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Double lumen catheter application and results in patients with end-stage renal disease: A prospective study single institutional experience

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ABSTRACT

Objective: The main objective of the present paper is to determine the indications, contraindications, complications and the results of temporary and permanent hemodialysis catheters in the patients with chronic renal failure. Material and Method: 280 interventions in 144 patients who were admitted to the department of nephrology in our hospitalwith chronic renal failure requiring hemodialysis and the catheterizationswere applied bysurgeons were included in the study. Results: Smaller diameter catheters were applied for low body size patients, large diameter catheters were applied for bigger body size patients; the most frequent reason for withdrawal was dysfunction in small size patients, but was the ending of the optimum usage period in the big body size patients; the most frequent reason for withdrawal of permanent access was the occlusion with clot (p: 0007); there was not any relationship between the abnormal route and the diameter of the catheter; the most frequent arterial puncture was encountered during the interventions on the right subclavian and left femoral veins (p: 0.01); vagal symptoms could appear during the interventions on the left subclavian vein (p: 0.001); there were statistically different catheter routes; both the infective events and the problems due to occlusion were most frequently encountered in the catheters which the arterial puncture occurred during their insertion (p: 0.002); none of the problem was encountered in the catheters which could be inserted after 5 or more puncture and these catheters were withdrawn since arteriovenous fistulae of these patients became suitable to usage (p: 0.041) were obtained. Conclusion: Both the indications, contraindications, complications and the results of catheterizations for hemodialysis which were applied frequently by surgeons, vascular surgeons, nephrologists and anesthetists and also the differences/features between/of temporary and permanent catheters were determined. We believe that evidences of this study will be helpful for clinicians.

Keywords: Catheter, hemodialysis, dialysis, chronic renal failure, ESRD

Introduction

The use of central venous dialysis for the first time in 1961 by Shaldon et al. was developed by Uldall in 1980 as dual lumen hemodialysis (HD) catheters. Percutaneous dialysis applications that find wide use in the clinic have begun with subclavian vein dialysis [1]. In the 2018 US Renal Data Report, 80% of patients initiated hemodialysis with a catheter and 21% are still in use 1 year after hemodialysis initiation [2]. Intravenous catheters of today are an indispensable element of especially emergency hemodialysis applications and although thanks to advanced technology they are much more successful than the historical ones, still to this date an ideal type of catheter could not be produced. For this reason, infections and intra-catheter thrombosis continue to be the biggest problem of hemodialysis catheters. Unfortunately, this is true for both temporary and permanent hemodialysis catheters [3], another confusion is the question of who should apply this catheterization procedure. This situation is uncertain for our country. Since it is not precisely clear about who is in charge of venous catheterization procedures, many branch physicians seen doing or attempting to do catheterization procedures whether or not they are relative to the subject, whereas; catheterization is not a simple vascular access procedure. It is a dynamic process that has certain rules in itself and it is possible for the mistake to be made to lead to results that will affect the whole life of the patient. A damaged vessel may have remained the only area in the following years where the patient could undergo hemodialysis, and because of this previously given injury, the patient may lose the chance of dialysis. It has been reported that subclavian venous stenosis due to HD catheter develops as high as 50%, and this stenosis can develop even months after the catheter is withdrawn from the vessel. As a result, failure of permanent catheters was found to be related to central venous stenosis by 24% [4]. Hemodialysis catheter use is associated with an eight-fold higher rate of vascular access-related bloodstream infections when compared with an arteriovenous fistula [5]. This was a marked improvement compared with the previous report for 2006 when the rate of all bloodstream infections in catheter-dependent patients was 4.2 (permanent catheters) and 27.1 (temporary catheters) per 100 patient-months, and access-related bloodstream infection rates were 3.1 (permanent catheters) and 17.8 (temporary

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catheters) per 100 patient-months [6]. For all these reasons, this study has been prospectively repaired and implemented in order to identify mistakes in practice with hemodialysis catheters, to emphasize the indications-contraindications and complications of catheters, to provide some clues to the applications and results.

Materials and Methods

Prospective study held in department of nephrology in Imam Hussein teaching hospital, Kerbala city, Iraq from period of Fed 2018 to the Aug 2020,A total of 280 catheterization procedures were performed in 144 patients. Until the catheter was withdrawn, the entire procedure on the patient was monitored and complications and other problems developed during this period were recorded. Twelve patients were removed from the study because they had to go to another centre for reasons such as they lived in the city after their catheter has been inserted. Therefore, in this publication, a total of 276 catheterization procedures is presented before the catheterization of the patients, information about the duration of CRF is taken, all demographic data, how many times the catheter was inserted, how many times the catheter was inserted into the region used at that time was questioned. All events that occurred during the catheter insertion stage (such as how many times it was punctured, arterial puncture, difficult/easy advancement of the catheter, hematoma development, etc.) were recorded. In addition, at the end of the applied catheterization process, it was checked whether the catheter was working or not, and it was checked whether the catheter was in the normal course of the catheter and whether the abnormal course was averse to the catheter function or the patient itself. It was also evaluated whether the catheters were sufficiently functional during the hemodialysis procedure. All complications and problems related to the catheter have been recorded during the time until catheter withdrawal. When the catheter is removed, it is noted that for what reason it is withdrawn.

Statistical Evaluation

The evaluations were carried out using the SPSS computer program. A chi-square test was used. Findings of $p < 0.05$ were considered significant.

Results

Demographic data of the patients are presented in Table (1), we find it appropriate to present the findings, which have significant values in the statistical results, as materials. It has been noticed that catheters with a smaller diameter (less than 10 French) in the small body size (<21.7 body mass index)group and larger diameters in the bigger body size group were used. In the small size catheter (7, 8 and 10 Fr catheters), the catheter size was the most frequent cause of dysfunction, while the most frequent cause of change in the big size catheters were found to be the end of the permitted period of application (p 0.02). The right internal jugular vein was most commonly used in women (p 0.029). In permanent catheters, one of the most common problems in the hemodialysis session after insertion of the catheter is obstruction of one of the lumens (p 0.002). There was no correlation between the catheter diameter and the wrong route followed by the catheter (p >0.05). The arterial puncture was most commonly encountered in interventions made from the right subclavian and left femoral veins (p: 0.01). It has been found that there are different catheter routes with statistical significance. It was observed that the right subclavian vein catheter could be observed on the same side jugular vein (p 0.014), the left subclavian vein catheter could pass the opposite side subclavian vein (p 0.001) or pass to the opposite side jugular vein could be observed (p 0.001). In patients who developed arterial puncture during catheterization, it was determined that catheter occlusion and infection development was more likely in the subsequent period (p 0.002). Catheters that can be inserted after five or more puncture are not as problematic until removed, and the catheters are pulled out due to the mature (p 0.041) fistula. The infected catheter has been dislodged spontaneously (p 0.001).

Table I. Patients data

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SD:

Variable	*n*=144 (%)						
	N	%	Minimum	Maximum	Mean	Median	Standard Deviation
Female	86	59.73					
Male	58	40.27					
Temporary catheter	238	85					
Permanent catheter	42	15					
Old DVT history	34	12.1					
Age			15	75	48.22	51.00	16.017
CRF duration (Month)			0	83	11.33	3.0	16.924
BMI (Body mass index)			15	33	22.12	20.0	5.465
Temporary catheter stay day			1	28	14.98	15.5	6.399
Permanent catheter stay day			7	48	21.43	19.0	14.808
Number of catheter insertion per person			1	3	1.46	1.0	0.554

Standard deviation, HD: Hemodialysis

Discussion

One of the most important means of connecting the patient with chronic renal failure (CRF) to life is hemodialysis. Intravenous catheterization is a method that is applied to almost every patient with CRF, especially with immediate use in situations such as excessive volume loading or highly impaired laboratory values due to renal insufficiency, or waiting for maturation of arteriovenous fistula or peritoneal dialysis. Even though it has been used in such a large group of patients, it is unlikely to say that use of intravenous catheterization is so accurate, due to the facts we observe in clinical practice. For example; subclavian stenosis due to hemodialysis catheter has developed as high as 50%, and this stenosis can develop even months after the catheter is withdrawn from the vessel. As a result, failure of permanent catheters was found to be related to central venous stenosis by 24% [2-4]. Before we evaluate the findings we have, we think it would be appropriate to specify some rules that we are following. In the literature, short-term catheter applications are between 1-6 weeks, and applications over 6 weeks are called "long-term use" [7].We prefer not to go above 21 days unless we are in a position to cope with our temporary catheterizations, especially because we are afraid of the infections. If the patient needs a catheter that lasts more than 21 days, then we are replacing the catheter. The rule that we follow in the catheterization procedure is that each catheterization is done from another region. At this point, we believe that we have prevented the bacterial colonization that the previous catheter created around and along the path of the previous catheter to be planted in the vein with the new catheter. Our other rule is; As a means of hemodialysis in the presence of CRF, we prefer arteriovenous fistula primarily. The choice of arteriovenous fistulas to protect from catheter-related complications, especially infection, is the result of the low number of permanent catheters in this study. Sterile temporary catheters have been applied during the time until the arteriovenous fistula has matured. Following the maturing process HD was continued from the fistula. Since permanent catheters were used in a patient group in which no fistula formation was possible and peritoneal dialysis was not possible, only 28 total permanent catheter applications were performed in this study. If we evaluate our results in the light of these basic approaches; We use catheters with a smaller diameter in the small body size group and larger diameter in the big body size group. One of the most negative consequences of catheterization is vein stenosis, which either prevents new catheterization in later periods or does not allow HD because of low flow, even if catheterization is allowed. It is easy to imagine that the preservation of the vascular system is vital for the patient with CRF if the CRF is thought to be a life-long illness. The preference of small diameter catheters (less than 10 Fr) on the small body surface is

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unfortunately a problem in HD applications. For this reason, it was determined that the most frequent change in catheter in the small body size and young age group was dysfunction, (p 0.02). It is possible to explain with the anatomical difference of women (p 0.029), that the right internal jugular vein is most used in women, mass belonging to the breast; can sometimes make difficulties in subclavian vein applications. However, it should be known that we prefer jugular venous administration in men as well. It is a known fact that jugular venous catheterization results in less stenosis than subclavian vein [2].In permanent catheters, the most frequent cause of catheter withdrawal is the occlusion of the catheter (p 0.007) and in permanent catheters, the most common problem during hemodialysis after catheter insertion is clogging one of the lumens (p 0.002) proves that they are meeting the expectations. Because, as we have stated between our basic rules, we use permanent catheters in cases where the peritoneal dialysis is contraindicated and in cases where it is not possible to open the fistula. In other words, the most important thing that permanent catheters used as the only remedy for dialysis in such cases is expected to be the longest time without catheter infection. From this point of view, it does put a smile on face that there are no infections at the beginning of withdrawal causes of permanent catheters that we apply. There was no correlation between the catheter diameter and the wrong route the catheter followed (p >0.05). Our goal here was that increased catheter diameter could increase the catheter stiffness, which would make it impossible to maneuver the catheter in vascular junctions and to follow a false route. However, this suspicion was found to be inaccurate. We think that it may be a good idea which hand was used dominantly by the practitioners when it was encountered in interventions made from the right subclavian and left femoral vein most frequently for artery puncture (p 0.01). In particular, it is possible that the left femoral venous is on the fore line for that reason. We have seen that those who use the right hand dominantly have difficulties during the practice of the left femoral vein. More pronounced vagal symptoms during catheterizations from the left subclavian vein. We can attribute its exposure to this anatomical difficulty. Because of this strain created by the anatomical difference, patients may have developed vagal symptoms [8].It was observed that in a patient who developed vagal symptoms, sudden shortness of breath occurred during dialysis and therefore the catheter was removed, and the patient recovered. The reason may be similar anatomical problems. Various catheter routes with statistical significance can be seen, but no problems have been encountered by this change. The conclusion to be drawn here is that different catheter routes have proven to be OK for as long as they allow HD. In one case the tip of catheter which introduce through right subclavian vein end in right jugular vein which cause tinnitus to the patient during hemodialysis and with time become tolerated and continue on dialysis. In those who developed arterial puncture in the course of catheterization, it was more likely that catheter blockage and infection developed in the following period (p 0.002). We think that this may be related to the hematoma that accumulates around the catheter. The hematoma that develops due to the artery puncture is a nutrient for the members of the colonization around the catheter. In addition, hematoma mass may cause pressure build-up and obstruction in the catheter. In particular, it is a strong possibility that the hematoma cannot be fully resorted and is responsible for the compression effect of the developing fibrosis. One problem that comes to mind here is about the number of punctures. That is, whether or not the number of punctures constitute a risk unless artery puncture is made. Catheters that can be inserted after five or more puncture are not as problematic until removed, and the catheters are pulled out due to mature fistula (p 0.041). This means that, as long as there is no artery puncture, 5 and above punctures do not cause any problems. The important thing here is whether or not there is arterial puncture. In other words, even if the catheter is inserted even after two punctures, if the first puncture is made into an artery, there is a possibility of infection and clogging in the long term. However, if the catheter is inserted even after a puncture over 5, but there is no arterial puncture, the problem will not be encountered. Of course, it is also important to remember that it is necessary to insert a catheter with the minimum number of punctures. Because of the increased number of punctures, the probability of arterial puncture will also increase. The infected catheter has been shown to be dislodged spontaneously (p 0.001). This reflects the importance of nursing services in everyday practice. During and after dialysis, the catheter

dressings must be made in a completely sterile fashion, and the same dressing should not be allowed to remain on the patient for long periods of time. Because colonization on the catheter can lead to infection, it is possible for the infected catheters to dislodge due to the loss of the integrity of the skin in the infected area, and thus the catheter can come out by itself. This can even lead to death of the patient who is unconscious or in a sleeping condition. For these reasons, infection should not be allowed in the catheter entry area and suture materials should be used which will cause less reaction. In cases of infection in the catheter area, it should be ensured that the catheter fixation seams are secure.

Conclusion

It is well known and recognized that catheters are not optimum for long-term dialysis because of their high morbidity and mortality. Greater emphasis should be placed on pre-ESRD education to create AVFs in patient for incipient dialysis and thereby minimize tunneled catheter use. The complications of infections and catheter dysfunction with thrombosis and sheath formation are the most common causes of patient morbidity, and relate to extra health care expenditure.

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