Exercise Combined With Continuous Passive Motion or Slider Board Therapy Compared With Exercise Only: A Randomized Controlled Trial of Patients Following Total Knee Arthroplasty

Background and Purpose. The primary purpose of this randomized controlled trial was to determine which method of mobilization—(1) standardized exercises (SE) and continuous passive motion (CPM), (2) SE and slider board (SB) therapy, using an inexpensive, nontechnical device that requires minimal knee active range of motion (ROM), or (3) SE alone—achieved the maximum degree of knee ROM in the first 6 months following primary total knee arthroplasty (TKA). The secondary purpose was to compare health-related quality of life among these 3 groups. **Subjects.** The subjects were 120 patients (n=40/group) who received a TKA at a teaching hospital between June 1997 and July 1998 and who agreed to participate in the study. **Methods.** Subjects were examined preoperatively, at discharge, and at 3 and 6 months after surgery. The examination consisted of measurement of knee ROM and completion of the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index and the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36). **Results.** The 3 treatment groups were similar with respect to age, sex, and diagnosis at the start of the study. There were no differences in knee ROM or in WOMAC Osteoarthritis Index or SF-36 scores at any of the measurement intervals. The rate of postoperative complications also was not different among the groups. **Discussion and Conclusion.** When postoperative rehabilitation regimens that focus on early mobilization of the patient are used, adjunct ROM therapies (CPM and SB) that are added to daily SE sessions are not required. Six months after TKA, patients attain a satisfactory level of knee ROM and function. [Beaupré LA, Davies DM, Jones CA, Cinats JG. Exercise combined with continuous passive motion or slider board therapy compared with exercise only: a randomized controlled trial of patients following total knee arthroplasty. *Phys Ther.* 2001;81:1029–1037.]

Key Words: *Continuous passive motion, Functional outcome, Randomized controlled trial, Rehabilitation, Total knee arthroplasty.*

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Total knee arthroplasty (TKA) surgery is a common orthopedic surgery performed to reduce pain and improve function in degenerative knee joints of geriatric populations. Because patients who receive joint arthroplasties are now being discharged from the hospital at an earlier stage in their recovery, a focus of rehabilitation is mobilizing the patient and regaining range of motion (ROM) in the knee. Because restricted knee ROM affects functional activities, knee ROM is still considered to be one of the primary indicators of a successful TKA.[1–4]

Continuous passive motion (CPM) machines are frequently used to increase knee ROM after a TKA and to promote a rapid postoperative recovery. Many clinical trials have been conducted on the efficacy and effectiveness of CPM for regaining ROM after surgery, but the results are contradictory. Some trials have shown that early postoperative knee ROM is improved with the addition of CPM,[5–11] whereas other studies have demonstrated no difference.[12–17] The variability seen with these results is, in our view, most likely the result of variation in the postoperative CPM protocols, sample sizes, and rigor of study design. The investigators in these studies, however, all concluded that the use of CPM did not affect the long-term knee ROM attained by 6 months after the operation.[5–17]

Although there are no long-term physical benefits from using a CPM machine, research findings suggest that knee flexion returns more rapidly and that fewer knee manipulations under anesthesia are required with the use of CPM.[6,10] Although CPM may improve ROM during the initial postoperative phase, there are a few disadvantages associated with its use. First, patients must remain in bed while the machine is being used. Bed rest is contrary to current practice in which rehabilitation centers focus on mobilizing the patient in preparation for hospital discharge. Second, studies showing early gains in knee ROM had protocols requiring up to 20 hours of daily use of a CPM machine, which does not appear to be realistic or cost-effective.[10,12,13] Third, additional technical and nursing support are required to operate CPM machines, because patients are dependent on health care personnel to set up the device. A fourth disadvantage is the expense incurred with the purchase and regular maintenance of the machines.

The slider board (SB) is a simple and less expensive device that was developed at a rehabilitation hospital by a group of physical therapists and an engineer in the early 1990s as an alternative to CPM machines. The device consists of a movable heel-cup fixed to a low-friction sliding mechanism that allows patients to flex and extend their lower extremity with minimal active movement of the quadriceps femoris and hamstring muscles (Figure). Its developers believed that the SB would offer similar benefits to CPM in this patient population while encouraging patients to actively participate in their rehabilitation. Because the SB provides low friction, only a minimal amount of active quadriceps femoris and hamstring muscle action is required to use it, and we believe that early use of the muscles should be advantageous to recovery. In addition, the SB can be used independently in either the supine or sitting position and requires no technical maintenance and mini-

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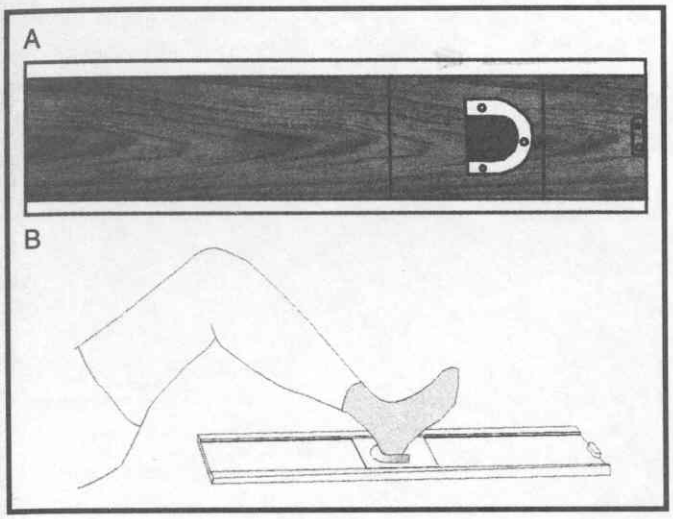

Figure.
Diagram of slider board. The slider board consists of a movable plate with a heel cup affixed to a board by low-friction polyethylene runners. (A) Superior view of slider board, (B) lateral view of slider board.

mal nursing support. Currently, no literature is available regarding the efficacy or effectiveness of the SB.

We believe that the short-term benefits of the SB are similar to those of CPM. We use the SB instead of CPM machines at our facility following TKA because the physical therapists and surgeons believe this device costs less to use. The SB has been used at our facility for approximately 4 years.

As both CPM machines and the SB were designed to improve knee ROM, goniometric measurements will provide an indication of the effectiveness of these 2 interventions. Knee ROM is directly related to function, as a minimum of 65 degrees of knee flexion is needed for walking and up to 105 degrees of knee flexion is required for tying shoelaces.[4,18]

In addition to determining which of the 2 adjunct ROM therapies was most effective, another goal of this study was to determine whether ROM therapy in addition to daily standardized exercise (SE) sessions was necessary to attain a higher level of recovery at 6 months following surgery.

The primary goal of our study was to determine whether CPM or SB therapy in addition to SE was more effective in increasing knee ROM within the first 6 months following a first-time or primary TKA than SE alone. Three treatment groups of patients who underwent a primary TKA were created. The first group received CPM and SE (CPM group), the second group received SB therapy and SE (SB group), and the third group received SE only (control group). The secondary purpose of this study was to determine whether there was a difference among these 3 groups in (1) joint-specific pain, stiffness, and function and (2) generic health status up to 6 months after surgery.

Our hypotheses were:

(1) Patients who use SB therapy with SE will attain similar knee ROM as those patients who use CPM with SE within the first 3 months after surgery.

(2) Patients who use either the SB or CPM as an adjunct to SE will attain greater knee ROM than SE alone in the first 3 months after surgery.

(3) Generic health status and knee ROM, pain, stiffness, and function will be similar for all 3 groups at 6 months after the operation.

Method

Design

The study design was a single-blinded, randomized controlled trial.

Subjects

A consecutive sample of patients who received a primary TKA at a hospital in Edmonton, Alberta, Canada, that completes an average of 400 to 500 TKAs annually was assembled between June 5, 1997, and July 17, 1998. Subjects were eligible for the study if they were scheduled for a primary TKA and were able to return for the postoperative visits. Patients undergoing revision knee surgery or receiving a unicondylar knee replacement were excluded from the trial. Twelve surgeons referred subjects.

Subject demographics are presented in Table 1. The mean age was 68.4 years (SD=8.6). Among the participants, 92% (n=109) had a diagnosis of osteoarthritis, and 56% (n=53) were women. Sixty-five percent (n=79) of the participants had no comorbidities. Sixty-one of the 120 participants had no other joint involvement (51%), whereas 9 participants had 3 or more arthritic joints (7.5%). The distribution of other arthritic joints was not different among the 3 treatment groups.

Of the 120 participants in the study, 17 subjects were lost to follow-up. An additional 10 patients were unable to return for the follow-up visits after discharge, but completed the questionnaires by telephone. The analysis of the subjects lost to follow-up for age, sex, diagnosis, and baseline measurements revealed no differences from the participants in this study. .

Table 1.
Subject Characteristics

Variable	Control Group (n=40)			SB Group (n=40)			CPM Group (n=40)			
	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range	P
Age (y)	69	8	50–84	68	9	39–83	68	9	43–84	.09[a]
	n	%		n	%		n	%		P
Female sex	12	30		20	50		21	52.5		.09[b]
Diagnosis of osteoarthritis (OA)	36	90		38	95		35	87.5		.50[b]
No comorbid conditions	28	70		22	55		29	73		.36[b]
≥1 other joints with OA	18	45		22	54		19	48		.72[b]

[a] Analysis by one-way analysis of variance.
[b] Analysis by chi-square analysis.

Procedure

Enrollment. When subjects attended the preadmission clinic (PAC) 1 month prior to surgery, they were asked to participate in the study. Upon agreement, written informed consent was received from all participants. Following completion of the assessment and all questionnaires, subjects were randomly assigned to 1 of the 3 treatment groups: the CPM group, the SB group, or the control group.

Randomization. Randomization was computer-generated in blocks of 30. Randomization codes were kept in sealed envelopes with consecutive numbering. Subjects were enrolled sequentially at the end of the enrollment visit.

Protocol. Subjects were examined preoperatively at the PAC, 5 to 7 days following surgery, and at 3 and 6 months after surgery. During each session, knee active ROM was measured by a research physical therapist who was unaware of the subject's group assignment. At the preoperative and the 3- and 6-month examinations, subjects completed a self-reported disease-specific questionnaire—the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index—and a generic health measure—the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36). Data regarding demographics, comorbidities (cardiovascular, renal, endocrine, neurological, and hepatic systems and other arthritic joints), and in-hospital complications were also collected from the medical charts.

Postoperative management. All subjects followed the institution's standardized clinical pathway for TKA that included medical, pharmaceutical, and rehabilitation care over a 5- to 7-day acute care hospital stay. The goal of the clinical pathway is to prepare patients for discharge from the hospital 5 to 7 days after surgery. Early mobility is encouraged throughout the hospital stay.

Immediately after the operation, a Jones bandage, which maintains the lower extremity in extension, was applied to the knee and remained *in situ* until the second postoperative day when the hemovac drain was removed from the knee joint. Subjects were allowed to sit during the first postoperative day, and they progressed to walking short distances on the second postoperative day.

The SE sessions commenced on the third postoperative day for subjects in all 3 groups. The SE sessions included walking within parallel bars or with a walker or crutches to each subject's tolerance. Knee active ROM exercises were performed in a sitting or lying position using the SB for 10 to 15 minutes at the subject's preferred rate of movement. In addition, short-arc quadriceps femoris muscle exercises without resistance and isometric knee extension exercises were done. Subjects attempted to complete 3 sets of exercises at 10 to 15 repetitions each. Straight leg raises without resistance and instruction in stair climbing were started 4 days after the operation. Ice was applied before and after treatment each day. The exercise sessions lasted 30 minutes on average, excluding the application of ice before and after exercise.

Intervention. Following hemovac removal, which occurred on the second postoperative day, CPM and SB therapy commenced. The CPM group received three 2-hour sessions with the CPM machine each day. The starting range was 0 to 30 degrees, and the range of movement was increased as tolerated. Ward nurses recorded adherence to CPM use in logs. The CPM group participated in an average of 1.8 sessions (SD=0.6, range=0.5–3.0) per day for an average time of 1.7 hours (SD=.05, range=0.75–2.8) per session. The most commonly missed session was the morning session (61%) when subjects typically provided self-care and received daily SE sessions and any routine radiology or laboratory tests.

The SB group was asked to perform a minimum of two 10-minute sessions per day in addition to the SB session during the daily SE session. Active knee flexion and extension in both sitting and lying positions were performed independently to patient tolerance. The SB group participated in an average of 1.7 sessions (SD=0.3, range=1–3) per day for an average time of 16.0 minutes (SD=5.0, range=7–27) per session. The SB group completed logs describing SB use with the assistance of ward nurses and the treating physical therapists.

Postdischarge rehabilitation. Prior to their discharge from the acute care institution, all subjects who were discharged directly home had physical therapy appointments scheduled either with a home care provider or in the community. Subjects who were transferred to other institutions received further therapy at the subacute care facility. Similar numbers of subjects from each group were discharged home or transferred to other facilities.

Measurement

The research physical therapist measured the active ROM of the knee in flexion and extension to the nearest degree using a large standard universal goniometer. Previous authors[19,20] have reported the reliability and validity of goniometric measurements of the knee. Rothstein et al,[20] in a clinical setting, found intratester reliability (r) of knee goniometric measurements to be .91 to .99. Intertester reliability was slightly lower for knee flexion (r=.88–.97) and moderately lower for knee extension (r=.63–.70). The same examiner did all preoperative, 3-month, and 6-month evaluations. All discharge evaluations were performed by a different examiner. Thus, the variability seen between the 3 treatment groups should have been minimally affected by the interobserver measurements, as one person performed all measurements at each assessment. Knee ROM measurement was done with the subject lying supine for both knee extension and flexion.

The WOMAC Osteoarthritis Index, which was designed to measure disability of the osteoarthritic hip and knee, has 3 subscales: pain (5 items), function (18 items), and stiffness (2 items). Each of the 25 questions is answered using a 5-point Likert scale. Three subscale scores are obtained by adding the items in the respective subscale. Data for reliability, internal consistency, and validity have been reported in clinical trials of anti-inflammatory drugs as well as in hip and knee arthroplasty studies.[21–23] In addition, previous researchers[24] concluded that a 10-point difference in WOMAC Osteoarthritis Index scores indicates that a clinically important difference is present.

The SF-36, a 36-item generic health measure, was used to determine overall health status. Eight dimensions were measured: bodily pain, physical function, role limitations due to physical function, general health perceptions, emotional health, role limitations due to emotional health, social function, and vitality. The validity and reliability of measurements obtained with the SF-36 have been extensively tested in this patient population.[25–28]

Because a profile of 8 dimensions may be difficult to interpret when the effect varies across all dimensions, 2 summary scores were developed for the SF-36.[29] The physical component summary and the mental component summary were calculated from the 8 dimensions and were standardized using norm-based methods. Summary scores describe the overall changes but do not capture the smaller changes within the specific domains. Because there is no global score for the SF-36, results are presented for each dimension and the 2 component summary measures.

Statistical Analyses

Summary statistics for the 3 treatment groups were calculated for knee ROM, the WOMAC Osteoarthritis Index, and the SF-36. Active knee flexion and extension measurements were analyzed with respect to treatment group. Chi-square tests were used for analysis of categorical data, and a one-way analysis of variance (ANOVA) was used for continuous data to determine differences among the 3 treatment groups. A repeated-measures ANOVA was used for knee ROM over the 4 measurement intervals. When differences were identified, Bonferroni *post hoc* testing was performed to determine differences between group pairings.

The WOMAC Osteoarthritis Index and SF-36 scores were transformed to scores ranging from 0 (worst) to 100 (best) to aid comparison between these scales.[30] In addition to examining statistical significance, we decided *a priori* that differences between groups on the WOMAC scale had to be a minimum of 10 points to attain a clinically significant difference.[24] A repeated-measures ANOVA was also used to analyze the WOMAC Osteoarthritis Index and SF-36 scores because these data were normally distributed.

For subjects who missed the 3-month follow-up, the outcome values from their last examination and the 6-month follow-up were averaged, whereas, for those subjects who missed the 6-month follow-up, the 3-month value was imputed for the 6-month measurement.

All analyses were performed on an "intent-to-treat" basis[31]; that is, all subjects were analyzed in their assigned groups. Five subjects, 4 from the control group and 1 from the SB group, were reassigned by their respective surgeons to the CPM group because of poor knee ROM. In a subgroup analysis, these 5 subjects did not have less ROM at discharge than the other partici-

Table 2.
Mean Knee Extension and Flexion (in Degrees)[a]

Assessment Interval	Control Group					SB Group					CPM Group				
	Extension		Flexion			Extension		Flexion			Extension		Flexion		
	$\bar{X}$	SD	$\bar{X}$	SD	n	$\bar{X}$	SD	$\bar{X}$	SD	n	$\bar{X}$	SD	$\bar{X}$	SD	n
PAC	−5	6[b]	112	15[b]	40	−8	5[b]	114	15[b]	40	−6	5[b]	115	16[b]	40
Discharge	−8	4	65	13	40	−8	4	62	17	40	−8	4	61	14	40
3 months	−3	6	91	11	32	−4	3	96	14	28	−4	4	94	11	33
6 months	−2	5	94	21	32	−2	3	96	22	28	−4	4	98	13	33

[a] Two-way analysis of variance for repeated measures (F=4, *df*=2) showed no difference in knee extension (*P*=.30) or knee flexion (*P*=.69) among the 3 groups over the 6-month measurement interval. PAC=preadmission clinic.
[b] One-way analysis of variance showed no differences in knee range of motion at baseline among the 3 groups (*P*=.86).

Table 3.
Scores on Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index by Group Over Time

Subscale	PAC[a]						3 Months						6 Months						
	Control Group (n=39)		SB Group (n=40)		CPM Group (n=38)		Control Group (n=34)		SB Group (n=32)		CPM Group (n=34)		Control Group (n=34)		SB Group (n=32)		CPM Group (n=34)		
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	*P*[b]
Pain	51	15	46	13	47	14	73	18	75	19	73	17	79	16	85	15	76	15	.62
Stiffness	49	18	50	22	44	15	62	18	63	21	63	18	69	19	73	19	65	21	.38
Function	53	15	41	13	51	14	72	17	72	17	73	13	77	18	81	15	74	15	.71

[a] One-way analysis of variance showed no difference at baseline among the 3 groups of pain (*P*=.20), stiffness (*P*=.38), or function (*P*=.64).
[b] Analysis by 2-way analysis of variance for repeated measures (F=3, *df*=2).

pants. Moreover, when these subjects were compared with the other 115 participants, their baseline demographics or outcome measurements were not different.

The power of the statistical analysis was calculated from the standard deviation of the preoperative knee flexion ROM of 12 to 18 degrees.[5,10] Based on a Cohen's medium effect size of 0.30, a level of significance of .05, and a power of 80%, a sample size of 120 participants was required in order to detect a difference of 5 degrees in knee ROM among the groups. Knee ROM was chosen as the primary outcome to be examined because it is considered a hallmark of success for a TKA and has important implications for functional recovery following a TKA.[3,4] Because large effect sizes have been reported for the use of health-related quality-of-life measures in people with TKAs,[32] the power analysis based on knee ROM with only a medium effect size is more conservative than one based on the health status measures.

All statistical tests were 2-tailed at a level of significance of .05. Statistical analyses were performed using the SPSS software version 7.5.*

Results

Knee ROM

Table 2 shows the mean active flexion and extension knee ROM over the 4 measurement intervals. All groups were similar in knee ROM when the study began. No differences in flexion or extension were seen among the 3 groups over the 6-month interval when analyzed using a 2-way ANOVA for repeated measures. Participants across all 3 groups demonstrated a similar pattern of knee ROM return during the 6 months.

WOMAC Osteoarthritis Index

No mean group differences were seen when the study began for pain, stiffness, and function when compared using a 1-way ANOVA. Using a 2-way ANOVA for repeated measures, no difference over time among the 3 groups was detected in any of the 3 subscales (Tab. 3).

SF-36

No differences among the treatment groups were seen in any of the 8 dimensions or the component summary scores when the study began or at any of the postoperative follow-up examinations when analyzed using a 2-way ANOVA for repeated measures (Tab. 4).

* SPSS Inc, 444 N Michigan Ave, Chicago, IL 60611.

Table 4.
Scores on Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) by Group Over Time[a]

	PAC[b]						3 Months						6 Months						
	Control Group (n=40)		SB Group (n=40)		CPM Group (n=39)		Control Group (n=34)		SB Group (n=32)		CPM Group (n=36)		Control Group (n=34)		SB Group (n=32)		CPM Group (n=36)		
Dimension	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	P[c]
Bodily pain	35	16	37	15	35	13	55	22	49	20	56	18	64	22	59	21	57	19	.80
Physical functioning	31	22	31	19	31	15	45	20	45	21	46	18	55	27	53	24	46	20	.79
Role physical	16	30	26	38	18	30	28	41	36	41	19	26	43	40	51	43	40	40	.12
General health	73	23	75	17	73	17	69	19	68	19	69	21	70	22	72	18	73	21	.94
Mental health	72	24	75	20	74	20	74	19	78	18	79	17	79	19	79	20	83	13	.71
Role emotional	73	42	62	46	62	44	81	34	61	38	68	41	84	32	86	31	73	39	.13
Social function	59	27	68	26	67	26	69	24	71	25	75	23	79	25	79	28	81	22	.53
Vitality	49	25	50	21	45	20	56	17	59	19	53	20	59	21	65	19	60	18	.33
PCS	29	8	30	7	29	6	34	9	35	9	34	7	38	10	38	10	36	10	.59
MCS	53	12	53	13	53	13	55	9	53	11	54	10	56	9	57	10	57	8	.99

[a] PCS=physical component summary, MCS=mental component summary.
[b] One-way analysis of variance showed no difference at baseline among the 3 groups in any of the 8 dimensions or the summary scores ($P>.05$).
[c] Analysis by 2-way analysis of variance for repeated measures ($F=3$, $df=2$).

Discussion

Our study was the first randomized controlled trial to compare the effectiveness of CPM and SB therapy added to routine SE in patients who received a TKA. Our findings suggest that the addition of either CPM or the SB to daily SE sessions is not warranted in the postoperative rehabilitation after a TKA when an early postoperative rehabilitation regimen is followed. Subjects who received daily SE sessions (ie, the control group) attained similar knee movement and reported similar pain, function, and health-related quality of life outcomes at 3 and 6 months as those subjects who received the CPM or SB. These findings agree with those of previous studies of long-term follow-up to CPM use for rehabilitation after a TKA.[9–12,14–18]

The knee ROM attained in all 3 treatment groups at 3 and 6 months was similar to that found in other studies.[9,12,14] Researchers who have reported favorable knee ROM with the use of CPM had protocols that required longer daily use and longer average hospital stays than we did.[5,6,10,12,14] In our study, use of the CPM was within the recommended length of time for attaining treatment benefits of 3 to 5 hours per day.[16]

Although some researchers instituted CPM immediately after the operation, we did not use the CPM until the second day after surgery. The use of CPM immediately after the operation was not possible at our facility because the mobilization regimen we use is designed to encourage mobility rather than bed rest. Because there were no differences among the treatment groups in terms of outcomes, we question the use of the CPM machines. We selected the SB as an adjunct therapy because it was thought to provide similar results to the CPM and yet permit the subject to perform the therapy independently. Although knee ROM at time of hospital discharge was less than that found in other studies, we had reached an expected level of knee ROM at 3 and 6 months after the operation.

Complication rates were no different among the 3 treatment groups. Twenty subjects experienced in-hospital complications, with 14 of these complications directly related to the knee joint that was replaced. Four complications were reported within the CPM group (1 hematoma, 1 erythema [hot, red, swollen knee], and 2 cases of increased knee joint swelling [warm, swollen knee]), 6 within the SB group (4 distal deep venous thromboses, 1 hematoma, and 1 mild infection), and 4 within the control group (2 cases of increased hemovac drainage, 1 hematoma, and 1 mild infection). The remaining 6 complications were cardiovascular complications (4), postoperative confusion (1), and a pulmonary embolism (1).

Within 6 months after hospital discharge, 5 patients reported complications directly related to the knee joint replacement. Two subjects, one from the SB group and one from the CPM group, required manipulation of the knee because of limited knee flexion at 3 months after the operation. One subject from the SB group had a deep venous thrombosis that required anticoagulation therapy. The control group had one subject with cellulitis of the knee and one subject with an infection managed by oral antibiotics.

Although other authors have suggested that not using CPM may result in poor knee flexion and subsequent need for interventions such as manipulations under anesthesia,[10,12] our findings did not support this assertion. Although only

the SB group reported distal deep venous thromboses, this rate is usual in patients receiving TKAs, even with routine use of anticoagulation therapy.[33]

A primary limitation of our study was that all subjects, regardless of the group, received one session of approximately 15 minutes of SB use during their daily exercise session. It is unlikely, however, that one daily session would have had a meaningful effect on a subject's recovery of knee ROM. We believed that any benefits that were due to the use of the SB as an adjunct therapy within the subject's room were likely masked by the overall effect of a postoperative mobilization regimen that encourages knee active ROM during activities of daily living.

A high proportion of subjects, regardless of adjunct CPM or SB use, reported pain relief (96%) and functional gains (82%) at 6 months. It is likely this patient cohort was representative of this patient population, as our findings are similar to the large gains found in previous hospital and community-based cohort studies of patients receiving a TKA.[34,35] The results are also congruent with the results reported in a meta-analysis of smaller studies examining TKA.[36] Favorable outcomes reported in the systematic review of 130 studies occurred in approximately 90% of patients.

Conclusion

Findings from our study showed that subjects who received CPM, SB therapy, or SE did not differ in terms of knee flexion at the time of hospital discharge or at 3 and 6 months after the operation. Self-reported pain, function, or overall quality of life was also not different at either of the postoperative measurement times. Those patients who receive a TKA typically have improvements in knee ROM, pain, function, and overall quality of life after surgery regardless of receiving CPM or SB therapy as an adjunct to daily SE sessions. Our study did not support our *a priori* hypotheses, because the adjunct ROM therapies did not alter the postoperative recovery of knee ROM.

We believe that it is difficult to justify the use of adjunct ROM therapy in addition to daily SE sessions when early mobilization regimens are being followed. As hospital stays are shortened, the rehabilitation of patients with TKA is directed toward preparing for discharge. For the physical therapist, we believe that the rehabilitation for patients recovering from a TKA should emphasize active knee movement rather than passive therapy to promote functional independence from the time of treatment initiation.

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