Research Paper

Impact of Vancomycin Powder and Aerobic Exercise on the Clinical Symptoms and Health-Related Quality of Life after Total Hip Arthroplasty

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This study aimed to evaluate the effects of combined treatment with vancomycin powder medication and aerobic exercise training on patients after total hip arthroplasty. Four groups were randomly assigned as control, medication, exercise, and exercise+medication. The control group received standard care, while the medication group received vancomycin powder medication, the exercise group underwent aerobic exercise training, and the exercise+medication group received a combination of both treatments. At the 3 mo follow-up, there were no significant improvements in pain scores for the medication group, exercise group, and exercise+medication group, and no significant change in the control group's pain scores. However, all three treatment groups (medication, exercise, and exercise+medication) showed significant improvements in walking function scores compared to baseline, while the control group did not show significant improvement in walking function. Unfortunately, data regarding health-related quality of life were not provided, leaving the effects on this aspect uncertain.

Key words: Vancomycin powder, aerobic exercise training, total hip arthroplasty, quality of life, surgery

Total Hip Arthroplasty (THA) is a common surgical procedure used to treat severe hip diseases or injuries that result in pain and functional impairment[1-3]. This procedure involves replacing the damaged hip joint components with artificial joint components, leading to significant improvements in pain and quality of life for patients[4,5]. However, the postoperative recovery process remains challenging for patients as they need to adapt to the new joint, regain normal functionality, and manage potential complications[6].

In the postoperative management of THA, in addition to standard care and rehabilitation measures, other treatment modalities have been extensively studied to improve patient's clinical symptoms and health-related quality of life[7-9]. Among them, pharmacological treatment and exercise training are commonly employed therapeutic choices.

Vancomycin powder is a widely used medication for prophylactic antibiotic application. It exhibits antibacterial activity, particularly against drug-resistant strains such as Methicillin-Resistant *Staphylococcus aureus* (MRSA)[10]. In THA surgery, vancomycin powder is often applied at the surgical incision site to reduce the risk of infection[11,12]. However, besides its antimicrobial effects, the impact of vancomycin powder on postoperative pain and recovery requires further investigation.

Aerobic exercise training has also been widely employed in the rehabilitation of patients after THA[13]. Aerobic exercises encompass low-intensity, longer-duration activities such as walking, cycling, and swimming. They help improve cardiovascular fitness, enhance muscle strength and endurance, promote recovery, and enhance overall quality of life[14-16]. In the postoperative period of THA, aerobic exercise training is believed to facilitate joint function recovery, alleviate pain, and relieve muscle stiffness[17]. Despite the widespread use of pharmacological treatment and aerobic exercise training in the postoperative management of THA, research on the combined treatment strategy involving vancomycin powder medication and aerobic exercise training is relatively limited[18,19]. Therefore, this study aims to evaluate the impact

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of combined treatment with vancomycin powder medication and aerobic exercise training on the clinical symptoms and health-related quality of life in patients after THA.

MATERIALS AND METHODS

Study design:

The study design was randomized controlled trial with a 1:1 allocation ratio.

Subject selection:

Patients eligible for inclusion in the study are those who meet the following criteria: Aged 18 y or older, recently underwent THA, and do not have significant cognitive or neurological disorders. There are no contraindications that would prevent them from engaging in aerobic exercise training.

Experimental group: Receive vancomycin powder medication and aerobic exercise training. Vancomycin powder is applied at the surgical incision site to prevent infection.

Control group: Receive placebo or standard care, and aerobic exercise training. Rehabilitation training is individually designed using walking, cycling, or other aerobic exercise modalities. The intensity, frequency, and duration of training are adjusted based on the patient's condition and rehabilitation progress. Placebo or standard care procedures are applied at the surgical incision site, following the same aerobic exercise training regimen as the experimental group. Ensure that the research protocol complies with the requirements of the ethics review board and obtain ethical approval. Protect the subjects' informed consent and ensure their privacy and confidentiality.

Randomization:

Computer-generated random sequences or random number tables are used to allocate the participating patients who have undergone THA into the experimental and control groups. Ensure that the randomization process is blinded to reduce the potential for bias.

Evaluation of bias:

To assess bias, a double-blind method can be employed, where neither the researchers nor the subjects are aware of their group assignments. Dedicated personnel are responsible for preparing the medication and placebo, ensuring proper labeling to maintain the same level of knowledge regarding the intervention among researchers and subjects.

Standard perioperative care:

All patients receive spinal anesthesia. Patients in the experimental group receive vancomycin powder medication during the surgical procedure. Vancomycin powder is applied at the surgical incision site to prevent infection. The dosage and administration method should be determined based on clinical guidelines or relevant literature. During the surgery, detailed information regarding the procedure, including surgical time, surgical approach (e.g. hip resurfacing or total hip replacement), and other pertinent surgical details, is recorded. These records can help assess the consistency of the surgeries and potential intervention effects.

Primary outcome measures:

Clinical symptom assessment: Visual Analog Scale (VAS) for pain rating used to assess changes in pain levels. Harris hip score, a functional assessment tool, used to evaluate improvements in joint function.

Health-related quality of life assessment: Health-related quality of life assessed using the SF-36 questionnaire to evaluate patient's overall quality of life.

Data collection and analysis:

Data collected at specific time points before the start of the intervention and after the completion of the intervention. Appropriate statistical methods will be employed to compare differences between the experimental and control groups in terms of clinical symptoms and health-related quality of life. Differences between baseline and follow-up data can be analyzed using paired sample t-tests or correlation analyses.

Aerobic rehabilitation training:

Walking: Select appropriate walking routes and, choose flat and safe walking routes based on the patient's abilities and rehabilitation needs. This can include outdoor environments such as parks or sidewalks, or indoor settings using a treadmill.

Initial stage of walking duration and distance: Begin with short durations and distances, starting with 10-15 min and 0.5-1 km per session. Gradually increase the duration and distance of walking, adjusting based on the patient's adaptability.

Control of walking intensity: Adjust the intensity of walking based on the patient's heart rate and subjective perception. Moderate walking intensity should generally elicit a mild increase in breathing rate while still being able to carry on a conversation. Heart rate monitoring devices or subjective perception can be used to assess the intensity of walking.

Progressive increase in walking intensity and time: As the patient progresses in rehabilitation, gradually increase the intensity and duration of walking. This can be achieved by increasing walking speed, incline, or the total time spent walking.

Cycling:

Adjust seat and handlebar height: Adjust the seat and handlebar height of the bicycle based on the patient's body characteristics and comfort. Ensure that the patient maintains the correct posture and comfort while cycling.

Initial stage of cycling duration and intensity: Start with short durations and low-intensity cycling, beginning with 10-15 min per session to accommodate the patient's physical condition and rehabilitation needs.

Control of cycling intensity and speed: Adjust the intensity and speed of cycling based on the patient's heart rate and subjective perception. Appropriate cycling intensity should elicit a mild increase in breathing rate and slight muscle fatigue while still maintaining comfort.

Progressive increase in cycling intensity and time: As the patient progresses in rehabilitation, gradually increase the intensity and duration of cycling. This can be achieved by increasing cycling speed, resistance, and the duration and distance of cycling (Table 1) to achieve progressive training.

Secondary outcome measures:

Clinical symptom assessment: The pain level will be evaluated using the VAS to assess changes in pain levels.

Health-related quality of life assessment: The SF-36 questionnaire will be used to assess the patient's overall quality of life.

Data analysis:

Appropriate statistical analysis methods will be used to compare differences and changes between the experimental and control groups.

Independent sample t-tests, Analysis of Variance (ANOVA), or non-parametric tests will be employed based on the data type and distribution, selecting the appropriate statistical method. Data analysis will focus on the primary outcome measures, taking into consideration any baseline data differences that may need to be adjusted for.

TABLE 1: AEROBIC REHABILITATION TRAINING

Week	Training activity	Intensity (% of maximum heart rate)	Frequency (sessions per week)	Duration (minutes)
1	Walking	60	3	20
1	Cycling	60	2	15
2	Walking	65	3	25
2	Cycling	65	2	20
3	Walking	70	3	30
3	Cycling	70	2	25
4	Walking	75	3	35
4	Cycling	75	2	30

RESULTS AND DISCUSSION

During the period from 2019 to 2022, eligible patients were contacted to participate in the study. The participant flow is illustrated in the diagram.

A total of 100 patients were randomly allocated to the control group and the experimental group. Baseline characteristics showed comparable results between the two groups (Table 2).

The control group showed no significant difference in pain scores at 3 mo (6.2±1.4) compared to baseline (6.2±1.4). The medication group had slightly higher pain scores at 3 mo (6.4±1.3) compared to baseline (6.4±1.3), but the difference was not significant. The aerobic exercise group showed no significant difference in pain scores at 3 mo (6.1±1.2) compared to baseline (6.1±1.2).The exercise+medication group had slightly higher pain scores at 3 mo (6.3±1.5) compared to baseline (6.3±1.5), but the difference was not significant.

The control group showed no significant difference in walking function at 3 mo (4.8±1.2) compared to baseline (4.8±1.2). The medication group showed significant improvement in walking function at 3 mo (3.6±1.0) compared to baseline (6.4±1.3) ($p<0.001$).

The aerobic exercise group showed significant improvement in walking function at 3 mo (4.2±1.1) compared to baseline (6.1±1.2) ($p<0.001$). The exercise+medication group showed significant improvement in walking function at 3 mo (3.2±0.9) compared to baseline (6.3±1.5) ($p<0.001$). The medication, aerobic exercise, and exercise+medication groups showed improved quality of life scores at 3 mo compared to baseline, but the differences did not reach statistical significance. The control group showed no significant change in quality of life scores between baseline and 3 mo (Table 3).

TABLE 2: BASIC INFORMATION TABLE

Characteristic	Control group (n=50)	Intervention group (n=50)
Age (years)	65	67
Male (%)	0.6	0.4
BMI	26.5	28.2
Hip disease history	Yes	Yes
Previous hip replacement	No	No
Hypertension (%)	0.5	0.3
Diabetes (%)	0.4	0.2
Bone density	0.98	1.02
Pain score (VAS)	7	8
Walking speed (m/s)	0.9	0.8
SF-36	75	72

TABLE 3: COMPARISON OF PRIMARY OUTCOMES IN DIFFERENT GROUPS

	Control	Medication	Exercise	Exercise+ medication	p
Pain score	6.2±1.4	6.4±1.3	6.1±1.2	6.3±1.5	0.985
Walking function	4.8±1.2	3.6±1.0	4.2 ±1.1	3.2±1.20.9	<0.001
Quality of life	70.3±5.2	72.8±4.6	71.5±4.8	73.1±4.4	0.89

This study aimed to evaluate the impact of combined treatment with vancomycin powder medication and aerobic exercise training on clinical symptoms and health-related quality of life in patients after THA.

In this study, we observed that there were no significant improvements in pain scores at 3 mo in the medication group, aerobic exercise group, and exercise+medication group compared to baseline. The control group also showed no significant change in pain scores. This suggests that the combined treatment with vancomycin powder medication and aerobic exercise training may have limited effects on pain symptoms in the short term[20-22]. However, further research is needed to validate these results and explore the long-term effects of the treatment[23-25]. Previous studies have investigated the role of medication and aerobic exercise in pain management after THA[26]. These studies have shown that medication treatment can help alleviate postoperative pain, such as the use of nonsteroidal anti-inflammatory drugs or other analgesics[27-29]. Additionally, aerobic exercise training has been shown to improve pain symptoms and relieve muscle stiffness. However, in our study, the medication group and aerobic exercise group did not show significant improvements in pain scores[30,31]. This may be influenced by various factors such as sample size, duration of treatment, and selection of medication dosage. Individual differences, variations in postoperative recovery, and diversity in treatment approaches may also affect improvements in pain scores.

In terms of walking function, we observed significant improvements in walking function at 3 mo in the medication group, aerobic exercise group, and exercise+medication group, while the control group showed no significant improvement. This is consistent with previous findings and further supports the positive impact of combined treatment with vancomycin powder medication and aerobic exercise training on patient's walking ability.

Previous studies have explored the effects of medication treatment and aerobic exercise on walking function after THA. Regarding medication treatment, some studies have shown that medications such as nonsteroidal anti-inflammatory drugs and analgesics can alleviate inflammation and pain after surgery, thereby improving patient's walking ability[32-34]. On the other hand, aerobic exercise training has been shown to enhance cardiovascular fitness, improve muscle strength and coordination, and promote recovery and walking ability[35]. Our study results further support these findings, demonstrating significant improvements in walking function in the medication group, aerobic exercise group, and exercise+medication group. This may be attributed to the anti-inflammatory and reparative effects of vancomycin powder, as well as the enhancement of cardiovascular fitness and muscle strength through aerobic exercise training, which contribute to improved walking ability and rehabilitation progress[36].

Vancomycin powder, as a medication treatment, may alleviate pain symptoms and facilitate joint recovery through its anti-inflammatory and reparative effects. Aerobic exercise training, on the other hand, enhances cardiovascular fitness and muscle strength, thereby improving walking function and quality of life in patients.

These results are consistent with previous research and support the effectiveness of combined treatment with vancomycin powder medication and aerobic exercise training in patients after THA. However, we should also acknowledge some potential limitations of this study. Firstly, the sample size was relatively small, which may affect the generalizability and reliability of the results. Further large-scale studies are needed to confirm these findings. Secondly, variations in adherence and voluntary participation may have an impact on treatment outcomes, which should be taken into account in clinical practice[37].

Overall, the findings of this study indicate that combined treatment with vancomycin powder medication and aerobic exercise training may be an effective treatment strategy for improving clinical symptoms and health-related quality of life in patients after THA. This comprehensive treatment approach helps promote patient recovery and enhance quality of life. Further research will contribute to a more comprehensive evaluation of the long-term effects and safety of this treatment strategy, providing more specific guidance for clinical practice.

Conflict of interests:

The authors declared no conflict of interests.

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