Misplacement of Central Venous Catheters, Abnormal Presentations, Abnormal Sites and Their Possible and Available Solutions

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ABSTRACT

Aim of Work *To address the problem of misplaced central venous catheters in the prospective of their presentation, impact on patients' health and how were they managed.* ***Patients and Methods*** *This is a retrospective study of 17 consecutive patients who were presented with misplaced central venous catheter. Patients demographics, presentations, site of the central vein puncture, type of the catheter, complications if any, existing comorbid conditions, investigations and the management of the misplaced catheter were recorded. Trials of repositioning of the catheters under fluoroscopy were attempted using the available tools and technology.* ***Results*** *Seventeen patients (10men, 7women) were included in this study. The catheters were Mahourker (9), porta A cath (7) and permicath (1). The common misplaced sites were the opposite subclavein vein in (7) cases and right ventricle in (4) cases. The presentation varied from accidentally discovered with x-ray to a serious conditions like chest pain (myocardial infarction), severe headache, dysphagia and hoarseness of voice(due to sigmoid sinus thrombosis). Four catheters were removed from the start. Ten patients were subjected to trial of repositioning over the wire under fluoroscopy. Repositioning succeeded in eight cases and failed in the remaining two.* ***Conclusion*** *Misplaced catheters can occur in normal or disturbed anatomy of the venous system. Presentations of misplaced catheters varies from being accidentally discovered, catheter malfunction, to serious presentations like acute chest pain and sigmoid sinus thrombosis. Diagnosis of the misplaced catheters should be kept in mind, but the clinical judgment is not enough. The management of misplaced catheters depends on the location of the catheter, indication for central access, and clinical condition of the patient.*

INTRODUCTION

Central venous catheters (CVCs) are useful in the management of various conditions, such as administring chemotherapy, total parenteral nutrition and performing haemodialysis. According to their particular indications, CVC is indented to serve a temporary or long-term (permanent) course.[(1)]

Misplacement is a well-recognised complication of central venous catheter placement, it includes advancing a catheter into an incorrect vein, or extending a catheter too far distally within a vessel or the catheter is too short to reach the optimum destination site. Proper attention must be given to identify the best access route, use of image guidance for initial access and catheter tip positioning. [(2)]

Aim of Work

To address the problem of misplaced central venous catheters in the prospective of their presentation, impact on patients' health and how were they managed.

PATIENTS AND METHODS

This retrospective study includes seventeen patients who presented to Kasr Al Aini hospital in the period between September 2013 & October 2015. Presentation varies from being accidentally discovered to serious complications, table (2).

Patients demographics, presentations, site of the central vein puncture, type of the catheter, complications, if any, existing comorbid conditions, investigations and the management were recorded.

When was appropriate, patients were subjected to trial of repositioning of the catheters over the wire under fluoroscopy in order to reach its proper destination. Otherwise, the catheter was removed whenever the indication for its use came to its end or removed and another one was inserted.

RESULTS

Seventeen patients (10men, 7women) were included in this study. Their age ranged between 39-74 (mean age 54.4 years). Patients' demographic information and co-morbidities are listed in Table-1.

Table-1: Patient demographic information and co-morbidities

Parameter	**No of patients** 17 (100)	**Co-morbidities**
Sex		Hypertension. (11/17, 65%)
Male	10 (58.8)	Diabetes (14/17, 82%)
Female **Age**	7 (41.2)	Chronic renal failure (10/17, 59%)
	39-74 (mean 54.4)	Malignancy (7/17, 41%)
		Ishemic Heart Disease (5/17, 29%)

The type of catheter, the vein punctured, the intended destination, the misplaced site, the complaint & complication, the investigations that were done and the management of the misplaced cath. are listed in Table-2.

Table-2: The type of catheter, the vein punctured, the intended destination, the misplaced site, the complaint & complication, the investigations that were done and the management of the misplaced catheter

type of cath	**vein punctured**	**intended destination**	**misplaced site**	**Complaint &complication**	**investigations**	**Management**
porta a cath	lt sc	rt atrium	Innominate (too short)	UL pain&swelling	Duplex thrombosis axillary subclavien innominate v	Removal
Mahorker	rt sc	SVC	azygos v	mahorker dysfunction	Angio	Repositioning
Mahorker	lt inj	SVC	right sc	accidently discovered	Xray	follow up
porta a cath	rt sc	rt atrium	Rt IJV	HEADACHE PAIN DYSPHAGIA HOARSENESS OF VOICE	CT BRAIN SIGMOID SINUS THROMBOSIS	removal
Mahorker	rt sc	SVC	Lt sc	accidently discovered	Xray	follow up
porta a cath	rt sc	rt atrium	RT VENTRICLE	P.E	xray, Ct chest	replacement after Failed reposition
Mahorker	lt inj	SVC	Rt sc	UL pain&swelling	Xray	removal
Mahorker	rt fem v	IVC SVC	ASCENDING LUMBAR	MAhorker dysfunction	ANGIO	Repositioning
porta a cath	rt sc	rt atrium	IJV UPWARD	pain inneck& dysfunction	neck xray coiled	Repositioning
Mahorker	lt inj	SVC	sc	UL pain&swelling	Angio	Repositioning
porta a cath	rt inj	rt atrium	RT VENTRICLE	Arrhythmia	Angio	Repositioning
Mahorker	lt inj	SVC	sc	mahorker dysfunction	Angio	Repositioning
Mahorker	lt fem v	SVC	iliac vein	mahorker dysfunction	xray coiled	Removal
Mahorker	lt sc	SVC	sc	mahorker dysfunction	Angio	Repositioning
porta a cath	lt inj	rt atrium	azygos v	porta a cath dysfunction	Angio	replacement after Failed reposition
porta a cath	lt sc	rt atrium	RT VENTRICLE	accidently discovered	Xray	follow up
Permicath	rt inj	SVC	RT VENTRICLE	Arrhythmia	Angio	repositioning

Sc=subclavian ; ijv =internal jugular vein ; svc = superior vena cava ; ul = upper limb ;P.E = pulmonary embolism

The catheters were nine Mahourker, seven port-A-Cath and one permicath. They were inserted through the right internal jugular vein in two and the left internal jugular vein in five patients. The right subclavian vein was the access for the insertion in five while the access was through the left subclavian vein in three patients. Two catheters were inserted through the femoral veins, one through either side. (Table 3). The intended destination was either SVC in mahourker and permicath or right atrium in porta A cath.

Table3: Type of the catheter and the site of vein punctured.

Type of cath	**The site of punctured vein**					
	Subclavien		**IJV**		**Femoral**	
	Right	**Left**	**Right**	**Left**	**Right**	**Left**
Mahourker	2	1		4	1	1
Porta|Acath	3	2	1	1		
Permicath			1			

The common misplaced sites were the opposite subclavein vein in (7) cases and right ventricle in (4) cases.

The presentation varied from being accidentally discovered (3) cases, catheter malfunction (7) cases, UL pain and swelling (3)cases and arrhythmia (2)cases to a serious conditions like pulmonary embolism (one case) due to presence of the catheter in the right ventricle and severe headache, dysphagia and hoarseness of voice (one case) due to sigmoid sinus thrombosis due to upward displacement insertion of the catheter into the IJV. (table 2)

Four catheters were removed three of them because the patients developed complications and the fourth was removed because there was no longer need for its presence. Ten patients were subjected to trial of repositioning over the wire under fluoroscopy. We managed to engage the proper site in eight cases. Repositioning failed in two cases (both port-A- catheters were damaged during the procdure) who were offered new catheters through the same puncture. while we removed the remaining two catheters. (Table 4).

Three catheters (2mahourker and one portaAcath) were accidentally discovered. However, their conditions didn't allow further intervention because of their difficult and hostile access veins and we decided to do follow up for these catheters.

Table 4: The management done for the catheter.

Type of cath	**Removal**	**Repositioning**	**Replacement After Failed Reposition**	**Follow up**
Mahourker	**1**	**5**	**-**	**2**
PortaAcath	**3**	**2**	**2**	**1**
Permicath	**-**	**1**	**-**	**-**

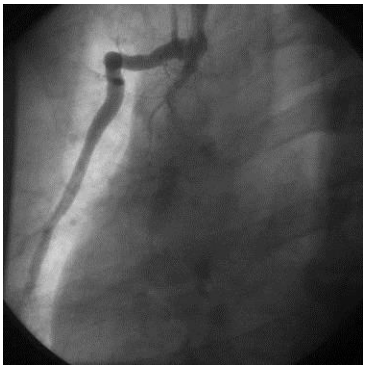

Fig. (1): Injection of contrast shows misplacement of the CVC into azygos vein.

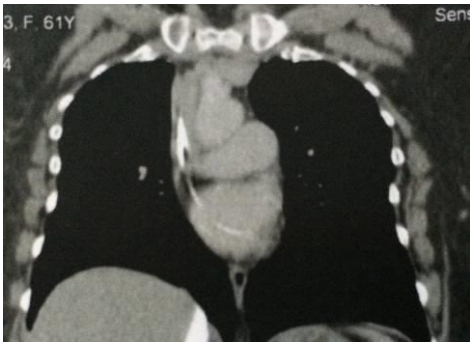

Fig. (2): CT scan showing deep advancement of the CVC into right ventricle.

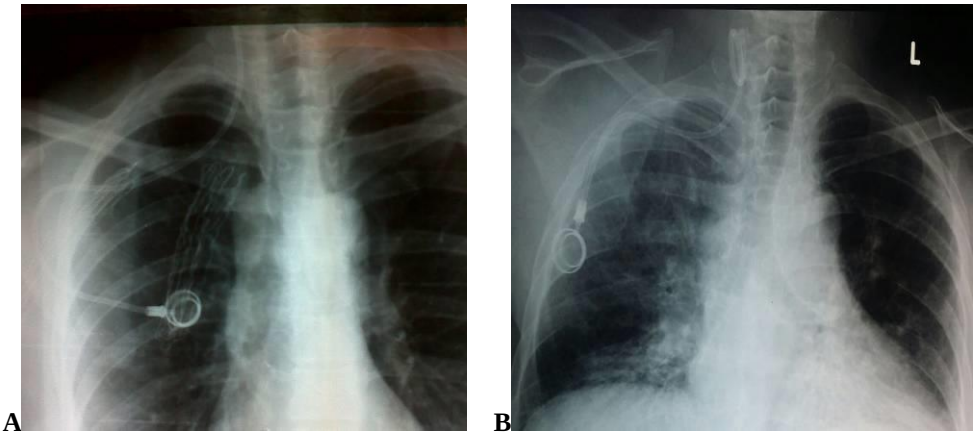

Fig. (3): (A) plain x-ray showing misplaced porta A cath in right IJV;
(B) plain x-ray showing coiled porta A cath in right IJV

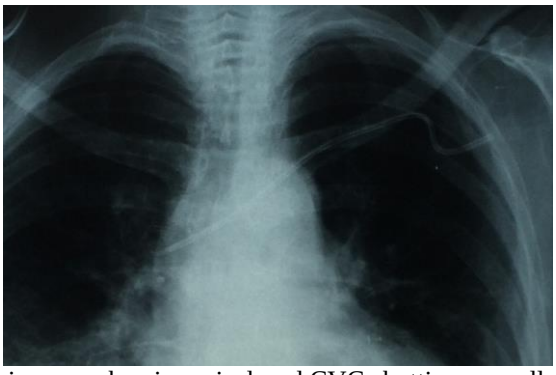

Fig. (4): plain x-ray showing misplaced CVC abutting on wall of the SVC;
as well as too short to reach the proper destination.

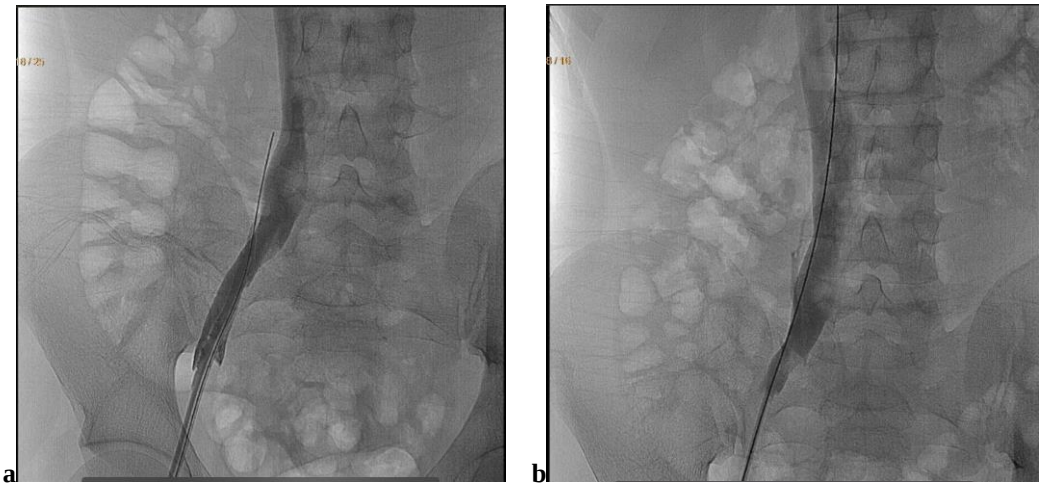

Fig. (6): a: venography showing misplaced wire in ascending lumbar vein . b: venography showing the wire repositioned inside the inferior vena cava.

DISCUSSION

Currently there are five different types of central venous catheter available for clinical use, each serve one or more clinical indication. moreover, each one has its length, manufacture material, merits for its use as well as different technique for its insertion. The scope includes: peripherally inserted central catheters (PICC), temporary central venous catheters (nontunnelled), long-term central venous catheters (tunnelled), Swan-Ganz catheters and implantable ports[(2)]. It can be mono-lumen or multi-lumen. 3 The incidence of malposition of catheters reported in the literature varies from 4–6%. [(4)] Our study included 17 misplaced catheters (9) mahourker (temporary central venous catheters (nontunnelled), (7) porta A cath (implantable ports) and (1) permicath (long-term central venous catheters (tunnelled),

Malposition is defined as a CVC tip in a vein other than the superior vena cava (SVC), or the right atrium, impingement with the lateral wall of the SVC (>40°) and arterial cannulation.5 It carries an increased risk of perforation. 6 We reported catheter misplacement in different sites of venous system. However, misplaced catheters have been reported in almost every possible anatomical position, including the arterial system, mediastinum, pleura, pericardium, trachea, oesophagus, subarachnoid space, and other aberrant sites. [(2)] Catheter misplacement can occur at the time of insertion or after a period of time due to migration of the tip. [(2)]

Nine catheters (53%) were in left side while eight (47%) were in right side. Ambesh SP et al reported that there was a statistically significant difference in venous malposition rate between right- and left-sided approaches, with a higher malposition rate for the left IJV approach due to the angle between the left innominate vein and the SVC. [(4)] Gibson F and Bodenham A mentioned that it does not vary with the side of insertion nor does it depend on whether the head is turned toward or away from the selected side. [(3)]

Malposition can occur in normal anatomy of the venous system. [(2)] This was the case in all patients of our study. We reported misplacement in IJV, SC, innominate, azygos, lumbar veins and right ventricle. However, misplacement can occur in the tributaries of brachiocephalic vein: the vertebral vein, the internal thoracic (mammary), inferior thyroid veins and sometimes the vein from the first intercostal.[(2)] All these tributaries can be site of misplaced insertion. [(2,7)]

Malposition also may be due to congenitally disturbed anatomical variations in the left thoracic venous drainage, such as persistent left superior vena cava, dominant supreme intercostal venous drainage to the hemiazygous, collateral internal mammary veins, or dilated supreme intercostal vein.[(3)] The most common variant of the SVC is the persistent left SVC. This may occur with a normal right-sided SVC (as in 82% of cases) or without (as a single left-sided SVC). Left-sided SVCs usually drain into the coronary sinus and then into the right atrium. They can, however, drain into the left atrium (8%), giving a risk of systemic air or particulate emboli from catheter usage. [(3)]

Malposition also may be due to acquired stenosis or obstruction of the central veins which can be classified into two types: external and internal causes. 3 external causes are usually mass lesions, of which more than 85% are malignant. Benign causes include substernal thyroid goitre, thymoma.[(3)] Thrombosis and stenosis of the central veins can occur due to placement of multiple catheters and longer duration in situ. Both subclavian venous location and poor catheter tip positions predispose to thrombosis. Catheter insertion through the left side of the neck furtherly increases the thrombosis risk. Tip of left-sided lines frequently abuts the endothelium of the lateral caval wall and incites mechanical as well as cytotoxic damage. Too proximally inserted catheter carries the same thrombosis risk due to slow blood flow around the catheter tip. Therefore, the Guidelines recommend limiting the use of temporary catheters in the internal jugular vein (IJV) for 3 weeks and in the femoral vein for 1 week. [(1)]

Nayeemuddin and his colleagues[(1)] mentioned that risk factors for misplaced catheter include doctor incompetence, no. of needle passes, BMI>30 or <20, coagulopathies and large catheter size. 5 The number of needle passes required to access the vein impacted the complication rate. If the vein was accessed on the first attempt, the overall complication rate was only 2% and was caused solely by line malpositioning. 1 Catheter tip movement after insertion depends on multiple factors, including phase of respiration, catheter type, insertion site,

body habitus, development of clot, and body position. [2]

Presentations of misplaced catheters, in our study, varied from being accidentally discovered to serious presentations like acute chest pain and sigmoid sinus thrombosis. Patients with IJV catheters misplaced into the subclavian vein experienced shoulder pain while patients with subclavian vein catheters misplaced into the IJV reported babbling sound and ear pain. König and Roscoe postulated that it occurs secondary to irritation of jugular bulb or cephalad end of ipsilateral IJV, which is innervated by the vagus nerve.[3] some authers reported trickling sensations in the throat during the placement of the guidewire. 3 others reported precordial pain while misplacement was in internal mammary vein. [8]

Diagnosis of the misplaced catheters should be kept in mind but the overall, clinical judgment had a sensitivity of 71%, specificity of 44% and overall accuracy of only 70%. K9 Without image guidance, the frequency of primary line malpositioning has been shown to be up to 3.7%. [1] Plain CXR; is essential and should be done as a routine after insertion of the catheter. However, a catheter may appears to lie in the correct position but actually is lying within the internal thoracic mammary) vein. 2 Fluoroscopic guidance of catheter placement is commonly considered to be a reliable method, but this may fail to demonstrate incorrect arterial insertion of a catheter in the ascending aorta adjacent to the SVC or in the presence of a vascular anomaly (e.g. right-sided aortic arch). [2]

The use of contrast has many benifits, including the following: better visualization of fine catheters. Occlusion of central veins will be seen by the lack of flow of contrast and the presence of collateral veins. Extravasation of contrast confirms that the catheter is extravascular. Pooling or backtracking of contrast around the catheter in the vessels is suggestive of thrombus or a fibrinsleeve. Intra-arterial injection of contrast is confirmed when the contrast flows away from the heart, catheters in pleura, pericardium, or peritoneum will show spread and then stagnation of contrast. [3] CT and magnetic resonance imaging are expensive but are very useful to guide management of complications. [3]

Four catheters were removed, three of them because the patients developed complications and the fourth was removed because there was no longer need for its presence. Ten patients were subjected to trial of repositioning over the wire under fluoroscopy. We managed to engage the proper site in eight cases while we removed the remaining two catheters after the attempt at reposition failed due to catheter damage. Both catheters were exchanged by new one through the same puncture. In most circumstances, a malpositioned or kinked catheter should be removed replaced, or repositioned, as soon as practicable. In patients with difficult venous access and a 'precious' catheter, an individual risk–benefit analysis should be made between retaining and using the catheter against insertion of a new one in the presence of limited availability of suitable vein for catheter insertion.[7]

The management of misplaced catheters depends on the location of the catheter, indication for central access, and clinical condition of the patient. [9] before taking it out, Abood et al recommended the following approach, First, consider the following questions:

- Can blood be aspirated through all lumens?
- Is the blood venous (i.e. low pressure, non-pulsatile, dark, deoxygenated blood)?
- Is the catheter on CXR consistent with placement within a central vein (i.e. overlies the trajectory of the SVC) and not kinked? [8]

We placed the tip of the replaced or repositioned catheters in the region of the junction of the superior vena cava and right atrium to avoid contacting the pericardial reflection. However, there is no clear consensus on the ideal radiographic landmark [2]. Catheter should be parallel to the longitudinal axis of the vein, such that the tip does not abut on the vein or heart walls at an acute angle or end on. [3] The upper level of the pericardial sac, as it traverses the SVC, lies below the level of the carina. Hence, the use of the carina as an X-ray landmark to identify the placement of a CVC tip outside of the pericardium, therefore minimizing the small but serious risk of cardiac tamponade if the tip perforates the vessel wall. 3 However, placing the tip in the upper-third of the right atrium provides better flow rates and significantly increases the catheter lifespan by reducing the development of tip thrombus, venous stenosis, and fibrin sheath. Furthermore, with the advent of softer catheters, the risk of myocardial perforation is low. [1]

Prevention of the misplaced catheters include the use of ultrasound guidance by experienced personnel[5] This also can be avoided by assuring that the J tip of the guidewire is pointing caudal during insertion. Additionally, turning the head toward the insertion side narrows the os of the IJV, and manual compression of the jugular can avoid misdirection. 10 Correct placement should be confirmed by free venous blood return, pressure transduction and post-insertion chest X-ray (bedside, anterior–posterior view). [5] One such approximation is made by premeasuring to a central destination point located just above one-third of the distance between the manubrium and the xyphoid, where the caval-atrial junction can be expected to be. It is common practice, then, to assess the final position of the catheter's tip radiologically, accepting that the pericardial reflection is below the carina. 6 To avoid the tip from abutting against the wall of the vein at an inappropriate angle, it is best to approach left-sided insertions with a 20-cm catheter and the right sided ones with a 16-cm catheter in adult patients.[6]

Ultrasound guidance can help the operator to decide the relationship between artery and vein, how often the venous anatomy is abnormal, which vessel is best to use, how much the head should be turned and the effect of patient position on the diameter of the vein. K3 but is of limited value in confirming tip position in the SVC.[3]

CONCLUSION

Misplaced catheters can occur in normal anatomy of the venous system., it also may be due to congenitally or acquired disturbed venous anatomy. Presentations of misplaced catheters varies from being accidentally discovered to serious presentations like acute chest pain and sigmoid sinus thrombosis. Diagnosis of the misplaced catheters should be kept in mind, but the clinical judgment is not enough. Plain CXR; is essential and should be done as a routine after insertion of the catheter. The management of misplaced catheters depends on the location of the catheter, indication for central access, and clinical condition of the patient.

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