**Clinical Research**

**Bundle of Care Promotes Arteriovenous Fistula Maturity in Patients with End-Stage Kidney Disease**

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**Background:** Arteriovenous fistula (AVF), as the hemodialysis access, has the advantages of safety, sufficient blood flow, and long use time. To establish ideal AVF, patients require good vascular condition. However, many teams often neglect preoperative preparation and exercises and have no concept of specialized nursing or bundle of care, directly leading to stenosis of the outflow tract and seriously affected surgical efficacy. This study aimed to evaluate the influence of bundle of care on AVF.

**Methods:** A total of 260 patients with end-stage kidney disease were included from January 2019 to December 2020 at Qilu Hospital, Shandong University. Patients were divided into 2 groups, and were treated with ordinary nursing care (the control group) or bundle of care (the observation group). Maturity of AVF fistula and postoperative complications were compared between 2 groups.

**Results:** The observation group was associated with larger internal diameter of the cephalic vein (6.524 ± 0.347 vs. 6.346 ± 0.32 4 mm) and faster blood flow at the anastomosis of AVF (568.2 ± 26.8 vs. 565.7 ± 27.5 mL/min) than the control group at 2 weeks after surgery (both \( P < 0.05 \)). The observation group had a higher maturity rate than the control group (93.1% vs. 81.5%, \( P < 0.05 \)) at 8 weeks after surgery. There were lower incidences of fistula stenosis (4.6% vs. 10.8%) and fistula thrombosis (2.3% vs. 7.7%) in the observation group than in the control group (both \( P < 0.05 \)). The secondary patency was higher in the observation group than in the control group (97.7% vs. 92.3%, \( P < 0.05 \)).

**Conclusions:** The use of bundle of care promotes AVF maturity and reduces postoperative complications in patients with end-stage kidney disease.

**INTRODUCTION**

The number of patients with end-stage kidney disease (ESKD) has continued increasing in recent years. Thousands of new patients are diagnosed every year. Given the low rate of kidney transplantation among patients with end-stage renal disease, vascular access and its creation, as the lifeline of hemodialysis, have become the center of research and attention. According to a Chinese annual report on kidney disease, 91.0% of all ESKD patients are treated with hemodialysis. Journal. All authors have seen the manuscript and approved its submission to your journal.

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Arteriovenous fistula (AVF) is the main vascular access (80.5%) for hemodialysis patients. Stenosis and thrombosis are the main causes of AVF dysfunction. Bundle of care (BOC), which represents the integration of a series of evidence-based nursing strategies, may optimize treatment results. In this study, we aimed to evaluate the impact of BOC on AVF in patients with ESKD.

METHODS

Patient Selection

This study of patients with ESKD was conducted at Qilu Hospital, Shandong University between January 2019 and December 2020. It was approved by the Institutional Review Board of Qilu Hospital, Shandong University (Registry number 2012021014). The written informed consent was obtained from all patients or their relatives.

The inclusion criteria were as follows: (1) Stage 4 or 5 chronic kidney disease according to the National Kidney Foundation (Kidney Disease: Improving Global Outcomes); (2) hemodialysis as kidney replacement treatment and immediate requirement for AVF creation; (3) age 18–80 years; and (4) ability to complete follow-up. A radial-cephalic AVF was created in all patients by using end-to-side anastomosis. Enrollment of patients consisted of 2 periods. First, we reviewed our electronic medical records system to identify patients who received AVF creation and ordinary nursing care from January 2019 to December 2019. Based on the above criteria, 130 patients with AVF were identified during this period, and were included as the control group. Second, we recruited patients with ESKD who agreed to receive AVF creation and BOC from January 2020 to December 2020. These patients were included as the observation group. The recruitment was finished once the number of the observation group reached that of the control group (both 130).

The patients were followed up by telephone 1 week after discharge for assessment of the tremor and murmur of the AVF and the patient’s progress with the functional exercises. At 1–2 weeks postoperative, the attending physician and the same ultrasound doctor assessed the vascular condition of the AVF using another B-ultrasound examination.

Methods of Care

Conventional nursing care. In our department, the patients would receive education after admission from the responsible nurse, in order to protect the blood vessels and skin of the upper limb ipsilateral to the fistula. It mainly included freedom from injury or puncture the veins in the upper limb. Instructions related to fistula care and function exercise were usually given at 2 days before AVF creation. Patients were also instructed to clean the ipsilateral upper limb at 1 day before AVF creation. After the patients returned to the ward after the operation, the condition of the AVF was monitored every 4 hr for 24 hr. Exercises promoting AVF maturity were performed from 1 day after surgery. Infrared therapy was usually performed from 2 days after surgery.

Bundle of care

Establishment of the bundle of care team. The BOC team consisted of 8 members, including 1 attending doctor, 1 head nurse, 1 charge nurse, and 3 senior nurses from our department, 1 sonographer, and 1 vascular surgeon.

Prehospital intervention and preliminary patient education. Patient assessment and screening during outpatient visits: One member of the BOC team provided a preoperative education sheet for patients preferring AVF creation that included basic disease control and physical exercise. The patients were instructed to control their blood pressure, blood glucose, fat intake, and avoid repeated puncture of the ipsilateral upper limb to reduce the risk of intimal damage. The functional exercise of the forearm on the surgical side included the following: (1) use the silicone ring grip to exercise relevant arm muscles, 2 times a day, each time 2 groups, each group of 15 times; (2) massage the forearm muscles for 2 min after each exercise and place a hot compress on the forearm twice a day for 15 min each time; and (3) after performing the exercises for 2 weeks, register for admission and prepare for AVF creation.

Perioperative management of bundle of care. After admission, the patients were asked to wear a warning bracelet on the wrist of the upper limb to remind them to protect the forearm vessels. Admission education was given by the responsible nurse. The attending doctor and the sonographer would use our Doppler ultrasound (Clover UltraSound System; Wisonic, Shenzhen, China) to evaluate and measure the diameter of the vessels.

The BOC team instructed patients to continue preoperative exercises until surgery. Preoperative examinations and education were also necessary before the operation. After surgery, the patients were instructed to raise the upper limb on the
surgical side. The BOC team monitored the tremors and murmurs of the AVF every 4 hr (15 min each time) and recorded the results on the treatment sheet. Infrared treatment was performed one time at postoperative 4 hr and twice daily thereafter. The infrared light was positioned 20–30 cm away from the skin and lasted 15 min each time. The BOC team provided guidance and assistance for postoperative functional exercises that were started immediately after surgery. On postoperative day 2, the attending doctor and the sonographer performed an ultrasound examination and assessed the vascular condition. The BOC team established a WeChat group and invited all postoperative patients to participate in the group.

Evaluation Standards for the Parameters

(1) AVF maturity: The AVF is useable at least 4 weeks (usually 8–12 weeks) after surgery and must meet the hemodialysis standards of a blood flow >220 mL/min to be used for 8 hemodialysis sessions per month.4 The definition of AVF maturity met the revised guidelines of the National Kidney Foundation and the Kidney Disease Outcome Quality Initiative (2006) as follows: (1) internal fistula blood flow >600 mL/min; (2) subcutaneous vein diameter >6 mL/min; (3) subcutaneous vessel depth <6 mm; and (4) puncture vessel length >60 mm and clear vessel boundary.5 In our study, the maturity was evaluated at 8 weeks after AVF creation.

(2) Internal diameter of the cephalic vein: This measurement was made by the attending doctor and the sonographer using Doppler ultrasound at 2 weeks before surgery, 1 day before surgery, 1 day after surgery, 2 days after surgery, and 2 weeks after surgery.

(3) Vascular access blood flow monitoring: It was performed by the same attending doctor and the sonographer using Doppler ultrasound at 1 day before surgery, 1 day after surgery, 1 week after surgery, and 2 weeks after surgery.

(4) Complications: They usually included fistula stenosis and thrombosis or occlusion. They were monitored daily by the attending doctor during hospitalization and by the patients daily after discharge. AVF stenosis was usually treated by percutaneous transluminal angioplasty in most patients. AVF thrombosis was usually managed based on the etiology. If there were few thrombi and they were mainly secondary to anastomotic stenosis, it would be treated by percutaneous transluminal angioplasty. If there were many thrombi and they were associated with cephalic venous aneurysms, the AVF would be ligated and a new AVF would be created in the proximal segment.

Statistical Analysis

Statistical analyses were performed by using SPSS Statistics software 21 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviations. Categorical variables were expressed as numbers and percentages. Differences between 2 groups were tested using the chi-squared test for categorical variables and the t-test for continuous variables. Values of \( P < 0.05 \) were considered statistically significant.

RESULTS

The Impact of Bundle of Care on Arteriovenous Fistula Maturity

There were no obvious differences in the internal diameter of the cephalic vein between 2 groups at 2 weeks before surgery, 1 day before surgery, and 1 day after surgery (all \( P > 0.05 \); Table I). However, the internal diameters were larger in the observation group than in the control group at 2 days after surgery and 2 weeks after surgery (both \( P < 0.05 \); Table I). Meanwhile, the blood flow at the
The anastomosis of AVF was faster in the observation group than in the control group at 2 weeks after surgery ($P < 0.05$; Table II). At 8 weeks after surgery, the AVF maturity rate was higher in the observation group (121, 93.1%) than in the control group (106, 81.5%; $P < 0.05$). Thus, BOC enlarged the cephalic vein, increased the blood flow at the anastomosis, and promoted the maturity of AVF fistula.

The Impact of Bundle of Care on Complications after Arteriovenous Fistula Creation

The incidence of fistula stenosis was lower (4.6% vs. 10.8%, $P < 0.05$; Table III) in the observation group than in the control group, as well as fistula thrombosis (2.3% vs. 7.7%, $P < 0.05$). The secondary patency was higher in the observation group than in the control group (97.7% vs. 92.3%, $P < 0.05$; Table III). Thus, the observation group was associated with less complications and better secondary patency than the control group.

DISCUSSION

Hemodialysis, the most important treatment for ESKD patients, effectively prolongs patient life expectancy and increases their ability to wait for kidney transplantation. AVF, as the hemodialysis access, has the advantages of safety, sufficient blood flow, and extended use time. An ideal AVF requires good vascular condition. Therefore, preoperative functional exercises are particularly important. The current study showed that BOC enlarged the internal diameter of the cephalic vein, increased the blood flow at the anastomosis, and promoted the maturity of AVF fistula. A good vascular condition is the basis for ideal AVF. BOC can guide patients to prevent and control diseases affecting the vascular condition and preoperative functional exercise, paving the way for high AVF quality.

Timely preoperative and postoperative ultrasound monitoring also contributes to AVF maturity, provides more quantitative and repeatable monitoring, and identifies postoperative complications. Our study indicated that BOC reduced postoperative complications and increased the secondary patency for AVF fistula. This study is a retrospective study; randomized controlled trails are required to verify the impact of BOC in future.

CONCLUSION

BOC promotes AVF maturity and reduced postoperative complications in patients with ESKD. It is a valuable method and should be recommended to ESKD patients who plan to receive AVF creation.

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