	1.13
Howell et al ⁸	87	5578	2.15
Nightingale et al ⁹	949	99,510	1.12
Present study	108	22,353	2.24

cava and right atrium. In its final position, the catheter tip should not pass through the right hilum.¹⁰

Catheter-related venous thrombosis is not common; only one case has been reported. Thus, we do not routinely use warfarin or heparin in our patients. Late thrombosis has been reported, with a frequency ranging from 0.38 to 1.15 per 1000 catheter days,^{3,6,7} and is therefore not a major clinical concern in our practice. We believe such differences are related to ethnicity.

During this review, we found an apparent difference in sepsis rate between haematological and non-haematological patients. Although this difference was not statistically significant ($p = 0.0529$), we nevertheless believe that non-haematological patients have low sepsis rate. One of the reasons for the low event rate was the small sample size. So we suggest that it is a relative safe procedure for non-haematological malignancy patients requiring long-term venous access.

Safe and proper handling of central lines^{8,9} depended very much on the hard work of our hospital's central line care team that was formed by dedicated senior nurses. We practise weekly saline flushing of all central lines in the day clinic. Moreover, we had to report any suspicion of line infection as soon as possible. To achieve a low sepsis rate, such team is a must.

CONCLUSION

Central venous catheter insertion is suitable for cancer patients requiring long-term venous access, especially for those with non-haematological malignancies. Early complications can be minimised by imaging guidance. A low infection rate can be achieved by dedicated team care. No statistical difference was found between patients having radiological or surgical catheter insertions.

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