Support Methods for Internal Shunt in Patients with Kidney Dysfunction

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Abstract

Two exercise training support methods were tested on 19 patients who had recently undergone an internal shunt procedure: a ball-gripping exercise (Group I), and a gripping exercise performed under increased pressure (Group II). Internal shunt growth was compared between groups by measuring the cross-sectional area of blood vessels. A significant increase ($p<0.05$) was observed in growth in group II. Participants in group I exhibited a negative attitude toward the support method, with comments such as "it was exhausting" and "I doubt that this exercise has any effect." Participants in group II were consistently positive toward the support method, with comments such as "it was regular exercise," "the number of puncture failures decreased," "I was able to feel confident about the shunt," and "I got the real feeling that my blood vessels were thickening." Thus, a support method that systematically encourages gripping under increased pressure was effective in promoting AVF growth.

Introduction

Since dialysis was approved as a medical treatment beginning in 1972, the number of dialysis patients has been on the rise due to an aging society and an increase in lifestyle diseases. At the end of 2007, the number of dialysis patients was 275,119, an increase of 10,646 people from 2006 (Japanese Society for Dialysis Therapy, Statistical Survey Committee, 2007)

Dialysis therapy requires access to blood which can be provided by an arteriovenous fistula (AVF), also known as an internal shunt. Its role is to stably provide a blood flow rate of about 200 ml/min each time dialysis is conducted (i.e., 2-3 times per week (Goya, Fukui, & Muto, 1999).

An AVF increases blood flow through an anastomosis between the cephalic vein and radial artery, near the area of where a wristwatch is worn, by infusing radial artery blood into the cephalic vein. The cephalic vein is punctured from outside the body in two places when dialysis is performed. Over 95% of patients undergoing dialysis therapy in Japan select and use this AVF method (Agishi, & Haruguchi, 2000).

Among previous studies of AVF growth, there have been reports of blood vessels expanding immediately after five minutes of exercise among patients with an AVF created an average of three months earlier (Oder, 2003). There have also been reports of increased radial cutaneous vein diameter after six weeks of exercise prior to AVF placement among patients with kidney dysfunction (Leaf, 2003). Furthermore, one report demonstrated that exercise performed between 3 months and 22 years after AVF placement increased vein diameter (Rina, 2003). However, there have been no comparative studies evaluating the effects of systematic exercise over a relatively long period of time.

The self-management of patients with kidney dysfunction after placement of a new internal shunt is very important, and it is vital that shunt growth is quick and smooth. Research on support methods for internal shunt growth remains a

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pressing need.

The objective of this study was to clarify the relationship between exercise strain on the upper arms and AVF growth, and to evaluate support interventions.

Method

Participants

Patients who had newly undergone an AVF procedure on their forearms participated in this study. Patients with serious heart conditions, impaired movement of the upper extremities, or difficulty communicating were excluded.

Facilities

The study took place at three general hospitals that utilize gripping exercises to promote AVF growth after placement. At each hospital, permission for this study was obtained from the ethics review committee.

Design

This study was a comparative study of two types of exercise intervention. We randomly divided 19 patients who had consented to participate in the study into two groups using the envelope method. Group I was a control group that performed the traditional exercise and Group II was an intervention group that performed a newly designed exercise.

Exercise Description

Group I used the ball-squeezing exercise method that is traditionally used at hospitals. After receiving instructions from staff, patients performed the exercises on their own. Group II performed an exercise in which they squeezed a ball while pressure was applied to their upper arm. From initiation until the second week, participants squeezed the ball 40-60 times for 2-3 minutes, three times daily. Then, until the fourth week, participants squeezed the ball 60-100 times for 3-5 minutes, three times daily. From the fourth week through 6 months, participants squeezed the ball 90-120 times for 3-6 minutes, three times daily. Before exercising, a blood pressure gauge added additional light pressure of 10 mmHg to patients' resting systolic blood pressure for 30 seconds on the upper part of the arm in which the AVF had been placed. The exercises were initiated seven days after AVF placement, once the wounded area had stabilized, with permission from the attending physician. The total exercise period was 6 months.

Evaluation of Growth

A Doppler ultrasonograph (probe: 7.5 MHz) was used to evaluate blood vessel growth. Growth was measured prior to exercise initiation and 2, 4, and 6 months after initiation. In order to ensure reliable evaluation of growth, measurements were made by a clinical laboratory technologist or physician who had mastered use of the ultrasonograph and was independent from this research group. After the positions of the radial artery proximal site, radial artery distal site, and cephalic vein proximal site were confirmed using ultrasound, a site on the proximal side, 4 cm from the anastomotic site, was measured three times, and the median value was recorded.

Analysis

Wilcoxon signed-rank sum test was used to evaluate growth over time, the Mann-Whitney U-test was used to compare growth between the two groups, and the significance level was set to a hazard ratio <5%.

Ethical Considerations

Voluntary participation in the study was requested verbally and in writing, and participants were free to withdraw during the study, knowing that withdrawing would have no effect on their treatment or nursing care. Personal information was handled such that individuals could not be identified when the study results were presented at conferences or in articles, and data were managed on a computer that was not connected with other computers. In addition, research progress and results were shared with those patients who requested this information.

Results

The average age of participants in Group I was 62.3±11.1 (9 men and 1 woman). Seven participants were diabetic and 3 were non-diabetic. Two participants had not yet started dialysis therapy during the research period. The average systolic blood pressure was 149±7 mmHg and average diastolic blood pressure was 75±2 mmHg. The average values for blood data were as follows: Ht was 28.9±2.2%, P was 5.9±0.9 mg/dL, Ca was 7.8±0.2 mg/dL, and total cholesterol was 147.2±24.7 mg/dL. None of the patients in this group smoked.

The average age of participants in Group II was 70.0±12.7 (7 men and 2 women). Six participants were diabetic and 3 were non-diabetic. Two participants had not yet started dialysis therapy during the research period. Average systolic blood pressure was 144±7 mmHg and average diastolic blood pressure was 79±3 mmHg. The average values for blood data were as follows: Ht was 29.1±1.2%, P was 4.4±0.3mg/dL, Ca was 8.7±0.5 mg/dL, and total cholesterol was 143.5±19.7 mg/dL. One patient in this group smoked. No significant difference between the two groups was found in systolic blood pressure, diastolic blood pressure, or blood data.

Participants in group I reported that the period of continuous exercise averaged 8.56±11.53 days, and noted “pain in the wound,” “exhaustion,” and “I doubt there is any effect of this exercise” as obstacles to continuous exercise. Participants in group II reported that, “it was regular, periodic exercise,” “the number of puncture failures decreased,” “I was able to be more conscious of the AVF,” and “I got the real feeling that my blood vessels were thickening” as reasons why they were able to continue the exercise.

In Group I, the average cross-sectional area increased from 0.135±0.048 cm^2 prior to exercise to 0.177±0.054 cm^2 in the second month, 0.217±0.069 cm^2 in the fourth month, and 0.234±0.082 cm^2 in the sixth month after beginning exercise. Thus, a significant difference was found (p<0.001). In Group II, the average cross-sectional area increased from 0.144±0.095 cm^2 prior to exercise to 0.239±0.082 cm^2 in the second month, 0.308±0.093 cm^2 in the fourth month, and 0.325±0.088 cm^2 in the sixth month after beginning exercise, representing a significant difference (p<0.001).

Compared to the baseline pre-exercise area of 100%, the average cross-sectional area in Group I increased to 134.7±26.1% in the second month, 171.9±63.0% in the fourth month, and 176.2±46.1% in the sixth month. In Group II, average cross-sectional area increased to 206.6±86.6% in the second month, 281.4±154.0% in the fourth month, and 302.9±174.6% in the sixth month.

A significant difference was found in blood vessel cross-sectional area after exercise between Group I and Group II in the second month (p=0.035). No significant difference between groups was found in the fourth (p=0.079) or sixth month (p=0.095).

Discussion

Upper extremity exercise performed soon after the AVF procedure can lead to increased blood flow in the AVF artery and an expansion of veins. It is thought that the increase in blood flow causes an adaptive response in the blood vessels that in turn causes blood vessel expansion (Kamiya, & Togawa, 1980). On the other hand, it has also been reported that stimulation of blood flow by exercise intervention causes the release of substances such as vasodepressor material from endothelial cells, which is responsible for the blood vessel expansion (Hardman, 1996).

Furthermore, blood congestion in veins also causes a blood vessel expansion effect, and blood vessel expansion may also be influenced by personal characteristics such as sex.

The group that performed the newly-designed exercise had significantly greater growth in the second month after beginning the exercise. This may be because (1) increased pressure on the AVF artery caused a temporary ischemic state, and after release, blood vessels expanded in response, (2) blood vessel expansion is an adaptive response that tries to stabilize the sheer stress from increased blood flow, or (3) AVF congestion due to increased pressure directly caused blood vessel expansion.

If the newly designed exercise is capable of inducing AVF growth, then (1) it may be possible to reduce blockages and constrictions caused by insertion and withdrawal of dialysis needles in cases where the newly placed AVF shows insufficient growth, and (2) further developments in this field hold promise because insufficient blood flow is the cause of AVF malfunction that occurs within 3-4 weeks after placement.

Limitations

This study compared exercise support methods, because although a control group without support methods would have been ideal, not providing a support method was ethically problematic. Since we compared the new method to a previously used method, this is not an accurate evaluation. Yet, we feel this was a valid comparison because participants displayed a negative attitude toward the traditional support method. Furthermore, we believe that demonstrating quantitative changes in blood vessel expansion over time to the participants, who were able to confirm the effectiveness of the new support method, effectively promoted its continuous use. We demonstrated that the newly devised support method was effective in promoting the growth of a newly placed internal shunt in patients with kidney dysfunction, but we were unable to determine the rational timing for exercise initiation and termination. Most kinds of self-management performed by dialysis patients are directly tied to treatment, and it is well known that the burden on patients is great. A precise method to support growth requires newly added features. In order to provide a clear and detailed exercise support method, it will be important to secure the necessary number of research participants and conduct a study stratified by features of pathological conditions and characteristics.

Conclusion

1. Active support intervention using light additional pressure and exercise, implemented soon after AVF placement, promotes AVF growth.
2. It is necessary to provide sufficient information about AVF to patients and medical practitioners in order to ensure that patients continue to perform the exercises.

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