Strength Exercises in Patients who will undergo Knee Arthroplasty via Fast-track Surgery: a randomised controlled study

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Summary

Background: One of the most frequent musculoskeletal and degenerative disorders in adulthood and that produces greater disability is knee ostearthritis; this injury produces greater disability and the solution in severe degrees is knee arthroplasty (TKA). In hospital MAZ, TKA is perfomed with the Fast-track a protocol allows patients to move as quickly as posible and whitout any complications. After the ATR, reductions of muscular strength appear, and with the loss of muscular mass associated with age, the risk of disability increases and that is why recovering musular strength is an important goal for orthopedic surgeons and specialists in rehabilitation.
Objective: The purpose of this study was to evalue the effectiveness of a simple resistance exercise program with elastics bands in patients who are going to unergo TKA usin Fast-track surgery.
Material and method: 48 patients scheduled for TKA in the first half of 2021 participated in this randomized controlled trial. A control group that performed the exercises according to the protocol established in the hospital and the intervention group that also performed exercises with elastic bands. The two groups performed the exercises one month before and after surgery and while the investigation lasted. A pain, stiffness and functional capacity were assessed with questionnaire WOMAC (Western Ontario and McMaster Universities) and the SPPB frailty screenung test battery (Short Physical Perfomance Battery). Handgrip strength, the thigh circumference and the body mass index (BMI) was also mesasured. All of this was evaluated in three times: one month before surgery (T1), fifteen days (T2) and one month (T3) after surgery.
Results: Both the intervention group and the control group obtained statistically significant improvements in the evaluations of WOMAC questionnaire and SPPB tests al 15 days and one month after surgery although the group that did resistance exercises with elastic bands obtained better results. Therre were no significant differences in handgrip strength, thigh circumference or BMI.
Conclusion: A pre and postoperative TKA resistance exercise program with elastic bands improves the effectiveness of the traditional program, reducing pain and stiffness, improving functional capacity, balance and gait speed and therefore autonomy and quality of life.

Key words:
Knee. Knee arthroplasty. Aging. Fast-track. Resistance training. Elastic bands.

Ejercicios de fuerza en pacientes que van a ser intervenidos de artroplastia de rodilla mediante cirugía *"Fast-track"*: un estudio aleatorizado controlado

Resumen

Antecedentes: Uno de los trastornos musculoesqueléticos y degenerativos más frecuente en edad adulta y que produce mayor discapacidad es la osteoartrosis de rodilla cuya solución en grados severos es la artroplastia de rodilla (ATR) que es una de las intervenciones más habituales en los últimos años. En el Hospital Mutua de Accidentes de Zaragoza (MAZ) se realiza con protocolo *"Fast-track"* que permite que los pacientes se movilicen lo más rápido posible y con pocas complicaciones. Inmediatamente después de la ATR aparecen importantes reducciones de la fuerza muscular y junto con la pérdida de masa muscular relacionada con la edad, aumenta el riesgo de discapacidad y es por ello qué recuperar la fuerza muscular es un objetivo importante.
Objetivo: El propósito de este estudio fue evaluar la efectividad de un programa de ejercicios de fuerza con bandas elásticas en pacientes que van a ser intervenidos de artroplastia total de rodilla (ATR) mediante cirugía *"Fast-track"*.

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Material y método: 48 pacientes programados para ATR en el primer semestre del 2021 participaron en este ensayo aleatorizado controlado. Un grupo control que realizaba los ejercicios según protocolo establecido en el hospital y el grupo intervención realizaba además unos ejercicios con bandas elásticas, un mes antes de la cirugía y un mes después de la misma, mientras duró la investigación. Se evaluó el dolor, la rigidez y la capacidad funcional mediante el cuestionario *Western Ontario and McMaster Universities* (WOMAC) y se hicieron la batería de pruebas de cribado de fragilidad SPPB *(Short Physical Performance Battery*) en tres momentos: Un mes antes de la cirugía (T1), quince días después de la cirugía (T2) y al mes de la intervención (T3). También se midió la fuerza de agarre manual en ambas extremidades superiores, el perímetro de muslo (tanto en la pierna que iba a ser intervenida como en la sana) y el Índice de masa corporal (IMC) en las tres evaluaciones.
Resultados: Tanto el grupo intervención como el grupo control obtuvieron mejoras estadísticamente significativas en las evaluaciones del cuestionario WOMAC y pruebas SPPB a los 15 días y a mes de la cirugía si bien el grupo que hizo ejercicios de fuerza con bandas elásticas obtuvo resultados mejores estadísticamente significativos. No hubo diferencias significativas en la fuerza de agarre manual, en el perímetro de muslo ni en el IMC.
Conclusión: Un programa de ejercicios de fuerza pre y postoperatorio de ATR con bandas elásticas mejora la eficacia del programa tradicional, disminuyendo el dolor y rigidez, mejorando la capacidad funcional, equilibrio y velocidad de la marcha y por lo tanto su autonomía y calidad de vida.

Palabras clave:
Rodilla. Artroplastia. Envejecimiento. "Fast-track". Entrenamiento fuerza. Bandas elásticas.

Introduction

One of the most common musculoskeletal and degenerative disorders occurring in adults and causing the greatest disability is knee osteoarthrosis (OA)[1,2]. Patients with knee OA suffer constant pain and functional disorders that often make their day-to-day life impossible[3]. Knee arthroplasty or knee replacement surgery (TKR) to reduce the pain and recover functionality is the most effective and most common treatment in severe cases of OA[4]. A prosthetic knee is a mechanical device consisting of various metal and plastic components that replaces the knee joint formed by the tibia and femur. This prosthesis will relieve the pain and improve function in the majority of patients with degenerative disease in this joint[5,6]. The number of knee arthroplasty surgeries in Spain has risen sharply in recent years, as well as in other countries in the same peer group, given that the indication criteria have broadened due to an ageing population and because it is an effect surgery. As a result, there are greater expectations and higher demand for this surgery among patients[7]. This changing situation has led to various studies demonstrating that it is one of the most common interventions in recent years[8]. In Spain, the number of prostheses has risen from 12,500 in 1995 to 25,000 in 2000[9]. There is no national register of knee arthroplasties at present, although work is being done in this regard[10]. However, according to data from the Spanish Federation of Healthcare Technologies (FENIN), approximately 35,000 prostheses were implanted in 2014 and, according to the most recent arthroscopy conference, this figure reached 60,000 in 2019. Considering the progressive ageing of the population, it is estimated that the number of these surgeries will increase significantly in the coming years.

At the Mutua de Accidentes de Zaragoza Hospital (MAZ), knee replacement surgery is undertaken using a "Fast-track" procedure[11]. This concept was introduced by professor Henrik Kehlet and is defined as any surgery that involves a multi-disciplinary team (traumatologist, anaesthesiologist, nursing staff, rehabilitation doctor and physiotherapist) and the treatment concepts of which, based on evidence, enable patients to mobilise as quickly as possible[12] and with few complications[13]; the patient being the most important part of the programme. The major principles of this procedure are listed below:

- The use of tranexamic acid: Therapy with tranexamic acid in knee arthroplasty reduces blood loss and minimises the need for a transfusion without increasing the risk of thrombosis or embolism[14].
- Administration of corticosteroids such as dexametasone (20 mg) or methylprednisolone (125 mg) for beneficial effects without negatively impacting the infection rate or increasing complications[15].
- A urinary catheter is unnecessary, as it is associated with more complications, a more prolonged stay in hospital, higher costs and a higher readmittance rate at 30 days[16].
- Surgery with intradural anaesthesia and, at MAZ, with ischaemia; i.e. without using a tourniquet: existing literature has demonstrated that no ischaemia reduces blood loss and also reduces post-operative inflammation[17], shortening the operation and guaranteeing a better cementation result.
- There is no intra-articular drainage: A femoral catheter was used for a long time and is still used today in some procedures as a treatment for pain after implanting a knee prosthesis[11], providing good treatment for the pain but not allowing for active mobilisation. Instead of a drain, the recommended treatment for pain is multimodal therapy with local infiltration analgesia (LIA) of the capsule and soft tissues with local anaesthetics (a total of 170 ml solution of ropivacaine at 0.2% sometimes accompanied by adrenaline and local anaesthetic) and application of a certain dressing in the operating theatre plus a compression bandage[18]. This minimises dressing changes and, therefore, handling of the wound. The patient can also shower without a problem the day after the operation.
- Early mobilisation stemming from early discharge, enabling faster and more effective recovery than the conventional protocol[19]:

Two hours after the operation, the patient is already performing active exercises and can walk with a walker. Early mobilisation en courages patient autonomy, conveys the immediate success of the operation and, as a result, eliminates fears and concerns[20] and also acts as an effective thrombosis prophylaxis[21].

One very important and key part of this programme is the information provided to the patient. Candidate patients for the programme attend an informative session, which is also referred to as preoperative education, that seeks to improve knowledge and the health results in patients[22]. Recent literature shows that offering an informative session to patients about the protocol to be followed before the surgery means they experience less anxiety, greater control of postoperative pain and greater understanding of their surgery[23], and the clinical protocols included in that preoperative education programme for knee replacement lead to shorter stays in hospital[24,25] and lower healthcare costs[26]. Those informative sessions deal with issues relating to the type of surgery, the chosen anaesthesia, the medication before and after, and exercises are explained and demonstrated for patients to do at home before the surgery. Several studies show that preoperative training programmes improve postoperative results in terms of pain and function[27,28]. These sessions are also attended by a family member acting as "coach" and this person will be the one encouraging and supervising the daily exercises at home. They are essential for obtaining successful results after the surgery[29]. Strong importance is placed on the patient as the centre of the process and they are involved in their own rehabilitation. It is important to use simple language to ensure optimal understanding of what is discussed[30] and to provide simple educational material with illustrations that will help that better understanding while minimising anxiety and improving results[31].

Furthermore, it is known that muscle strength reductions of up to 60%[32] appear after TKR that, together with the loss of muscle mass related to age, increases the risk of disability[33]. Quadricep strength and function is highly important in ensuring the success of the intervention[34]. Evidence shows that patients who undergo a knee arthroplasty operation obtain better results if they strengthen the musculature of both legs before the surgery via a programme of exercise[35]. In fact, it is believed that preoperative quadricep strength is a strong indicator of functional performance one year after the TKR[36], so recovering muscle strength is an important goal for orthopaedic surgeons and rehabilitation specialists[37].

In light of the above, the purpose of this study is to evaluate the effectiveness of a simple home-based pre- and postoperative strength training programme using elastic bands in patients awaiting TKR. Elastic bands were chosen for their ease of use, accessibility and low cost[38].

Hypothesis

The hypothesis was made that a specific strength exercise programme using elastic bands performed before and after knee arthroplasty leads to a postoperative improvement when compared with the control group (which engages in the exercises established for the current protocol).

Material and method

Design of the study

A controlled and randomised trial was conducted to assess the postoperative period and the effectiveness of including a strength training programme with elastic bands in comparison with a control group engaging in mobility exercises and isometrics exercises. The intervention took place at the Traumatology service under the agreement between MAZ and the Spanish Social Security system. Those patients with stage 3 severe or very severe stage 4 knee arthrosis are proposed for arthroplasty, established according to the Ahlbäck classification system[39,40].

Informed consent was obtained from all patients and the study was initially approved by the ethics committee of the MAZ Hospital and by the Ethics and Research Committee of the Regional Government of Aragon (CEICA) under C.I. PI21/220.

The sample size consisted of 48 patients for convenience (surgeries scheduled during the study period).

Inclusion and exclusion criteria

Those patients who meet the criteria for inclusion in the knee arthroplasty protocol are recruited and given an appointment with a relative/companion to attend an informative session one month prior to the intervention, in groups of two patients.

Inclusion criteria

- Patients over 65 years of age who are scheduled to undergo a TKR.
- Patients: ASA (American Society of Anaesthesiologists) I (healthy patient), ASA II with one or more compensated medical pathologies (controlled high blood pressure, controlled diabetes *mellitus*, smoker, controlled asthma, stabilised chronic obstructive pulmonary disease, obesity, cardiac arrhythmia with normal average ventricular heart rate and with antiaggregate-anticoagulant) and ASA III (patient with one or more medical pathologies, with at least one of them catalogued as decompensated but with said decompensation not posing a risk to life).
- They must sign the informed consent tied to the protocol.

Exclusion criteria

- Patients ASA IV (pathology that poses a constant threat to life), ASA V (moribund patient who is not expected to survive without the operation) and ASA VI (brain-dead: organ donor).
- Under 65 years of age.
- Allergy to any of the drugs proposed during the course of the protocol or contraindication for the administration thereof: Tra-

nexamic acid, nonsteroidal anti-inflammatories), paracetamol, COX-2 inhibitors (cyclooxygenase), corticosteroids, tramadol, ropivacaine, pantoprazol, heparins, oral anticoagulants... although they may be included if these drugs can be replaced with others of a similar effect.
- Patients with significant anaemia (haemoglobin below 13 g/dl in both women and men) or with coagulation abnormalities (excluding drug-induced by oral anticoagulants).
- Refusal by the patient to take part in the study.
- Absence of family support.
- Simultaneous participation in another study.

Randomisation and blinding

The selected patients were randomly allocated to the intervention group or the control group in pairs following the theoretical part of the informative session by individually tossing a coin, with heads being the control group and tails being the intervention group. The patients were not informed about which group they were allocated to. The physiotherapist was the only person with this knowledge, who was also the researcher.

Procedure

The patients and their relative/companion were given an appointment to attend the informative session one month before the intervention, in groups of two, at the hospital. The sessions were held by the physiotherapist responsible for the rehabilitation protocol alongside the traumatologist and they took place on the floor of the hospital where arthroplasty patients are admitted, enabling the patient to familiarise themselves with the environment. The sessions are provided in groups so as to foster interaction with other patients with the same pathology, and time is given for them to ask any questions and have any doubts resolved.

The first study assessment (T1) took place individually and via an interview with the researcher after the informative session in the rehabilitation room.
- Demographic data: Gender, age, weight and height, calculating the BMI (body mass index).
- WOMAC questionnaire (Western Ontario and McMaster Universities)[41] to determine the level of pain, stiffness and functional disability in the patient, assessed on a scale from 0 to 4, with 0 being none (absence of pain, functional disability and stiffness) and 4 being a lot (very severe pain, very severe stiffness and very severe disability). The maximum total WOMAC score was 96 points for all 24 item included.
- Frailty screening test using the Short Physical Performance Battery (SPPB), which is one of the star tests for assessing functional capability and frailty in persons of advanced age. Frailty is related to disability, with the risk of falls and the appearance of disease. Using this tool will be vital for detecting and classifying these people[42,43]. They are three simple tests: balance, sitting down and standing up, and walking speed. The score obtained reflects a certain level of frailty. The lower the SPPB score, the higher the risk of suffering adverse situations (0-3 = major limitations; 4-6 = moderate limitation or pre-frail; 7-9 = minor limitation or frail; 10-12 = no limitation or autonomous).
- Handgrip strength using a manual dynamometer (model T.K.K. 5001 GRIP-A, Tokyo, Japan), this being considered among the manual dynamometers with the highest validity and reproducibility[44]. This is performed on the dominant and non-dominant limbs. The patient remains standing with their arm outstretched and their shoulder at a 45º abduction. Each patient performs the test twice, maintaining pressure for two seconds and resting for one minute between measurements, with the dynamometer open position set at 5 cm for both men and women[45]. The best result was recorded, measured in kilograms, starting with the dominant hand.
- Muscle circumference: with the patient seated on the exam table, knee outstretched and exposed, at 10 cm from the kneecap[46]. This measurement was taken from the two limbs.

The second assessment (T2) is conducted 15 days after the surgery, before the staples are removed from the postoperative wound. The same data are collected under the same conditions as T1. The 3-metre walking speed test is conducted without crutches.

The third assessment (T3) is conducted approximately one month after the operation. The wound is checked and the same data are collected as in T1 and T2.

All the assessments are conducted in the same room using the same procedure (iPhone SE chronometer) and by the same assessor at the same time.

Intervention

Patients and their companions are informed during the informative session about the protocol to be followed. The session starts by introducing the medical team and discussing issues related to their stay in hospital, the surgery, the type of anaesthesia, looking after the wounds at home, dealing with postoperative pain, training on transfers, progress on walking after the surgery (with a walker on the day of surgery, with crutches the next day) and how to go up and down stairs. Finally, the physiotherapist shows the exercises (researcher) and this is when the two study groups are combined; the control group and the research group.

Both the control group and the intervention group receive the same information and only belonging to one group or another changes the exercises to be performed.

Intervention on the Control Group

The exercises aimed at maintaining articular range and muscle tone are explained and performed:
- Laying down in the supine position: bending and stretching the knee, bending and stretching the foot, 45º hip bending, quadricep isometrics.
- Seated: active bending and stretching of the knee.
- Standing: active bending and stretching of the knee.

All the exercises are performed slowly and without the appearance of pain, following the protocol. The patient is asked to perform 10 repetitions of each exercise twice a day. After the intervention and now with the prosthesis, the patient is reminded that they should continue to perform the same exercises.

Intervention on the Intervention Group

The same exercises as the control group are shown, performed and supervised, adding other exercises with a medium resistance elastic band (red, Theraband®[47,48]) to work on muscle strength:

- In the supine position with ankle bands: hip flexion with outstretched knee, abduction and extension of the knee with hip and knee flexion.
- Seated with ankle bands: knee extension.
- Seated with ankle bands: hip flexion, abduction and extension.

These exercises are repeated twice a day, maintaining muscle contraction for two seconds, slowly and without pain, 10 repetitions during the first two weeks increasing to 15 repetitions during subsequent weeks until the day of surgery; the exercises continue at home following hospital discharge after the surgery, 15 repetitions twice a day. The elastic band is one metre long and provided to each patient already knotted and ready to perform the exercises correctly.

The patient learns the exercises to perform at home in both groups under supervision by the physiotherapist. Given the age of the patients (all over 65 years), the companion is an essential part of the process because they will need to oversee and supervise correct performance of the exercises. It is stressed that the companion attending the informative session should be the same person who comes to the hospital for the surgery and stays with the patient at home.

Two leaflets are given to the participants; one with all the information from the session and another with the exercises described in detail. This is so the patient is clear on and committed to the exercises they need to perform before and after the surgery. Emphasis is placed on the importance of performing the exercises and they are encouraged to perform them correctly, thereby involving the patient in their own rehabilitation.

On the day of surgery, the physiotherapist will perform the rehabilitation with the patient on the two days they are admitted to hospital based on the protocol. When discharged, the patients in both groups are reminded that they should continue to perform the exercises as explained during the preoperative session.

The WOMAC questionnaire, the SPPB frailty test, handgrip test, knee circumference and patient weight tests are repeated 15 days after the surgery and before the staples are removed.

All the tests and measurements are repeated one month after the surgery when the patient visits the clinic for discharge. Records are made of the rehabilitation sessions conducted at home on both occasions.

All the assessments — the initial assessment during the informative session (T1), at 15 days (T2) and at 30 days (T3) post-surgery — are conducted in the same room and by the same person (researcher) and at the same time.

Statistical analysis

The demographic characteristics were reported as absolute and relative frequencies for the categorical variables and as an average with standard deviation for the continuous variables. Firstly, the normality of quantitative variables was confirmed using the Shapiro-Wilk test. To assess whether significant differences exist between the groups at the start of the intervention, the Student's T-test or Wilcoxon test was performed. The chi-squared test was used for the only categorical variable (gender).

The ANOVA test for repeated measurements with the Bonferroni post hoc test was used to analyse the inter- and intra-group data from the results of the data with normal distribution. The Mann-Whitney U-test was used to analyse inter-group data with a non-normal distribution and the Wilcoxon test to analyse intra-group data with non-normal distribution.

All the data were analysed using SPSS version 20 statistical software and the analyses were conducted by the researcher.

Results

Basal characteristics of the participants

A total of 48 participants were included in the study, who were randomly allocated to one of two groups; an intervention group and a control group. Two patients were excluded from the surgery because they presented cardiac problems incompatible with the inclusion criteria; both of them were in the control group.

Table 1 shows the demographic data of the patients and it can be seen that the starting characteristics of both groups were similar.

Table 1. Initial Characteristics.

	Control Group N = 22	Intervention Group N = 24	*P* value
Gender	50% men	45.8% men	0.777
Age	73.27 ± 6.56	70.96 ± 0.985	0.108
BMI	32.42 ± 4.25	30.58 ± 0.353	0.096

BMI: body mass index.

Table 2. Initial Measurements.

	Control Group N = 22	Intervention Group N = 24	*P* value
Total WOMAC	65.54 ± 8.59	60.75 ± 8.41	0.774
W pain	12.22 ± 2.58	11.41 ± 2.06	0.108
W stiffness	5.13 ± 1.75	5.54 ± 1.02	0.472
W FUN CAP	48.18 ± 6.3	43.79 ± 7.79	0.472
Total SPPB	4.86 ± 1.49 PRE-FRAIL	5.91 ± 1.97 FRAIL	0,208
SPPB BAL	2.36 ± 0.72	2.29 ± 0.76	0.392
SPPB SS	1.68 ± 0.56	1.8 ± 0.76	0.393
SPPB WS	0.86 ± 0.351	1 ± 0.3	0.16
HANDGRIP DL	25.64 ± 9	26.58 ± 11.32	0.986
HANDGRIP NDL	23.73 ± 8.8	24.84 ± 11.63	0.72
CIRCUMFERENCE PL	51.55 ± 4.89	51.33 ± 4.68	0.881
CIRCUMFERENCE NPL	51.73 ± 4.76	51.29 ± 4.61	0.754

W: WOMAC; FUN CAP: Functional capability; BAL: Balance; SS: Sitting and standing; WS: Walking speed; DL: Dominant limb; NDL: Non-dominant limb; PL: Prosthetic limb; NPL: Non-prosthetic limb.

Result measurements

Table 2 shows the initial measurements from all the tests conducted: The WOMAC questionnaire scores in their totality and in the three sections and the scores recorded in the SPPB screening tests. Finally, the measurements of handgrip strength and muscle circumference.

There are no statistically significant differences at the start of the study (P >0.05) and we therefore have two groups that are initially similar in terms of functional capability, frailty, strength and overall condition.

As results from the inter-group analysis, we analysed the results in terms of the WOMAC questionnaire and the frailty test in Table 3, and handgrip, muscle circumference and BMI in Table 4.

Table 3. Inter-group results in WOMAC and SPPB variables.

Variable	Group	T1	T2	T3	T2-T1	T3-T1
WOMAC pain	IG	11.41 ± 2.06	3.21 ± 2.08	1.21 ± 1.38		
	CG	12.22 ± 2.58	6.36 ± 3.12	3.13 ± 2.45	<0.001*	0.002*
	DIF	-0.81	-3.15	-1.92		
WOMAC stiffness	IG	5.54 ± 1.02	2.29 ± 1.12	1.17 ± 0.76		
	CG	5.13 ± 1.75	3.68 ± 1.04	2.05 ± 1.29	0.001*	0.008*
	DIF	-0.41	-1.39	-0.88		
WOMAC FUN CAP	IG	43.79 ± 7.79	13.54 ± 5.61	5.75 ± 3.09		
	CG	48.18 ± 6.30	27.27 ± 7.30	16.4 ± 10.32	<0.001**	<0.001**
	DIF	-4.39	-13.73	-10.65		
Total WOMAC	IG	60.75 ± 8.41	19.04 ± 8.02	8.13 ± 3.87		
	CG	65.54 ± 8.59	37.31 ± 9.77	21.59 ± 13.22	<0.001**	<0.001**
	DIF	-4.79	-18.27	-13.46		
SPPB BAL	IG	2.29 ± 0.76	3.50 ± 0.59	3.83 ± 0.38	0.133*	0.841*
	CG	2.36 ± 0.72	3.18 ± 0.73	3.77 ± 0.52		
SPPB SS	IG	1 ± 0.30	1.92 ± 0.65	3.38 ± 0.92	0.004*	0.008*
	CG	0.86 ± 0.35	1.36 ± 0.49	2.55 ± 1.10		
SPPB WS	IG	1.80 ± 0.76	3.46 ± 0.93	3.79 ± 0.51	0.002*	0.190*
	CG	1.68 ± 0.56	2.64 ± 0.95	3.50 ± 0.80		
Total SPPB	IG	5.91 ± 1.97	8.87 ± 1.62	11 ± 1.50	0.001**	0.016**
	CG	4.86 ± 1.48	7.18 ± 1.70	9.91 ± 1.70		

IG: Intervention group; CG: Control group; FUN CAP: Functional capability; BAL: Balance; SS: Sitting and standing; WS: Walking speed; DIF: Difference between groups.
*Mann-Whitney U-test for parametric distributions; **Repeated measurements ANOVA.

Table 4. Inter-group results for the handgrip, muscle circumference and BMI Variables.

Variable	Group	T1	T2	T3	T2-T1	T3-T1
HANDGRIP DL	IG	26.58 ± 11.32	27.37 ± 10.85	27.87 ± 10.70	0.40*	0.15*
	CG	25.64 ± 9	26.90 ± 8.60	27.04 ± 8.74		
HANDGRIP NDL	IG	24.84 ± 11.63	24.95 ± 10.55	25.62 ± 10.67	1*	0.063*
	CG	23.73 ± 8.8	23 ± 9.64	24.81 ± 9.10		
PL circumference	IG	51.33 ± 4.68	51.64 ± 4.86	51.72 ± 4.94	0.180*	0.064*
	CG	51.55 ± 4.89	51.70 ± 4.87	51.77 ± 4.98		
NPL circumference	IG	51.29 ± 4.61	51.47 ± 5.02	51.70 ± 4.83	0.151*	0.015*
	CG	51.73 ± 4.76	52.18 ± 5.05	52 ± 5.09		
BMI	IG	30.58 ± 3.23	30.37 ± 3.11	30.22 ± 3.03	0.079*	0.067*
	CG	32.42 ± 4.08	32.26 ± 3.99	32.16 ± 3.92		

DL: Dominant limb; NDL: Non-dominant limb; PL: Prosthesis limb; NPL: Non-prosthesis limb; BMI: Body mass index.
*Repeated measurements ANOVA.

Table 5. Intra-group Results for the Intervention Group.

Variable	T1	T2	T3	T2-T1	T3-T2	T3-T1
WOMAC pain	11.41 ± 2.06	3.21 ± 2.08	1.21 ± 1.38	0.001	0.018	<0.001
WOMAC stiffness	5.54 ± 1.02	2.29 ± 1.12	1.17 ± 0.76	<0.001	0.023	<0.001
WOMAC FUN CAP	43.79 ± 7.79	13.54 ± 5.61	5.75 ± 3.09	0.001	<0.001	0.001
Total WOMAC	60.75 ± 8.41	19.04 ± 8.02	8.13 ± 3.87	<0.001	<0.001	<0.001
SPPB BAL	2.29 ± 0.76	3.50 ± 0.59	3.83 ± 0.38	<0.001	0.745	<0.001
SPPB SS	1 ± 0.30	1.92 ± 0.65	3.38 ± 0.92	0.012	0.003	<0.001
SPPB WS	1.80 ± 0.76	3.46 ± 0.93	3.79 ± 0.51	<0.001	0.582	<0.001
Total SPPB	5.91 ± 1.97	8.87 ± 1.62	11 ± 1.50	<0.001	<0.001	<0.001

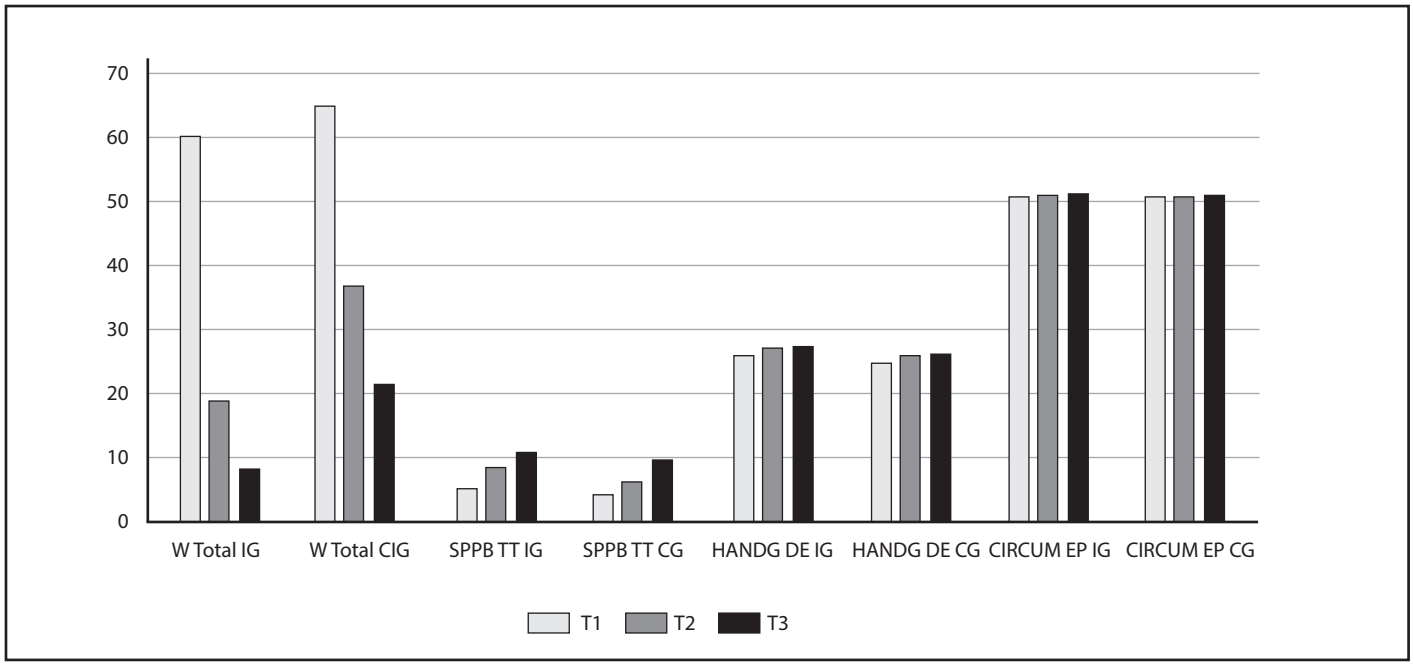
FUN CAP: Functional capability; BAL: Balance; SS: Sitting and standing; WS: Walking speed.

Table 6. Intra-group Results for the Control Group.

Variable	T1	T2	T3	T2-T1	T3-T2	T3-T1
WOMAC pain	12.22 ± 2.58	6.36 ± 3.12	3.13 ± 2.45	<0.001	<0.001	<0.001
WOMAC stiffness	5.13 ± 1.75	3.68 ± 1.04	2.05 ± 1.29	0.031	0.016	<0.001
WOMAC FUN CAP	48.18 ± 6.30	27.27 ± 7.30	16.4 ± 10.32	<0.001	<0.001	<0.001
Total WOMAC	65.54 ± 8.54	37.31 ± 7.77	21.59 ± 13.22	<0.001	<0.001	<0.001
SPPB BAL	2.36 ± 0.72	3.18 ± 0.73	3.77 ± 0.52	0.016	0.104	<0.001
SPPB SS	0.86 ± 0.35	1.36 ± 0.49	2.55 ± 1.10	0.179	0.008	<0.001
SPPB WS	1.68 ± 0.56	2.64 ± 0.95	3.50 ± 0.80	0.010	0.010	<0.001
Total SPPB	4.86 ± 1.48	7.18 ± 1.70	9.91 ± 1.70	<0.001	<0.001	<0.001

FUN CAP: Functional capability; BAL: Balance; SS: Sitting and standing; WS: Walking speed.

Figure 1. Values for the Main Variables in the Three Measurements.



W: WOMAC; IG: Intervention group; CG: Control group; TT: Total; HANDG: Handgrip; DE: Dominant extremity; CIRCUM: Muscle circumference; EP: Extremity with prosthetic; T1: Initial test; T2 and T3: Second and third tests.

Statistically significant differences were observed in all variables with P <0.001 in the WOMAC questionnaire, both in the tests at 15 days (T2) after the surgery and at 30 days (T3).

In the results from the tests to assess frailty, we observed no significant differences in the balance test from the second and third measurements; there is a significant difference at 15 days after the surgery in the sitting down and standing up test while this difference disappears at 30 days; and the same can be said about the 3-metre walking test. On the other hand, the total score (which establishes the existence of frailty or not) appears with an initial assessment of "fragile", with an assessment of "pre-frail" at T2 and concludes with "autonomous" in the final measurement one month after surgery (approximately two months following the initial assessment), the scores being statistically significant with a P <0.001.

In terms of the inter-group results for handgrip strength, muscle circumference and BMI, there are no statistically significant differences in any of their variables (Table 4).

The results from the intra-group assessments are shown in Tables 5 and 6, observing statistically significant improvements in both groups.

Finally, Figure 1 graphically shows the evolution of the main variables in the three measurements.

Conclusions

Engaging in a programme of exercises both before and after TKR surgery with elastic bands is effective at reducing pain and stiffness, improving functional capability, balance and walking speed, and, therefore, autonomy and quality of life.

Conflict of Interest

The authors declare no conflict of interest whatsoever.

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