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REORGANIZATION OF EQUILIBRIUM AND MOVEMENT CONTROL STRATEGIES AFTER TOTAL KNEE ARTHROPLASTY

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This work was aimed at identifying changes in posturomotor control strategies in patients with unilateral total knee arthroplasty. Using kinetic and kinematic data, a previous study had revealed that, during a side step, patients with unilateral knee arthritis showed a shortened monopodal phase and a lengthened postural phase when the affected leg was the supporting one. It was expected that these strategies would be modified after undergoing total knee arthroplasty. Postoperatively the durations of the monopodal phase and of the postural phase became similar when the operated limb was supporting and when the sound limb was supporting. Concerning the upper body movements, the same asymmetrical results as before surgery were observed. Hence, patients with total knee arthroplasty exhibit posturomotor strategies which, although they become close to normal, remain asymmetrical. The durations of the monopodal and of the postural phases could be considered to assess the results of total knee arthroplasty.

Key words: knee arthritis, total knee arthroplasty, movement analysis, evaluation

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INTRODUCTION

Total knee arthroplasty (TKA) has become a very common orthopaedic operation. When TKA is performed, pain alleviation and increase in passive range of motion (1) are usually obtained, whereas proprioception is found to remain decreased as before surgery (2, 3) and muscle strength diminished (4). Although functional improvement is usually observed, clinical assessment of disabilities proves to lack accuracy as shown by the study by Zambelli & Leyvraz (5).

Hence, several investigations using movement analysis devices in patients with TKA have been performed in order to assess gait. Olsson & Barck (6) evaluated patients after TKA. Considering cadence, gait cycle, vertical forces and single support time, the authors observed that normal gait was not achieved. Berman et al. (7) studied patients with unilateral knee arthritis before and after TKA. Double support time was found to be decreased whereas step length and velocity were increased after total knee replacement. Normal values were not, however, reached. Mattsson et al. (8) recorded an increase in the self-selected speed in patients who had undergone unicompartmental knee arthroplasty. The ratio between the affected and the sound leg in single support had increased towards normal values. Kelman et al. (9) performed gait laboratory analysis during stair ascent and descent in patients with posterior cruciate sparing total knee arthroplasty. The results revealed a symmetric pattern during stair descent and minor asymmetries during stair ascent.

Most of these studies led to the conclusion that gait patterns of patients with TKA differed from those of able-bodied subjects. These works, however, did not study the coordinations between posture and movement in patients with TKA, such as those which occur during initiation of gait.

The analysis of kinetic, kinematic and EMG recording data during single leg flexion (10), lateral leg raising (11) and gait initiation (12–15) has provided information about the coordination between posture and leg movement. Gait initiation has shown to be a complex biomechanical task which not only involves a forward acceleration of the centre of mass in the sagittal plane but also includes events which take place in the frontal plane (i.e. first shift of the centre of pressure towards the stepping leg prior to heel-off, then second shift of the centre of pressure towards the supporting leg) (16–18). Owing to this coordination between the ground reaction forces in the sagittal and frontal plane, gait initiation is a rather complex process. In our study, we investigated the side-step, which requires a weight transfer in the frontal plane but does not include the forward propulsion component of locomotion (19), and thus is less complex than gait initiation. The result of this work should enable a better understanding of the gait initiation process.

Furthermore, studies in the frontal plane had already been carried out. Mesure et al. (19) analysed side step in poliomyelitis patients with asymmetrical lower limb impairment (i.e. motor deficit predominantly affecting the quadriceps). This study has shown that a new strategy was built in order to maintain equilibrium during a side step. The findings of the study by Mouchnino et al. (11) during lateral leg raising in below-knee amputees were indicative of a central adaptation of the postural organization to the peripheral impairments using new sequences of muscular activation. Hence, studies in the frontal plane have

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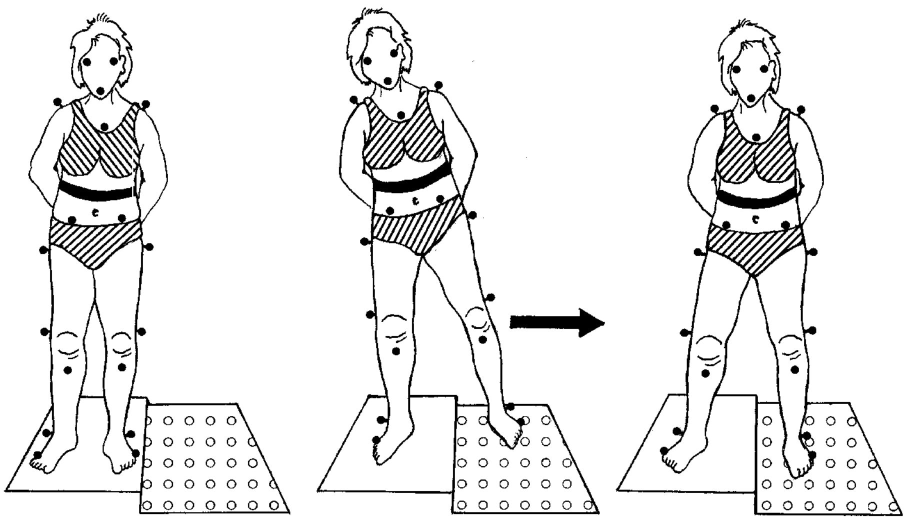

Fig. 1. Subject performing a side step to the left. 16 light-reflecting markers are placed on anatomical landmarks (see Methods). Postural phase; the subject is standing on his two feet on one force-plate; monopodal phase and landing phase; each foot is on a different force-plate.

proved to provide valuable information on the coordination between equilibrium and movement in patients with distal unilateral lower limb impairments.

Hence, in a previous study (20), a kinetic and kinematic analysis of a side step was conducted in patients with unilateral knee arthritis. It was shown that the duration of the postural phase and the intensity of the horizontal ground reaction forces exerted during the postural phase were increased when the pathological limb was supporting. The monopodal phase was shortened on the pathological leg. These results were indicative of adaptive posturomotor strategies mainly aimed at shortening the monopodal phase on the affected leg.

The aim of this study was to identify modifications in equilibrium and movement control strategies in patients with TKA during a side step, using a kinetic and kinematic analysis. These results could be of interest to improve both the rehabilitation program of patients after undergoing TKA, and the evaluation of the results of total knee replacement.

MATERIAL AND METHODS

Subjects

Eight patients, 5 males and 3 females (mean age 67 years, range 46–77) were included in the study. The mean weight was 78.1 kg (SD 15.9) and the mean height 1.68 metres (SD 0.1).

The criteria for inclusion were a unilateral symptomatic knee arthritis with an indication of total knee arthroplasty. The patients were scheduled for TKA within 15 days after the recordings. Six out of these patients belonged to the population group analysed in the previous study on equilibrium and movement strategies in patients with knee arthritis (20). From the 10 patients included in the previous study, 3 were lost for follow up and one had a hip fracture.

Criteria for exclusion were a contralateral knee arthritis or neurological, vascular or other pathologies which could influence stance and gait.

All patients were referred and operated by the same surgeon. The same type of posterior cruciate-sparing prosthesis (Nex-Gen, ZIMMER*, BP 10494401 Vitry-sur-Seine, Cedex, France) and the same technique were used in all patients.

The average pre-operative Hospital for Special Surgery (HSS) score [10] was 59.1 with an SD of 10.15 with a maximum of 100 [10]. The mean pain visual analogue scale (VAS) (21) value was 49 mm (SD 9) (VAS; worst pain ever 100 mm, no pain 0 mm).

The mean postoperative HSS was 80.8 (SD 8.4) and the mean postoperative pain VAS value was 7 mm (SD 9).

Twelve age-matched healthy subjects, 6 males and 6 females, were tested for comparisons. Mean age was 71 (66–78) years. The mean weight was 64 kg (SD 12.8) and the mean height 1.64 metres (SD 0.1).

Methods

The kinematic study was carried out using an optoelectronic system and the data were analysed using its dedicated software (ELITE*, Bioengineering Technology and Systems, Via Capecelatro 66, 20148 Milano, Italy) (22). Sixteen light-reflecting markers (Fig. 1) were placed on anatomical landmarks: bilaterally, on the lateral edge of eye orbits, acromions, anterior-superior iliac crests (AIC), greater trochanters, external femoral condyles, external malleoli, anterior tibial tuberosities, 5th metatarsal heads (M5). The movements of the markers were recorded by four infra-red cameras, positioned in front of the subjects at a frequency of 100 Hz.

The kinetic parameters were recorded from two AMTI* (Advanced Mechanical Technology Inc. 151 California Street, Newton, Massachusetts, 02158, USA) force-plates (Fig. 1) at a frequency of 100 Hz.

Experimental procedure

The procedures followed were in accordance with the standards of the local ethical committee. All patients were examined by the same specialist in physical medicine and rehabilitation in order to be sure that the criteria for inclusion and exclusion were followed. The clinical assessment included the HSS score and a VAS for pain. For each subject, all recordings were done during the same session.

Patients were first recorded 15 days before surgery and, then, 1 year after surgery.

The subject stood barefoot on one of the 2 force-plates, facing the 4 cameras. The instruction was given to perform a single step side-wards, the amplitude of which being at least 30 cm, so that the moving limb would land on the second force-plate (Fig. 1). A series of 10 trials were run with the subject moving the right leg and another series of 10 trials with the subject moving the left leg. In the case of a side step to the right,

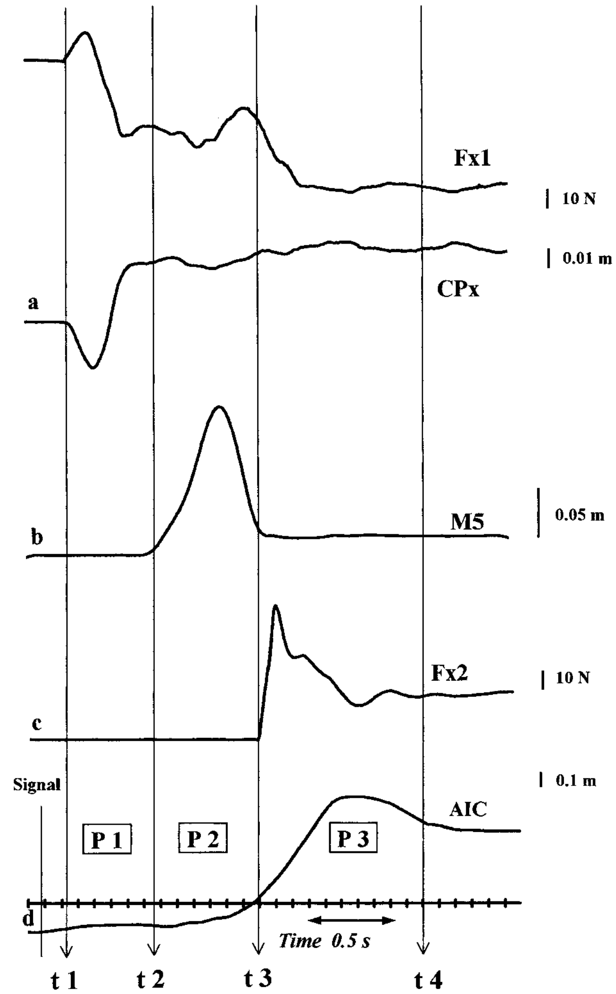

Fig. 2. Determination of the different phases of the movement: (a) t1: first shift of the centre of pressure in the frontal plane (CPx) recorded from the first force-plate. (b) t2: first displacement of the marker placed on the top of the 5th metatarsal (M5). (c) t3: reception of the leading foot on the second force-plate (horizontal ground reaction force in the frontal plane: Fx2). (d) t4: end of the displacement in the frontal plane of the marker placed on the anterior iliac crest (AIC) of the side of the moving limb. P1: postural phase. P2: monopodal phase. P3: landing phase. The first curve on top shows the changes in the horizontal ground reaction forces (Fx1) recorded on the first force-plate.

the supporting leg during the monopodal phase was the left one. The supporting leg during the monopodal phase of a side step to the left was the right leg.

Parameters and data analysis

1. Movement duration: Three phases were defined on the basis of kinematic and kinetic parameters (Fig. 2).

- Postural phase (P1) (ms): the motor task begins at the time t1 corresponding to the first shift of the centre of pressure (CPx) in the frontal plane recorded from the first force-plate. The end of the postural phase took place at time t2 with the onset of the movement of the marker placed on the 5th metatarsal head (M5).
- Monopodal phase (P2) (ms): this phase started at time t2 and ended at time t3 corresponding to the landing of the foot on the second force-plate. This information was given by the beginning of the recordings on the second force-plate (Fx 2).
- Landing phase (P3) (ms): it started at time t3 and finished at time t4 with the end of the displacement of the marker placed on the anterior superior iliac crest (AIC).
- Total movement duration (ms): from time t1 to time t4.

2. Kinetic variables:

- The displacement of the centre of pressure (CPx) in the frontal plane (mm). The CP is the point of application of the resultant of the vertical ground reaction forces. The CPx displacement represents an accurate index of the angular acceleration of the centre of gravity (CG) in the frontal plane (13, 23). Its position was assessed from the force-plates recordings. The peak amplitude of the centre of pressure shift was measured in the frontal plane between the value at the onset of the first displacement of the CP and the first peak value occurring during the postural phase.
- The horizontal ground reaction forces from the first force-plate in the frontal plane. The horizontal ground reaction forces in the frontal plane (Fx) recorded from the first force-plate were quantified (Fx 1) (N). As can be seen in Fig. 2, the horizontal ground reaction force (Fx) moved in opposite direction to the CP. Fx was measured at the first peak of the curve occurring during the postural phase.
- The horizontal ground reaction forces were recorded from the second force-plate (Fx 2), in order to determine the end of the monopodal phase (Fig. 2).

3. Kinematic variables:

- the movements of the markers placed on the 5th metatarsal head (M5) and on the AIC on the moving side were recorded in order to define the beginning of the monopodal phase and the end of the landing phase.
- the displacements of the markers placed on the acromion and on the AIC on the supporting side were analysed. The peak amplitude of the movement of the marker placed on the acromion and on the AIC toward the supporting side was measured (mm).
- the time interval between the first CPx peak (t1′) and the beginning of the displacement of the marker placed on the acromion on the supporting side was measured (ms). The time interval between the beginning of the movement of the marker placed on the acromion on the supporting side and the beginning of the movement of the marker placed on the 5th metatarsal head (t3) on the moving side was also calculated (ms) (Fig. 3).

Statistical methods

The statistical analysis was performed using analysis of variance (ANOVAs) for the parameters dealing with movement durations, centre of pressure displacements and horizontal ground reaction forces. A Student's *t*-test was used to study the kinematic parameters. A paired Student's *t*-test was used in patients to compare steps with the affected leg supporting (ALS) and steps with the sound leg supporting (SLS), and also to compare steps with the operated leg supporting and steps with the ALS before surgery.

RESULTS

Movement analysis data

1. Movement duration (Figs 4, 5, Tables I, II):

- *Postural phase P1 (Fig. 4):* Before surgery, the duration of P1 was longer for ALS steps than for SLS steps ($F(2,48) = 5.003E$; $p < 0.001$) and than for steps of control subjects ($F(2, 48) = 6.834E$; $p < 0.001$). There was no difference between SLS steps and steps of control subjects.

  After surgery, there was no difference in the duration of P1 between ALS steps and SLS steps, and steps of control subjects.

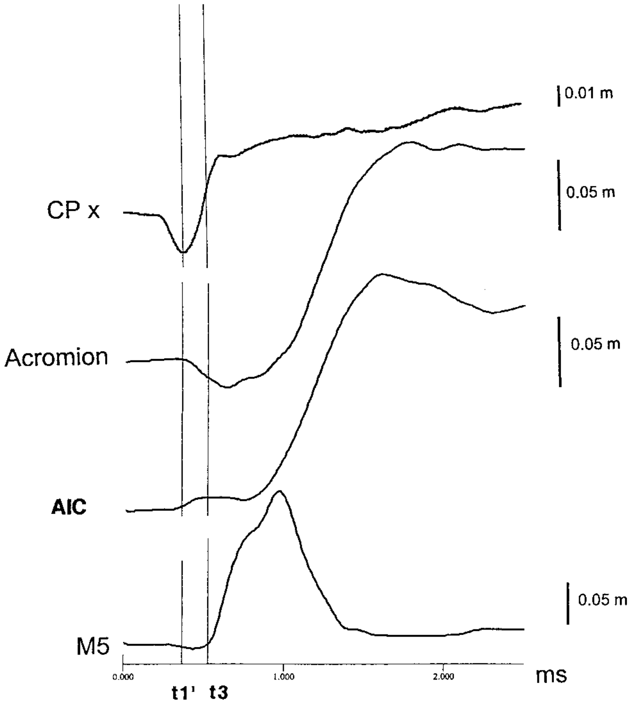

Fig. 3. Recordings in one patient:

- of the displacement of the centre of pressure in the frontal plane (CPx)
- of the movement in the frontal plane of the marker placed on the Acromion on the supporting side,
- of the movement in the frontal plane of the marker placed on the anterior iliac crest (AIC) on the supporting side,
- of the movement in the vertical plane of the marker placed on the 5th metatarsal head (M5) on the moving side.

The acromion begins to move toward the supporting side at time t1′ when the CPx has already reached its first peak displacement in the frontal plane. The take-off of the 5th metatarsal head is delayed and occurs at time t3.

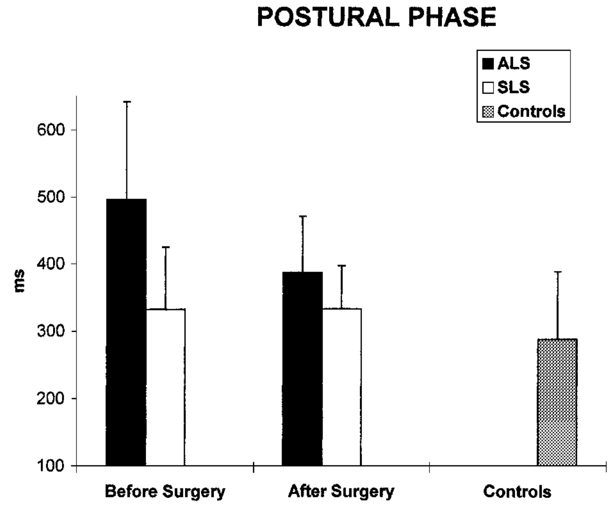

Fig. 4. Duration of the postural phase, before and after surgery, in patients when the affected limb is supporting (ALS), and when the sound limb is supporting (SLS) and in controls.

P1 was shorter for ALS steps after surgery than before surgery but the difference was not statistically significant.

- *Monopodal phase P2 (Fig. 5):* Before surgery, the duration of P2 was shorter for ALS steps than for SLS steps ($F(2,48) = 3.104E$; $p < 0.05$). There was no difference between ALS steps and steps of control subjects nor between SLS steps and steps of control subjects.

  After surgery, there was no difference in the duration of P2 between ALS steps and SLS steps. In both cases the duration of P2 was similar to the values of control subjects.

  No difference was found between the values recorded before and after surgery.
- *Landing phase P3:* Before surgery, there was no difference in the duration of P3 between ALS steps and SLS steps, both being longer than in control subjects ($F(2,48) = 4.460E$; $p < 0.01$ and $F(2,48) = 6.646E$; $p < 0.001$ respectively).

  After surgery, no changes occurred; there was no difference in P3 duration between ALS and SLS steps, both being longer than in controls ($F(2,48) = 3.683E$; $p < 0.05$ and $F(2,48) = 4.924E$; $p < 0.01$ respectively) and not significantly different than before surgery.
- *Total movement duration:* Before surgery, there was no difference in the total movement duration between ALS steps and SLS steps, both being longer than in control subjects ($F(2,48) = 4.989E$; $p < 0.01$ and $F(2,48) = 4.702E$; $p < 0.01$ respectively).

  After surgery, no changes occur; there was no difference in the total movement duration between ALS steps and SLS steps, both being longer than in controls ($F(2,48) = 3.772E$; $p < 0.05$ and $F(2,48) = 3.899E$; $p < 0.05$ respectively) and not significantly different than before surgery.

2. *Kinetic parameters (Tables III, IV):*

- Initial displacement of the centre of pressure (CPx) in the frontal plane during the postural phase:

  Before surgery the initial displacement of the CPx was higher for ALS steps than for SLS steps ($F(2,48) = 2.865E$; $p < 0.05$). No difference was found between patients and controls.

  After surgery no difference was found in the CPx initial displacement between ALS steps and SLS steps. Postoperatively the CPx displacement was higher for ALS steps than for steps of controls $F(2,48) = 3.556E$; $p < 0.05$).

  No difference was found between the values recorded before and after surgery.
- Horizontal ground reaction forces in the frontal plane during the postural phase:

  Before surgery, Fx was increased for ALS steps as compared to steps of control subjects ($F(2,48) = 3.184E$; $p < 0.05$). No difference was found between ALS steps and SLS steps nor between SLS steps and steps of control subjects.

  After surgery, Fx remained higher for ALS steps than for steps of control subjects ($F(2,48) = 4.52E$; $p < 0.01$). No

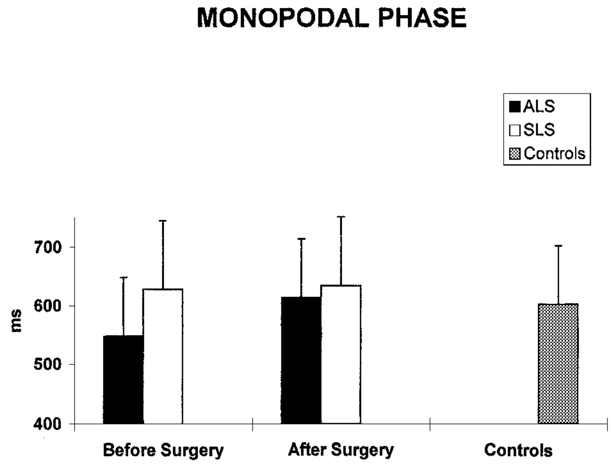

Fig. 5. Duration of the monopodal phase, before and after surgery, in patients when the affected limb is supporting (ALS), and when the sound limb is supporting (SLS) and in controls.

difference was found between ALS steps and SLS steps nor between SLS steps and steps of control subjects.

No difference was found between the values recorded before and after surgery.

3. Kinematic parameters (Fig. 3, Tables V & VI):

- Displacement of the marker placed on the acromion on the supporting side:

  Both in control subjects and in patients, the marker placed on the acromion on the supporting side moved first toward the supporting leg and then toward the moving side. Before surgery, the initial displacement of the marker placed on the acromion toward the supporting side was larger for ALS steps than for SLS steps ($p < 0.01$) and than for steps of control subjects ($p < 0.05$). After surgery the displacement of the marker placed on the acromion remained higher for ALS steps than for SLS steps ($p < 0.01$) and than for steps of control subjects ($p > 0.05$). No difference was observed between the results recorded before and after surgery. No difference was found between SLS steps and steps of controls both before and after surgery.
- Displacement of the marker placed on the AIC on the supporting side:

  In controls, the marker placed on the AIC moved directly toward the moving leg in most recordings.

  On the opposite, in patients, the marker placed on the AIC moved first toward the supporting leg and then toward the moving side. Before surgery the first displacement of the AIC marker on the supporting side was more important for ALS steps than for SLS steps but the result was not statistically significant.

  After surgery, the displacement of the AIC marker remained more important for ALS steps than for SLS steps but the result was not statistically significant.

  No difference was observed between the results recorded before and after surgery.
- In patients as well as in controls the beginning of the movement of the marker placed on the acromion on the supporting side occurred at the time of the peak displacement of the center of pressure CPx in the frontal plane (t′1) (Fig. 3).
- In control subjects, the beginning of the movement of the marker placed on the 5th metatarsal head occurred 210 +/− 60 ms after the beginning of the movement of the marker placed on the acromion on the supporting side. In patients, before surgery, the movement of the 5th metatarsal head marker was delayed for ALS steps (360 +/− 110 ms) as compared to SLS steps (160 +/− 90 ms) ($p < 0{,}01$) and to steps of control subjects ($p < 0{,}01$). No difference was observed between SLS steps and steps of control subjects. After surgery, there was no difference between ALS steps (270 +/− 60 ms) and SLS steps (200+/− 60 ms) nor between patients and controls. No difference was found between the results recorded before surgery and the ones recorded after surgery.

Table II. *Mean value and standard deviation of the duration of the postural phase, of the monopodal phase, of the landing phase and of the total step duration for steps with the sound leg supporting (SLS) before and after total knee arthroplasty (TKA) and for steps of controls. The differences were not statistically significant.*

	SLS before TKA	SLS after TKA
Postural Phase (ms)	332 ± 83.9	333.5 ± 64
Monopodal phase (ms)	628.6 ± 117.7	634.6 ± 118.3
Landing phase (ms)	1104.2 ± 172.9	1021.2 ± 123.6
Total duration (ms)	2025.9 ± 312.6	1970.3 ± 192.8

DISCUSSION

This study was conducted in a sample of patients with unilateral

Table I. *Mean value and standard deviation of the duration of the postural phase, of the monopodal phase, of the landing phase and of the total step duration for steps with the affected leg supporting (ALS) before and after total knee arthroplasty (TKA) and for steps of controls. The differences were not statistically significant.*

	ALS before TKA	ALS after TKA	Controls
Postural phase (ms)	495.6 ± 146.1	386.9 ± 92.9	287.9 ± 78.3
Monopodal phase (ms)	548.5 ± 37.5	614 ± 119.3	603.2 ± 83.9
Landing phase (ms)	1001.3 ± 124.5	967.7 ± 196.8	809 ± 98.2
Total duration (ms)	2045.8 ± 262	1961.5 ± 232.7	1700.3 ± 128.2

Table III. *Mean value and standard deviation of the initial displacement of the center of pressure in the frontal plane (CPx) before and after surgery for steps with the affected leg supporting (ALS) and steps with the sound leg supporting (SLS) and for steps of controls.*

	ALS	SLS	Controls
CPx before surgery (mm)	21.4 ± 4.7	13.8 ± 5.6*	
CPx after surgery (mm)	24.4 ± 6	20.1 ± 4.2	
CPx (mm)			15.6 ± 9.6

* $p < 0.05$ versus ALS.

knee arthritis who did not suffer from any other pathology. All the patients were operated by the same surgeon, using the same type of prosthesis. The mean HSS score was 80.8 (s.d. 8.4) which is considered as a good result (10). Pain VAS values decreased from 48.2 s.d. 9.1 before surgery to 7.71 (s.d. 9.21) after TKA. These criteria have allowed to select an homogeneous population. Hence, comparisons could be made, before surgery between steps with the affected leg supporting and steps with the sound leg supporting, comparisons after surgery between steps with the operated leg supporting and steps with the sound leg supporting and finally comparisons between steps with the affected leg before surgery and steps with the operated leg.

A previous study (22), developed in patients suffering from a severe unilateral knee arthritis before TKA has shown that the timing of the sequence of events occurring during a side-step, as well as the amplitude of the CP displacement and the horizontal ground reaction forces during the postural phase were selectively modified in an asymmetrical way according to the leg used as supporting leg during the task.

The present study has shown that post-operatively, patients with TKA tended to develop more symmetrical posturomotor strategies with respect to the leg used as supporting one during the side-step, thus indicating that the process was markedly improved. However, several parameters remained asymmetrical showing that patients did not recover the same strategies than controls after undergoing total knee arthroplasty.

A complete recovery was observed as concerns both the postural and the monopodal phases. Hence, the duration of the monopodal phase, which was shortened for steps with the ALS pre-operatively, was significantly increased after surgery for steps with the operated leg supporting (Fig. 5) so as to reach

Table IV. *Mean value and standard deviation of the horizontal ground reaction forces in the frontal plane Fx before and after surgery for steps with the affected leg supporting (ALS) and steps with the sound leg supporting (SLS) and for steps of controls. The differences are not statistically significant.*

	ALS	SLS	Controls
Fx before surgery (N)	15.2 ± 3.5	11.1 ± 6.5	
Fx after surgery' (N)	17.5 ± 4.2	14.4 ± 3	
Fx (N)			9.1 ± 4.3

Table V. *Mean value and standard deviation of the displacement of the marker placed on the acromion on the supporting side before and after surgery for steps with the affected leg supporting (ALS), for steps with the sound leg supporting (SLS) and for steps of control subjects.*

	ALS	SLS	Controls
Acromion displacement before surgery (mm)	37.51 ± 18.6	18.8 ± 12	
Acromion displacement after surgery (mm)	31.3 ± 15.3	21.5 ± 10.9**	
Test	NS	NS	
Acromion displacement (mm)			15.6 ± 7.4

* $p < 0.01$ versus ALS.

values similar to steps with the SLS. These findings can probably be partly related to the pain relief observed after TKA as assessed by the important decrease in VAS values. It is also likely that increased muscular strength is involved in the lengthening of this phase. The same complete recovery was also observed as regards the postural phase. Before surgery, the duration of the postural phase was lengthened for steps with the affected leg supporting. After surgery, there was no difference in the duration of the postural phase between steps with the operated leg supporting and steps with the sound leg supporting (Fig. 4). Furthermore, before surgery, the peak amplitude of the initial displacement of the center of pressure (CPx) was more important for ALS than for SLS steps. Postoperatively there was no difference in the peak amplitude of the initial displacement of the CPx between ALS steps and SLS steps.

However, there was evidence of persisting impairments. For instance, the total movement duration remained longer in patients after surgery than in controls no matter which leg was the supporting one. This result was not related to the durations of the postural and monopodal phases, but to the duration of the landing phase which remained significantly longer in patients after surgery than in controls no matter which leg was supporting.

A persisting asymmetrical behaviour was observed in the upper body movements, which were determined from the displacements of the markers placed on the acromion and on the anterior iliac crest on the supporting side. In controls, the

Table VI. *Mean value and standard deviation of the displacement of the marker placed on the anterior iliac crest (AIC) on the supporting side before and after surgery for steps with the affected leg supporting (ALS), for steps with the sound leg supporting (SLS) and for steps of control subjects. The differences are not statistically significant.*

	ALS	SLS	Controls
AIC displacement before surgery (mm)	11.4 ± 9.8	4.2 ± 5.6	
AIC displacement after surgery (mm)	8.4 ± 8.9	4.96 ± 5.1	
AIC displacement (mm)			−2.07 ± 0.6

acromion first moved toward the supporting side and, then, toward the moving one. On the opposite, the anterior iliac crest marker moved directly toward the moving side. Hence in controls, the movement of the acromion resulted from a leaning of the upper body toward the supporting side around the hip joint, and not from a whole body displacement around the ankle joint. In patients, as in controls, the marker placed on the acromion moved first toward the supporting leg and then toward the moving one. As opposed to what was observed in controls, the anterior iliac crest marker moved first toward the supporting leg and then toward the moving leg.

Before surgery, the movement of the acromion toward the supporting side was more important for the ALS steps than for the SLS steps. The movement of the marker placed on the anterior iliac crest toward the supporting side was more important for ALS steps than for SLS step. Hence, for ALS steps, the leaning of the upper body around the hip joint was associated with a whole body movement toward the supporting side, around the ankle, which explained the increase in the acromion displacement. Postoperatively, the same type of movement was observed in patients for steps with the operated limb supporting.

These results show that the asymmetrical motor strategies which were built up by the patients before surgery have become partially irreversible.

Evaluation of knee arthritis is usually based on clinical examination which allows the quantification of impairments, such as pain, restricted range of motion or reduced muscular strength, but does not always reflect the disabilities related to knee arthritis (9). More information concerning disabilities is provided by clinical scales such as the HSS score. Walking distance or stair climbing are often evaluated based on questionnaires. Using a movement analysis system, it was possible to record quantified results, measured during a motor task involving the lower limbs such as a side-step. This methodology has allowed to identify and quantify parameters (i.e. duration of the postural and of the monopodal phase) which are significantly modified in patients after surgery as compared to before surgery. Hence, it was observed that the duration of the monopodal phase on the affected leg was increased after successful TKA so as to reach the same values as the ones of the monopodal phase on the sound leg. Post-operatively, the duration of the postural phase of steps with the ALS became similar to that of the postural phase of steps with the SLS. This study, thus, provides the means of a new approach to the quantification of disabilities in patients after undergoing TKA.

After undergoing TKA, the duration of the monopodal phase on the affected leg, which was shortened pre-operatively, increased significantly and reached the same values as the duration of the monopodal phase on the sound leg. Post-operatively, the duration of the postural phase, which was increased before TKA for steps with the ALS, became similar to the duration of the postural phase of the steps with the SLS. The landing phase and the total movement duration were still longer than in controls no matter which leg was the supporting one. The movements of the upper body remained asymmetrical post-operatively. Hence, these findings show that, although they remain different from those of control subjects, posturomotor control strategies tend to become symmetrical in patients after undergoing successful total knee replacement.

This study has allowed to identify parameters which were significantly modified after TKA. These results, which should be verified in a larger group of patients, provide the means of a new approach to the evaluation of disabilities in patients after undergoing total knee arthroplasty. This study is in accordance with previous authors (6, 8, 9) in that it shows that the performances of patients with TKA, although they become close to normal, remain not normal.

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