■ ORIGINAL ARTICLES

The effects of bubble bath hydrotherapy on knee range of motion in patients who have undergone total knee arthroplasty

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ABSTRACT:

This study examined whether hydrotherapy performed in bubble baths improves knee range of motion in patients who have undergone total knee arthroplasty.

The subjects included 11 patients (two males and nine females) who underwent unilateral total knee arthroplasty. In this study, we measured knee range of motion test results pre- and post-bubble bath. The mean difference in range of motion test results obtained pre- and post-bubble bath showed the passive knee flexion range of motion of the involved limbs, the active knee extension range of motion of the involved limbs and the passive knee extension range of motion of the involved limbs to all significantly improve following hydrotherapy performed in bubble baths.

Key words: bubble bath, range of motion, total knee arthroplasty

INTRODUCTION

Patients undergoing total knee arthroplasty (TKA) experience pre- and post-surgical pain and a decreased range of motion (ROM) in the knees. Knee flexion ROM influences the activities of daily living, such as sit-to-stand movements [1)], removing socks [1)] and normal walking [1, 2)]. Therefore, rehabilitation to improve knee ROM is provided starting in early stages of recovery in patients who undergo TKA.

Therapeutic exercises to improve knee ROM involve ROM exercises performed on beds. However, ROM movements are more easily performed in water than on beds. Water buoyancy significantly reduces the contact forces and stress on weight-bearing joints, bones and muscles, while water pressure reduces injury swelling, while also increasing the blood circulation [3)]. Aquatic hydrodynamic resistance forces can be regulated during exercise by controlling the instantaneous kinematic conditions of the body and selecting appropriate resistive devices [3)]. Therefore, hydrotherapy is physiotherapy that can be easily performed even in the early postoperative periods.

Many studies [4-6)] have examined the effects of hydrotherapy movements, such as walking or performing squats in pools; however, few medical facilities have pools that are available for therapeutic purposes. Hydrotherapy includes exercises performed not only in pools, but also in bubble baths, Hubbard tanks or whirl pool baths. However, few reports have shown whether hydrotherapy performed in bubble baths, Hubbard tanks or whirl pool baths improves the ROM.

This study examined whether hydrotherapy performed in bubble baths improves the knee ROM in patients who have undergone TKA.

SUBJECTS

The subjects included 11 patients (two males and nine females) who underwent unilateral TKA. The mean ± SD age, height, body mass and body mass index of the patients were 76.9± 6.2 years, 151.1 ± 9.5 cm, 63.9 ± 12.9 kg and 27.1 ± 3.5 kg/m^2, respectively. The period of time that had elapsed since surgery for the subjects was 13.3 ± 1.9 days.

Seven patients underwent TKA of the right knee and four patients underwent TKA of the left knee.

All subjects gave their written informed consent.

Considering the potential risk of infection, all subjects started intervention after suture removal. In addition, we excluded any subjects with urinary incontinence and those whose physicians did not permit them to bathe.

METHOD

The intervention was a one day (10 minute) program consisting of active ROM exercises performed in a bubble bath. The active ROM exercise directed subjects to conduct a knee flexural extension repeatedly in succession for 10 minutes within the ROM of the knee.

The water temperature was maintained at 39.0 ℃. The hydrotherapy room temperature was set at a comfortable temperature for the patients, and it was left to their discretion. A hot water bath, ranging from 37℃ to 40℃, is recommended for the subjects to decrease pain and to increase soft tissue extensibility, because this temperature range has been shown to increase the temperature of subcutaneous tissue to within the range required to produce these effects [7)]. Therefore, we decided to set the water temperature at 39 ℃.

The bubble bath used was called “Elevate Bath” (Sakai Medical Care Co., Ltd.) (Figure). The patients were placed in a sitting position with the processus xiphoideus near the surface of the water.

The exercises were discontinued

immediately if the patients developed any negative side effects, such as dizziness or nausea.

Figure Elevate Bath

In this study, we measured knee ROM test results pre- and post-bubble bath. Active and passive knee ROM were measured with a goniomter immediately pre- and post-bubble bath. The measurement position was the dorsal position, and the basic axis and movement axis at the measurement was the thighbone and a fibula, respectively. Only one set of measurements was taken for each patient. The person who made the measurements was a physical therapist with more than 10 years of clinical experience and the same physical therapist measured all patients.

The patients received physical therapy, such as muscle strengthening exercise (e.g. quadriceps femoris muscle setting and straight leg raising), ROM exercise and walking exercise, in addition to the bubble bath, and there were no differences in the major physical therapy program among the patients.

This study compared knee ROM test results obtained pre- and post-bubble bath. The Wilcoxon signed-rank test was used for the statistical analyses. The results were defined as being statistically significant when the possibility of error (p) was less than 5%.

RESULTS

No patients showed any negative side effects to the bubble baths.

The results of a univariate analysis are shown in the Table. The mean difference in ROM test results obtained pre- and post-bubble bath showed the passive knee flexion ROM of the involved limbs, the active knee extension ROM of the involved limbs and the passive knee extension ROM of the involved limbs to all significantly improve following hydrotherapy performed in bubble baths.

Table Mean change scores in range of motion test for the pre- and post-bubble bath (n=11)

	pre-bubble bath	post-bubble bath	*P* value
Active knee flexion ROM of the involved limbs (degrees)	86.8±17.5	90.9±15.5	.066
Passive knee flexion ROM of the involved limbs (degrees)	90.9±15.9	96.4±15.7	.003
Active knee extension ROM of the involved limbs (degrees)	-10.9±10.2	-8.2±7.8	.034
Passive knee extension ROM of the involved limbs (degrees)	-10.9±10.2	-7.3±7.9	.011

For Wilcoxon signed- rank test, mean±SD is reported.

ROM: range of motion

DISCUSSION

This study examined whether hydrotherapy performed in bubble baths improves the knee ROM in patients who undergo TKA. Our findings demonstrated that bubble bath hydrotherapy improves the knee ROM in the involved limbs.

Giaquinto et al. [4] demonstrated that 40 minutes of walking after 20 minutes of passive exercise in special pools positively affects the WOMAC subscales, including pain, stiffness and function. Hydrotherapy programs consisting of manual resistance knee extension and flexion, 4- way straight leg raises, mini-squats and walking 800 feet are associated with significant ($p < 0.05$) increases in the knee ROM as shown in pre- and post-tests [5]. Therefore, many studies have indicated that hydrotherapy movements, such as walking or performing squats in pools are useful for improving ROM. The results of this study showed that hydrotherapy performed in bubble baths improves the passive knee flexion ROM of the involved limbs, the active knee extension ROM of the involved limbs and the passive knee extension ROM of the involved limbs. We conducted knee ROM exercises only in the bubble baths; however, our results showed improvements in the knee ROM similar to those observed with regular exercise therapy, such as walking or squatting in pools.

Bubble baths provide a generalized form of heat that permits the simultaneous treatment of multiple painful joints and muscles. The mechanical stimulation of the bubble bath promoted the increased vascular flow of the lower limbs and led to analgesia due to a micromassage effect [8]. Moreover, bubble baths eliminate the force of gravity, and the buoyancy of water is useful for minimizing stress on joints during ROM exercises. Additionally, warm water may encourage muscle relaxation, thereby reducing guarding around joints and enhancing movement, which enables movement through a larger ROM [9]. The findings of our study suggest that bubble bath hydrotherapy improves the knee ROM of the involved limbs.

Active knee flexion ROM of the involved limbs alone did not show any significant improvement post-bubble bath. Muscle strength and endurance have been found to decrease during the initial 30 minutes after the application of deep or superficial heating agents [10-12] . Therefore, we considered that the muscle output would decrease by the bubble bath due to the hyperthermia, and the active knee flexion ROM of the movement against gravity was found to have decreased.

Postoperative rehabilitation for patients who have undergone TKA requires that physical therapists perform exercises with patients in environments that provide ease of movement. Therefore, rehabilitation using bubble baths is useful for improving knee ROM in patients that have undergone TKA.

There are several limitations associated with the present study. Because this study included only a small number of subjects, it was not possible to perform adequate examinations. It is not apparent whether improvements in ROM associated with hydrotherapy are short-term or persist for long periods of time. It is therefore necessary to examine this issue in more detail in future studies.

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