CENTRAL VEIN STENOSIS IN PATIENTS UNDERGOING HEMODIALYSIS THROUGH ARTERIOVENOUS ACCESS: EXPERIENCE FROM A UNIVERSITY HOSPITAL OF NEPAL

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Abstract:

Introduction: Adequate delivery of hemodialysis is only possible through effective access. This is most commonly achieved through an arteriovenous fistula, followed by an arteriovenous graft, and tunneled cuffed catheter. Central vein stenosis is a common and troublesome issue in patients undergoing hemodialysis through arteriovenous access, usually due to preexisting temporary internal jugular catheter or permanent cuffed tunneled catheter. They commonly present with swelling of the neck, breasts and extremities. Some of the major predisposing factors for development of CVS are placement of multiple catheters, longer duration, location in subclavian vein, and placement on the lefthand side of the neck.

Objective: The main aim of this study is to identify the interventions done for failed arteriovenous fistulas and evaluate the cases feasible for balloon angioplasty.

Methods: This is a retrospective descriptive cross-sectional study where all the cases of angiograms with or without angioplasty for stenosis in drainage of arterio-venous fistulas created for dialysis access from October 1st 2020, to January 31s 2022, were included in the study. In each case, detailed imaging of drainage and the presence of central vein stenosis were noted. The possibility of balloon angioplasty for the central vein stenosis was noted, along with the outcome after the procedure.

Results: There were 62 interventions for failed arteriovenous fistulas. Of them, central vein stenosis was present in 27 cases (43.5%), which included 16 (59.3%) males and 11 (40.7%) females. In 26 patients (96.3%), there was a history of catheterization involving the central vein at least once. The number of cases with a history of catheterization in the involved vein for one time, two times, or more than two times was 6 (22.2%), 15 (55.6%), and 4 (14.8%), respectively. Prominent visible collateral was present in 11 (40/7%) patients, with the most common sites being both the neck and chest (5 cases). The most common indication of intervention was swelling, present in 22 (81.5%) cases. Innominate veins were involved in 15 (55.5%) cases. Negotiation of a catheter via stenosis was feasible in 15 cases (55.6%), while balloon angioplasty was possible in 6 (22.2%) cases.

Conclusion: Central vein stenosis can cause fistula failure. The primary intervention done in these cases includes balloon angioplasty; however, stenting can be done if this fails.

Keywords: Arteriovenous fistulas, Balloon Angioplasty, Central Venous Catheterizations, Hemodialysis

СТЕНОЗ ЦЕНТРАЛЬНОЙ ВЕНЫ У ПАЦИЕНТОВ, ПРОХОДЯЩИХ ГЕМОДИАЛИЗ ЧЕРЕЗ АРТЕРИОВЕНОЗНЫЙ ДОСТУП: ОПЫТ УНИВЕРСИТЕТСКОЙ БОЛЬНИЦЫ НЕПАЛА

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Аннотация:
Введение: Адекватное проведение гемодиализа возможно только при наличии эффективного доступа. Чаще всего это достигается с помощью артериовенозной фистулы с последующей установкой артериовенозного трансплантата и туннелированного катетера с манжеткой. Стеноз центральной вены является распространенной и неприятной проблемой у пациентов, находящихся на гемодиализе через артериовенозный доступ, обычно из-за ранее существовавшего временного внутреннего яремного катетера или постоянного туннельного катетера с манжеткой. Обычно они проявляются отеками шеи, груди и конечностей. Некоторыми из основных предрасполагающих факторов развития сердечно-сосудистых заболеваний являются размещение нескольких катетеров, большая продолжительность их действия, расположение в подключичной вене и расположение на левой стороне шеи.

Цель: Основная цель этого исследования — определить вмешательства, выполняемые при неудачных артериовенозных фистулах, и оценить случаи, в которых целесообразно выполнить баллонную ангиопластику.

Методы: Это ретроспективное описательное перекрестное исследование, в которое были включены все случаи ангиограмм с или без ангиопластики по поводу стеноза при дренировании артерио-венозных фистул, созданных для доступа к диализу с 1 октября 2020 года по 31 января 2022 года. В каждом случае отмечали детальную визуализацию дренажа и наличие стеноза центральной вены. Отмечена возможность баллонной ангиопластики при стенозе центральной вены и результат после процедуры.

Результаты. Было проведено 62 вмешательства по поводу неудачных артериовенозных фистул. Из них стеноз центральной вены имелся в 27 случаях (43,5%), среди которых были 16 (59,3%) мужчин и 11 (40,7%) женщин. У 26 пациентов (96,3%) в анамнезе хотя бы один раз была катетеризация центральной вены. Число случаев в анамнезе катетеризации пораженной вены однократно, два и более двух раз составило 6 (22,2%), 15 (55,6%) и 4 (14,8%) соответственно. Выраженные видимые коллатерали присутствовали у 11 (40/7%) пациентов, причем наиболее распространенными местами были как шея, так и грудь (5 случаев). Наиболее частым показанием к вмешательству был отек, имевший место в 22 (81,5%) случаях. Безымянные вены были поражены в 15 (55,5%) случаях. Перемещение катетера через стеноз было осуществимо в 15 случаях (55,6%), а баллонная ангиопластика — в 6 (22,2%) случаях.

Заключение: Стеноз центральной вены может привести к несостоятельности фистулы. Первичное вмешательство, проводимое в этих случаях, включает баллонную ангиопластику; однако, если это не помогло, можно провести стентирование.

Ключевые слова: артериовенозные фистулы, баллонная ангиопластика, катетеризация центральных вен, гемодиализ.

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Introduction:

Adequate delivery of hemodialysis (HD) is only possible through effective access. This is most commonly achieved through an arteriovenous fistula (AVF), followed by an arteriovenous graft (AVG), and a tunneled cuffed catheter [1–4]. Central vein stenosis (CVS) is a common and troublesome issue in patients undergoing HD through arteriovenous access, usually due to a preexisting temporary internal jugular catheter or permanent cuffed tunneled catheter [5]. They commonly present with swelling of the neck,breasts, and extremities [6]. Some of the major predisposing factors for the development of CVS are the placement of multiple catheters, their longer duration, their location in the subclavian vein, and their placement on the left-hand side of the neck [7]. Central venous cannulation leads to intimal injury. It is associated with focal endothelial denudation, increased smooth muscle cells, and vein wall thickening [8].

Physical examination may reveal swelling of the limbs and breasts and the formation of collaterals, which are indicative of the presence of CVS. However, angiography is used to make a definitive diagnosis [5]. AVFs typically develop stenoses in the juxta-anastomotic region. The swing segment for brachial-basilic AVF and the cephalic arch for brachial-cephalic AVF, whereas AVGs typically develop stenoses at the graft-venous anastomosis [9–12].

Although endovascular treatment modalities such as balloon angioplasty are available for treatment, most of the time they are not possible. Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines for vascular access suggest intervention in symptomatic cases [13]. In feasible cases, balloon angioplasty has been shown to increase the annual patency rates of arteriovenous fistula [14]. Intervention for central vein stenosis is comparatively new in Nepal, and this study highlights the evaluation and management of such cases.

Methodology:

All the cases of angiograms with or without angioplasty for stenosis in the drainage of an artero-venous fistula created for dialysis access from October 1st, 2020, to January 31st, 2022, were included in the study. In each case, detailed imaging of drainage and the presence of central vein stenosis were noted. The location of stenosis in the internal jugular vein, subclavian vein, innominate vein, and superior vena cava was also noted. Additionally, the confirmation of the presence of CVS and the presence of collateral and collateral sites were also noted. Collaterals were classified anatomically as collaterals of the neck or chest. The lesion was defined as stenosis if there is at least a 50% reduction in the size of the lumen compared to the prestenotic normal site. [15]

The AV fistula was punctured using a 20-gauge (G) cannula in a preferred site, which was usually the most superficial part, along with the presence of at least two centimeters of straight vein. Following the insertion of the guidewire, a vascular sheath of size 5F or 6F was inserted. Then 10–15 ml of contrast Ultravist 370 (0.769 g of Iopromide in 1 ml) was injected via the sheath flush line to take images of the peripheral vein and central vein. For intervention, a JR (Judkins right DxTerity Diagnostic Catheter, Medtronic) catheter 3.5 and 4 with a guidewire of 0.035 inch diameter and 150 cm length hydrophilic guidewire (Radifocus Guidewire M, Terumo) and a guiding coronary wire of diameter 0.014 inch and length 190 cm BMW (Hi-torque Balanced Middle Weight Universal II, Abbott) were used. Balloon angioplasty was done in indicated cases only if a guidewire and JR catheter could be negotiated across the

stenosis and the stenosis did not involve major tributaries. If a 5F sheath is being used, the 5F sheath is replaced by a 6F or larger sheath in order to do ballooning. Following this, a guiding catheter JR 3.5 with a 0.071-inch diameter (Launcher, Medtronic) along with a guidewire is inserted just proximal to the stenosis segments. The length of the stenosis is measured to select the appropriate balloon size. After removal of the guidewire, the balloon and BMW are inserted and positioned at the stenosis, making sure the indicator in the balloon is across the stenosis. Using an inflator device, the Everest 30 survival kit (Medtronic), the balloon is inflated between nominal pressure and rated burst pressure (RBP) and held for 2 minutes. If wasting is detected, the pressure is increased while remaining within the rated burst pressure. Then the balloon is deflated, and the flow in the stenotic segment is checked using contrast. The procedure is repeated if needed.

The database was created in Microsoft Excel and analyzed in SPSS 19.0. The nominal variables were expressed in frequency. Scalar variables will be expressed as mean, standard deviation, and range. Parametric variables will be compared using the t-test or ANOVA. Nonparametric variables will be compared using the Chi square test.

Results:

There were 62 interventions for failed AV fistulas. Of them, central vein stenosis was present in 27 cases (43.5%). Of the patients with central vein stenosis, 16 (59.3%) were male and 11 (40.7%) were female. The mean age of the patient with central vein stenosis was 39.9 years (range 18–69 years, SD 18.4 years). In 12 cases, central vein stenosis was present on the right side (44.4%), while in 15 cases, it was present on the left side (55.6%). None of the cases had central vein stenosis on both sides. In 26 patients (96.3%), there was a history of catheterization involving the central vein at least once. In 6 patients (22.2%), there was a history of catheterization in the involved vein for one time, while in 15 cases (55.6%), it was two times, and in 4 cases (14.8%), there was a history of catheterization in the involved vein for more than two times. In 15 cases (55.6%), the catheter was able to negotiate the stenosis. Prominent, visible collateral was present in 11 (40/7%) cases. The most common site of collateral was both the neck and chest, present in five cases. The most common indication of intervention was ipsilateral upper limb swelling, present in 22 (81.5%) cases. The most common central vein involved was the brachiocephalic vein, present in 15 (55.5%) cases. In six cases (22.2%), ballooning was possible.

Table 1: Details of cases of central vein stenosis

Details	Number (%)
Total cases of central vein stenosis	27
Total male patients with central vein stenosis	16 (59.3)
Total female patients with central vein stenosis	11 (40.7)
Central vein stenosis on the right side	12 (44.4)
Central vein stenosis on the left side	15 (55.6)
History of catheterization in involved central vein	26 (96.3)

Number of catheterizations in involved central vein 1 2 More than 2	 2 (7.4) 20 74.1) 4 (14.8)
Number of central vein stenosis with possibility of negotiation of catheter	15 (55.6)
The presence of collateral in central vein stenosis	11 (40.7)
Location of collaterals in central vein stenosis	Neck only: 2 (18.2) Chest only: 3 (27.3) Neck and chest: 5 (45.4) Neck, chest and abdomen: 1 (9.1)
Indication of intervention in AV fistula failure cases due to central vein stenosis.	Ipsilateral upper limb swelling: 22 (81.5) High venous pressure causing issues during dialysis: 12 (44.4) Clotted fistula: 6 (22.2)
Central veins involved	Subclavian vein: 11 (40.7) Brachiocephalic (innominate) vein: 15 (55.5) Superior vena cava: 6 (22.2)

Discussion

Nearly 100 years have passed since the first hemodialysis was performed for a uremic patient, yet it remains a procedure with various complications, of which central vein stenosis is one [16, 17]. Common causes of AV fistula failure are thrombosis of the fistula and stenosis of the fistula, which can be present in the peripheral venous segment or in the central veins. [18] The incidence of central vein stenosis (CVS) varies with the location and type of central vein catheters [19]. A study among 133 patients on dialysis (50% subclavian catheters and 50% jugular vein catheters) showed central vein stenosis in 42% of the subclavian group and 10% of the jugular vein group [19]. With reference to other studies, collaterals are commonly formed in the neck, chest, and shoulder, which is similar to our study. [20][21]

Balloon angioplasty is the recommended approach to CVS. In a study of CVS patients, balloon angioplasty was feasible in 72% of cases. [5]. In another study done by Horita et al. in 2021, balloon angioplasty was possible in 97% of the cases. Previous studies have also identified success rates of > 80%. [22,23] It has a very high initial technical success rate, ranging from 70% to 90%. A more recent study using high-pressure balloons noted better results with primary angioplasty alone, with an unassisted patency rate of 60% at 6 months and 30% at 12 months. [5] However, among the patients who underwent balloon angioplasty, there were high chances of immediate recoil because of endothelial injury resulting in restenosis of the central vein. [24] In comparison to other studies, our study had a lower percentage (22% of cases feasible for balloon angioplasty).

Elective stent placement is indicated in cases of frequent restenosis in the short term after balloon angioplasty. A study done in 2015 showed promisingly good results with the use of stents [15]. The technical success rate is high, and the primary and assisted patency rates were significantly better. In a study done by Agrawal in 2015, stent placement was done for 26 patients with failed balloon angioplasty. The patency rate was 84% using a stent and 81% for balloon angioplasty alone after 1 month of follow-up. However, following up on the patients who underwent stenting for CVS had equivalent results in comparison to balloon angioplasty [25]. Our study did not use stents because of their high cost and fear of obstructing the collateral veins.

Research involving 23 patients who underwent secondary stent placement due to refractory stenosis following angioplasty showed that the median primary central vein patency was 138 days (19% at 1 year) and the median secondary central vein patency was 1036 days (64% at 1 year) [26]. In cases where intervention is not possible, venoplasty is a surgical correction to address central vein stenosis; however, this is associated with considerable risk.

Conclusion

Balloon angioplasty is the preferred technique used in cases of central vein stenosis, with a good outcome after the procedure. In cases of failed balloon angioplasty, stenting can be an alternative option.

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