The Knee xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

The Knee

Gait and functional status analysis before and after total knee arthroplasty

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ARTICLE INFO

Article history:
Received 5 January 2017
Received in revised form 12 April 2018
Accepted 4 June 2018
Available online xxxx

Keywords:
Total knee arthroplasty
Gait analysis
Physical therapy
Functional status
Gonarthrosis

ABSTRACT

Background: Among the procedures for severe gonarthrosis, total knee arthroplasty (TKA) is considered a successful method patient satisfaction and functional improvement; however, TKA is commonly associated with incompletely recovered gait function. The aim of this study was to evaluate the influence of TKA and physiotherapy programmes on gait features and patient-reported functional status and the relationship between them, leading to broader knowledge of the origins of long-term gait disturbances.
Methods: Walking speed, step length and single support time were analysed by GAITRite system in 60 healthy controls and 21 TKA patients analysed at four time points: one day before and five days after surgery and before and after a three-week rehabilitation (12 and 15 weeks after surgery). Functional status was assessed using the Western Ontario and McMaster Osteoarthritis Index (WOMAC).
Results: At all time points, the TKA subjects walked significantly slower than the controls, but walking speed continuously increased after surgery. Gait asymmetries were observed in single support time (before surgery) and step length (after surgery). Partial restoration of gait function was observed 12 weeks after surgery and completion of the rehabilitation programme. An indirect correlation between gait velocity and function WOMAC subscores was found.
Conclusions: Patients after TKA were characterised by significant improvements in self-reported functionality and progressive reduction of gait abnormalities, probably related to pain reduction. However, at 15 weeks after surgery, patients exhibited step length asymmetry, which could be considered as an effect of habits of three-point crutch gait in the early postoperative period.

1. Introduction

Osteoarthritis (OA) is a cartilage degenerative disease that causes more disability with respect to mobility than any other single disease in the elderly [1, 2]; OA is a disease with multifactorial aetiology, which occurs more often in women than in men. Several studies have pointed out the importance of biomechanical factors in the destructive cascade of this disease [3, 4], especially in the knee, which is the load-bearing joint most frequently affected by OA [5–7], probably due to excessive compressive stress of the articular cartilage and subchondral bone [4, 8]. It is particularly observed across the medial compartment, which is probably due to the greater load applied to this compartment during walking and other weight-bearing activities (60–80% of

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https://doi.org/10.1016/j.knee.2018.06.004
0968-0160/

total intrinsic knee compressive load) [9–11]. However, there is no clear evidence to determine whether biomechanical abnormalities such as increased knee adduction moments cause or occur as a result of OA [12]. Nonetheless, the progression of knee OA contributes to altered gait patterns as efforts are made to avoid pain by minimising joint forces. There is a body of evidence indicating gait adaptations in people with advanced knee OA, including significantly reduced walking speeds and step length [13, 14].

In turn, one of the most common procedures for management of end-stage severe knee OA is total knee arthroplasty (TKA). Based on patients' self-reported measures of pain and function, such as the Western Ontario and McMaster Osteoarthritis Index (WOMAC), TKA is considered a successful procedure with high patient satisfaction [15], especially because of the significant reduction in pain and improvement in functional capacity. However, TKA is commonly associated with incomplete recovery of the normal knee joint function, and in most cases, within one to two years after TKA, the gait remains slower than that observed for asymptomatic controls [16].

Nonetheless, deficits in knee joint function are poorly analysed immediately after arthroplasty and in contrast to total hip replacement, the knowledge of early TKA functional mobility outcomes is still insufficient [17, 18], despite a compensatory mechanism exhibited by the treated knee probably related to physiological incompatibility of the endoprosthesis [19]. However, observed disturbances in gait and knee biomechanics are more often analysed at least six months after surgery. Hence, it is unclear whether postoperative abnormal gait is a result of patterns adopted before the surgery, soon after surgical intervention or a combination of both factors [16]. Therefore, recognition of specific gait impairments following surgery may help to determine adequate patient care including rehabilitation strategies focused on improving knee function and gait retraining to optimise recovery following TKA and to prevent the development of compensatory mechanisms [20].

Considering these points, the purpose of this study was to evaluate the influence of TKA and postoperative physical therapy programmes on spatio-temporal gait features, patient-reported functional status and the relationship between them. We compared spatio-temporal gait parameters as well as gait symmetry between the control group (CTR) and patients with TKA, who were tested at four time points, including the early postoperative period. This study condition allowed us to determine whether the postoperative abnormal gait is a result of patterns adopted before the surgery or resulting from mechanical changes accompanying the TKA procedure [16]. Because of potential sex-specific differences in gait kinematics [21] we also analysed the impact of gender on TKA-related gait disturbances.

2. Material and methods

2.1. Material

Eighty-nine patients with unilateral end-stage knee osteoarthritis selected from the waiting list (with the mean average waiting time for the TKA procedure of 4.7 ± 1.5 years) for primary TKA were assessed for eligibility for the purposes of this study. Individuals were enrolled based on medical documentation and imaging via standard radiographs performed within one month of the enrolment date. Following the main inclusion criteria, all patients were affected by symptomatic, severe OA of the treated knee (confirmed as grade IV according to the Kellgren–Lawrence system) diagnosed according to the American College of Rheumatology. Moreover, only patients who had no OA symptoms in the contralateral knee were included. However, the contralateral knee status was not confirmed radiologically. Other exclusion criteria included symptomatic OA of other lower limb joints, lower limb surgery (within the three years before inclusion in the study), neuromuscular disease and advanced cardiovascular disorders. In a further research stage with medical interview and physical examination, only patients able to walk independently along a six-metre walkway without a gait aid and possessing full extension and at least 60° of knee flexion were included in the study. Finally, the TKA group included 21 patients (for characteristics, see Table 1), who were tested four times: one day before surgery, five days after surgery, 12 weeks after surgery (pre-rehabilitation) and 15 weeks after surgery (post-rehabilitation). The flow diagram of participants with TKA, reasons for exclusion from the study and the scheme of assessment in particular stages are presented in Figure 1.

The CTR group consisted of 60 asymptomatic healthy participants, who were tested once for gait patterns. The TKA and CTR groups did not differ anthropometrically, except for body weight. The characteristics of the CTR group are shown in Table 1.

Table 1
Characteristics of the groups analysed.

	TKA (n = 21) Mean ± standard deviation	CTR (n = 60) Mean ± standard deviation
Age (years)	63.5 ± 9.5	65.1 ± 6.4
Sex (women/men)	14/7	41/19
Height (cm)	165.7 ± 8.2	163.9 ± 7.4
Weight (kg)	79.6 ± 12.2[a]	73.7 ± 10.2
BMI (kg/m^2)	29.1 ± 4.6	28.2 ± 3.8

BMI, body mass index; CTR, control group; TKA, total knee arthroplasty group.
[a] Difference from the control group statistically significant at the level of $P < 0.05$.

Please cite this article as: Bączkowicz D, et al, Gait and functional status analysis before and after total knee arthroplasty, Knee (2018), https://doi.org/10.1016/j.knee.2018.06.004