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Postural Stability and Proprioception Abnormalities in Patients with Knee Osteoarthritis

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Featured Application: Since proprioception and postural stability are related to clinical and functional performance outcomes, clinical management of patients with knee osteoarthritis (OA) should include their ongoing assessment and training during rehabilitation.

Abstract: Knee osteoarthritis (OA) leads to the damage of all joint components, with consequent proprioceptive impairment leading to a decline in balance and an increase in the risk of falls. This study was aimed at assessing postural stability and proprioception in patients with knee OA, and the relation between the impairment in postural stability and proprioception with the severity of OA and functional performance. Thirty-eight patients with knee OA were recruited. OA severity was classified with the Kellgren–Lawrence score. Postural stability and proprioception were assessed in double- and single-limb stance, in open- and closed-eyes with an instrumented device. Functional performance was assessed using the Knee Score Society (KSS) and the Short Performance Physical Battery (SPPB). Relationships between variables were analyzed. Postural stability was reduced with respect to reference values in double-limb stance tests in all knee OA patients, while in single-stance only in females. Radiological OA severity, KSS-Functional score and SPPB were correlated with greater postural stability impairments in single-stance. Knee OA patients show decreased functional abilities and postural stability impairments. Proprioception seems to be impaired mostly in females. In conclusion, clinical management of patients with OA should include an ongoing assessment and training of proprioception and postural stability during rehabilitation.

Keywords: knee; functional performance; functional abilities; risk of falls; age related diseases; cartilage; standing balance; sensory receptors

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1. Introduction

Knee osteoarthritis (OA) is one of the most common age-related diseases featured by cartilage loss and subchondral bone damage [1,2]. Even if these latter are typically used to quantify disease severity, it is known that knee OA affects almost all of the other components in the knee joint including the ligaments, the menisci, the nerves and the muscles acting on the affected joint [3–6]. It has been postulated for a long time that the degeneration of knee joint proprioception increases as osteoarthritis worsens [4–8]. Sensory receptors located in the knee joint components are damaged resulting in the generation of abnormal proprioceptive sensory signals informing the brain on joint position and joint movement in an incorrect manner [4,9]. The abnormalities in proprioception contribute to a decline in balance control, also defined as postural stability, and as a consequence to an increase in the risk of falls [10–14]. In addition to proprioception impairment, other variables affecting balance have been claimed: muscle strength, radiograph visual indications of the severity of knee OA, pain, and knee alignment [12,15]. A clear relationship between the impairment of balance and proprioception and the degree of functional impairment as measured by means of common scoring systems has not yet been demonstrated [8].

Literature has reported impairments in standing balance and proprioception in people with knee OA both through clinical tests [8,15–17] and laboratory-based measurements [17–20]. These studies clearly show that the lack or the inappropriate proprioceptive information arising from the knee joint has a negative effect on static and dynamic balance control. However, most of these previous researches were based on the instrumental assessment of postural stability in bipodalic stance. Considering that single limb stance is very common during basic movements of daily life such as walking (where single stance lasts about 80% of the gait cycle) or climbing a stair, testing single stance stability seems to be even more of relevance for people showing bipodalic balance impairment. In particular, assessing postural stability in single stance with closed eyes, excluding the visual control, allows indirect evaluation of the effectiveness of the proprioceptive control [21].

Based on these considerations, the aim of this study was to assess postural stability and proprioception in patients with knee osteoarthritis during a double-limb and a single-limb standing postural stability task, and the relation between postural stability and proprioception impairments with the radiological severity of knee OA, and impairments in functional performance as measured by clinical scores.

2. Materials and Methods

2.1. Ethical Issues

This is an observational pilot study approved by the Institutional Ethical Committee (N PG0007673, 28 July 2017) and registered in the Clinicaltrial.gov website with the number NCT03837041. All of the participants signed an informed consent to participate in the study.

2.2. Participants

All the patients admitted in the Surgical Unit collaborating in the project for receiving a total knee arthroplasty (TKA) for symptomatic primary knee OA between April 2018 and March 2019 were assessed for eligibility. Inclusion criteria were age between 45 and 75 years, BMI < 35 [22], ability to stay on a single limb, and absence of known neurological diseases. Exclusion criteria were: previous surgery to both lower limbs, post-traumatic or inflammatory knee OA, valgus/varus deformity (hip knee ankle angle > or < 10°). One hundred twenty patients were considered eligible, 64 patients refused to participate in the study for organizational problems, or because they were not interested in the study. Fifty-six patients agreed to participate in the study. Eighteen patients were excluded as they did not meet inclusion criteria. Thus, 38 patients participated in the study. A flow-chart showing patients' recruitment is reported in Figure 1.

2.3. Assessments and Data Analysis

The functional assessments were performed by one investigator (GB) who was unaware of the knee undergoing surgical intervention.

The radiological severity of knee OA was quantified by visual inspection of the knee radiography, assigning a 0 to 4 score according to the Kellgren–Lawrence scale [23] where 0 = no sign of OA, 1 = doubtful, 2 = minimal OA, 3 = moderate OA, and 4 = severe OA. Two assessors (LL and MGB) assigned the score, and in case of disagreement a third assessor (SZ) was consulted.

The Short Physical Performance Battery (SPPB) [24] was used to clinically assess the function of the lower limbs in terms of balance, walking ability and chair standing. For balance assessment, the test consisted in maintaining a side-by-side, a semi-tandem and a tandem stance for 10 s. Walking ability was assessed measuring the time employed to walk for 4 m. The chair stands required participants to stand-up from a chair for five repetitions, holding arms across the chest. Each test has a score ranging from 0 to 4 where 0 represents the inability to perform the task and 4 represents the best performance according to the test requirements. Final maximal score of the test is thus 12, which represents the highest level of functional ability. The score of each participant was calculated and used for further analysis.

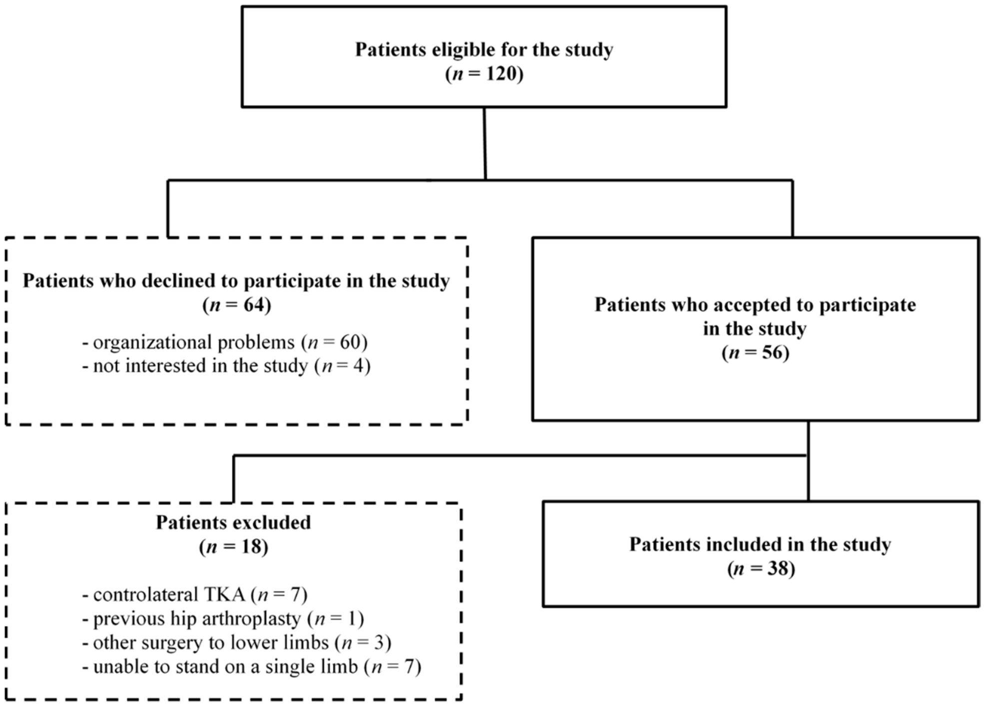

Figure 1. Flow chart showing patients' recruitment.

The Knee Society Score (KSS) [25] was used to assess knee function, pain and mobility. It is composed of two parts: a function score, assessing patient's mobility in terms of walking, stair climbing and the use of walking aids; and a clinical score assessing knee pain, range of motion, joint alignment and stability. The function score (KSS-F) and clinical score (KSS-C) were calculated and used for further analysis. The score of each part ranges from 0 to 100, with 100 representing the highest level of function.

Balance and proprioception were assessed using the Delos Postural Proprioceptive System (Delos S.r.l., Turin, Italy) [21,26,27]. The Delos system is composed of a vertical controller, a horizontal bar and a software for assessment and data analysis. The vertical controller is applied on a patient's sternum with elastic bandaging; following the calibration by means of a specific software (DPPS 6.0), it defines and records the trunk inclination in the frontal (x) and sagittal (y) plane by means of a two-dimensional accelerometer unit. The horizontal bar, instrumented with an infrared sensor, is placed in front of the patient for hand support (Figure 2). The bar measures the number and the duration of hands contact on it. According to Le Clair and Riach [28], postural assessment is assessed during the performance of two tasks: a stabilometric static bipodalic test (double stance test), and a static monopodalic test (single stance test). The double-stance test consists of two trials: the first with open eyes (OE) and the second with closed eyes (CE), while standing on a flat wooden surface with the arms resting at sides for 20 s. The patient is asked to stay still and to minimize body sway. No feedback on postural stability is provided during the tests. Participants are allowed to rest for 15 s after each trial. The variable considered for this test was the Postural Instability value, measured in degrees, both in the OE and CE trials [21]. The single-stance test consists of four trials of 20 s each, standing on the wooden flat surface with the arms aligned at the sides. Two trials are performed with OE, one in single stance support on the right lower limbs, and one on the left limb.

The limb not touching the ground is maintained with knee flexed. The same trials are repeated with CE. The variables considered for this test were: the Stability Index (SI), a score (0–100%) based on two components: autonomy and average postural instability (PIxy, cone of instability). High values of SI in CE trials correspond to refined proprioceptive control, expression of effective proprioceptive reflexes that are able to stabilize the subject rapidly before the vestibular responses can be activated [21]. The difference between OE and CE trials quantifies the Visual Gain, that is the visual dependence of postural stability. In order to compare data from patients to a reference healthy sample of the same age and sex, data provided by the literature [21] were used, similarly to other previously published papers [29,30].

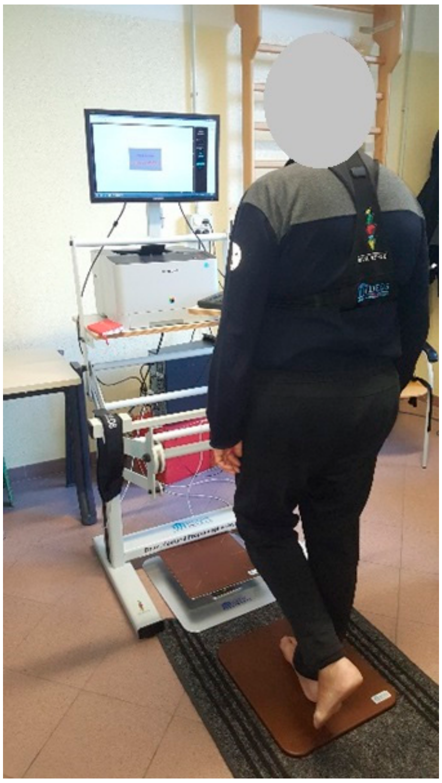

Figure 2. A patient during the single-stance test.

2.4. Statistical Analysis

Descriptive statistics were used to summarize data. The Shapiro–Wilk test was used to test data distribution. A one-way analysis of variance (ANOVA) was used for continuous, normally distributed data, and the Mann–Whitney test was used for independent non-parametric samples, to investigate the differences between male and female patients as well as between KOA limb and contralateral limb. Kendall's Tau correlation was used to assess correlation between ordinal variables (Kellgren–Lawrence). The Spearman rank correlation was used for the correlation between other clinical-functional variables and instrumental parameters. Since a matched population of healthy subjects was not available to compare with KOA patients, differences between the variables obtained from the patients from Delos tests were obtained from comparison with reference data provided by the literature [21]. This was obtained converting means or ratios with 95% confidence intervals to p values. It is based on the idea that, under a normal-distribution assumption, a 95% confidence interval (CI) is about 4 standard errors wide. From the CI it is so possible to estimate the standard error mean (SEM) for each group. Then, the standard error (SE) for the difference between the two group means can be calculated together with the p-value which can be found in a normal distribution table. Since values provided by the literature are provided separately for men and women, this separation was also maintained in the present study.

All statistical analyses were considered significant for $p < 0.05$ and were performed using SPSS v.19.0 (IBM Corp., Armonk, NY, USA).

3. Results

General data on patients were reported in Table 1. Participants were 21 females and 17 males. The mean age of the participants was 66.8 ± 7.6 for females and 69.35 ± 3.9 for males. According to the Kellgren–Lawrence scale 33.3% of patients had a score 3, and 66.7% a score 4. No differences were found between males and females for age, BMI, and Kellgren–Lawrence score. Significant differences were found between males and females for KSS-F ($p = 0.004$) and the SPPB test ($p = 0.001$), where males had a better performance.

Table 1. General data of the patients.

		Mean	SD	*p* Value
Age	F	66.8	7.6	0.60
	M	69.3	3.9	
	all	67.9	6.3	
BMI	F	30.6	5.1	0.11
	M	27.9	3.1	
	all	29.4	4.4	
Kellgren–Lawrence	F	3.6	0.5	0.52
	M	3.7	0.4	
	all	3.6	0.5	
KSS-Clinical	F	57.1	19.0	0.69
	M	54.8	16.5	
	all	56.1	17.7	
KSS-Functional	F	55.2	12.5	0.004
	M	68.5	14.3	
	all	61.1	14.7	
SPPB	F	6.5	2.5	0.001
	M	9.3	2.0	
	all	7.7	2.6	

SD = standard deviation; ANOVA = analysis of variance; F = females; M = males; all = all patients; BMI = body mass index; KSS = Knee Society Score; SPPB = Short Physical Performance Battery.

3.1. Postural Stability and Proprioception Assessment

3.1.1. Double-Stance Test

The mean PI value measured during the double-stance test for males and females was significantly higher with respect to the reference values, both in the OA and CE trials (Table 2).

Table 2. Double limb stance test.

		Mean	SD	*n*	*p* Value
PI-OE	F	0.63	0.23	21	<0.0001
	M	0.66	0.20	17	<0.0001
	all	0.63	0.22	38	
PI-CE	F	0.84	0.27	21	<0.0001
	M	0.82	0.21	17	<0.0001
	all	0.83	0.23	38	
Reference data OE [a]	F	0.45	0.14	117	
	M	0.46	0.13	119	
	all	n.a.	n.a.	-	
Reference data CE [a]	F	0.58	0.17	117	
	M	0.65	0.19	119	
	all	n.a.	n.a.	-	

SD = standard deviation; *n* = number of patients; F = females; M = males; all = all patients; n.a. = not available; PI-OE = Postural Instability open eyes. PI-CE = Postural Instability closed eyes; OE = open eyes; CE = closed Eyes. [a] Reference data from Riva et al. [21] on a sample of patients ranging in age from 65 to 74 years.

3.1.2. Single-Stance Test

The SI and AU values both for OE and CE trials for females and males for the KOA limb are reported in Table 3, and compared with reference values.

Table 3. Single limb stance test.

		SI			*p* Value	AU			*p* Value
		Mean	SD	*n*		Mean	SD	*n*	
Average (KOA limb and contralateral) OE	F	64.5	12.1	21	<0.0001	79.5	14.4	21	0.01
	M	71.2	14.2	17	0.25	85.7	14.8	17	0.40
	all	67.4	13.3	38	-	82.2	14.7	38	-
KOA limb OE	F	59.1	17.9	21	<0.0001	74.8	21.9	21	0.01
	M	69.1	19.7	17	0.21	84.5	20.6	17	0.39
	all	63.5	19.1	38	-	79.1	21.6	38	-
Contralateral Limb OE	F	65.8	19	21	0.02	79.7	21.1	21	0.06
	M	73.2	16.1	17	0.37	86.8	15.3	17	0.39
	all	69.1	17.9	38	-	82.8	18.8	38	-
Reference data OE [a]	F	74.9	20.4	119		858	20.0	119	
	M	76.6	17.5	117		89	17.4	117	
	all	n.a.	n.a.	-		n.a.	n.a.	-	
Average (KOA limb and contralateral) CE	F	36.5	9.5	21	0.06	47.7	13.2	21	0.11
	M	37.4	13.8	17	0.31	50.4	17.0	17	0.40
	all	36.9	11.4	38	-	48.9	14.8	38	-
KOA limb CE	F	37.8	12.9	21	0.21	48.1	15.4	21	0.16
	M	35.3	13.3	17	0.16	48.5	17.2	17	0.36
	all	36.6	12.9	38	-	48.3	16	38	-
Contralateral Limb CE	F	34.4	14.1	21	0.05	46.6	19.0	21	0.14
	M	39.6	16	17	0.40	52.3	19.6	17	0.37
	all	36.7	15	38	-	49.1	19.2	38	-
Reference data CE [a]	F	40	14.6	119		50.5	17.9	119	
	M	41.4	15.8	117		53.2	19.2	117	
	all	n.a.	n.a.			n.a.	n.a.	-	

SI = Stability Index. AU = Autonomy during single limb test; SD = standard deviation; *n* = number of patients; KOA = Knee Osteoarthritis; F = females; M = males; all = all patients; n.a. = not available; OE = open eyes; CE = closed eyes; [a] Reference data from Riva et al. [21] on a sample of patients ranging in age from 65 to 74 years, 117 males and 119 females.

The Stability Index (SI) was found statistically lower with respect to reference values only for females both when considering the average value between the two limbs and also when considering the OA limb and the contralateral limb separately. Correspondently, Autonomy (AU) was significantly lower with respect to reference values both for the average value and for the single limbs.

In the trial with closed eyes (CE) females showed reduced Stability Index values with respect to the reference data, but only for the trial with singles stance on the contralateral limb ($p = 0.05$). As a consequence, Visual Gain, that is the difference between the trial with open eyes and closed eyes, was reduced in the female group (Table 4). No difference was found for males for the Stability Index and Autonomy.

Table 4. Visual Gain.

		Mean	SD	*n*	*p* Value
VG-single average	F	28.0	11.1	21	0.02
	M	33.7	13.8	17	0.39
	all	30.5	12.5	38	-
VG-single reference data [a]	F	35.2	16.0	119	
	M	34.5	15.7	117	
	all	n.a.	n.a.	-	

SD = standard deviation; N = number of patients; F = females; M = males; all = all patients; n.a. = not available; VG = Visual Gain; [a] Reference data from Riva et al. [21] on a sample of patients ranging in age from 65 to 74 years.

No relationship was found between age, BMI and KSS-C with postural stability and proprioception variables. The average Stability Index at OE was also correlated to KSS-F (Rho 0.456, $p = 0.004$) and SSPB (Rho = 0.380, $p = 0.019$), which means that a better KSSF and SPPB score corresponds at higher Stability Index (Table A1).

The radiological degree of knee OA, as measured by the Kellgren-Lawrence score, was significantly correlated to the Stability Index when standing on the KOA limb with OE (tau = −0.277, $p = 0.039$) and with average Stability Index with OA (tau = −0.313, $p = 0.020$), which means that at higher degrees of Kellgren–Lawrence, lower Stability Index was present (Table A2).

4. Discussion

Proprioception is supposed to be compromised with progressive osteoarthritis due to impairment of joint structures and muscles, thus affecting receptors and paths conducting afferent signals. Furthermore, proprioception may be impaired due to the symptoms of osteoarthritis, such as pain and joint oedema [6,31]. Together with visual and vestibular sensory inputs, proprioception is one of the most important factors affecting balance ability. The evaluation of balance and, in particular, proprioception in patients with knee osteoarthritis is thus essential to understand possible effects on functional performance during the activity of daily life, risk of fall and, possibly, to have objective tools for the assessment of rehabilitation and surgical therapeutic strategies outcome.

A recent review [32] reported that although different devices have been used across time to assess balance and proprioception in patients before and after total knee replacement, no standardized comprehensive evaluation protocol presently exists. In the present study an innovative device for postural stability and proprioception assessment, the Delos Proprioceptive System, was used. It demonstrated providing reliable parameters as already reported in the literature [21,29,30]. In particular, the Delos system allows estimating the proprioceptive component of postural stability when standing on single stance with closed eyes. High values of Stability Index in the trial with closed eyes are in fact assumed to be indicative of a more refined control, as expression of effective proprioceptive reflexes that are able to stabilize the patient rapidly before the vestibular responses can be activated [21].

To our knowledge, this is the first time that proprioception assessment is obtained through an objective instrumental measure; most of the research on proprioception evaluation is carried out by means of clinical or instrumental test based on the knee position sense, or sensations of passive, slow knee motion [8].

Findings in the present study on postural stability in double stance confirm previous data reported in the literature in patients with knee OA of a worst performance with respect to healthy people both in the trials with open eyes and closed eyes, when postural stability is assessed via posturography [19]. Usually, when posturography is performed, the velocity and the displacement of the center of pressure are recorded to assess postural stability [19]. Our study differs from previous research since an accelerometer was placed over the trunk of the patients to measure trunk oscillation and displacement. In addition, the device used in our study allowed quantifying the autonomy of the patients in maintaining a steady stance without the need of additional external sensitive information, which in our case was represented by touching a bar.

With regards to single stance tests, only the group of females showed a reduced Postural Stability with respect to the reference data, both when standing on the KOA limb and on the contralateral only in the trial with open eyes. This worst performance is consistent with reduced Autonomy (which means that women spent more time during the test holding the bar placed in front of the patient for hand support, thus avoiding a fall). Since the trials were conducted in an open eyes condition, it should be speculated that these results should be related to a combination of impaired proprioception and impaired balance, but also to a lower muscle strength and worse functional performance abilities, when compared to males. Studies have reported high levels of functional impairments in females' patients with knee OA [33]. Previous research has also reported high pain in females [33], however, in our study, KSS results, which account also for knee joint pain, showed no differences between males and females and thus knee pain should not be the explanation of our results.

Results from trials with closed eyes are also worse in the women patients compared to the reference data, but with results showing a trend to statistical significance only for the contralateral limb ($p = 0.05$), and without significant changes in Autonomy. This result was quite unexpected. Based on the premise that Stability on a single limb eliminating visual control should enlighten the quote of proprioception control, data provided from the present study support this assumption, and only in the female patients. Also, no between-limb differences were found. Considering that patients included in the study were scheduled for a unilateral knee prosthesis, a possible explanation of this symmetry is that knee OA usually affects both knees [34]. Another possible explanation of this result, is represented by the low scores of the Stability Index and the Autonomy of healthy subjects. It is likely to think that performing a single-limb stance task with eyes-closed leads to the recording of low scores for postural stability for patients with knee OA, but also for healthy adults and elderly, in particular if they are sedentary and not involved in balance exercise programs [35,36]. This means that adults/elderly individuals mostly rely on other afferent sensitive information, such as tactile information, more than sensitive information arising from other proprioceptors, when asked to maintain postural stability on a single limb and with eyes closed.

Findings in the male patients also need careful interpretation. Although values reported by these patients were always below the reference values both for SI and Autonomy, and both in the OE and CE trials, evidence from statistical analysis did not demonstrate differences. Some explanation should be hypothesized, such as greater muscle strength in the lower limb, which allows a good compensation to the lack of postural stability in single support, as discussed below.

In general, clinical-functional scores of patients in the present study are not different from values available in other studies on knee OA patients for KSS [37–39] and for SPPB [40–42]. Also, knee OA as radiologically measured by means of the Kellgren–Lawrence score resulted in correlation to the average Stability Index in the open eyes trial, suggesting that a worse functional performance is present in more severe radiological OA. This finding confirms previous evidence of impaired postural stability in patients with osteoarthritis of the knee, especially those diagnosed with grade III or IV degeneration [6,17,20]. The worst performance of women in the clinical-functional scores, namely the KSS-F and SPPB scores, confirm a strong relationship between clinical and instrumental tests, in accordance with previous literature reporting higher levels of disability in females compared to males with knee OA [43]. It has also been reported that females usually have a more severe pathology than males and higher levels of pain [44,45], but, in our findings, females did not show significant differences with men in the radiological level of knee OA, and in the KSS-C, which includes pain assessment. Other factors, such as muscle strength, or previous and current physical activity level, might give important information for the interpretation of this result. In particular, quadriceps strength, one of the main features of knee OA [46] which has been shown to be more reduced in women than in men with knee OA [47,48], has a significant correlation with static and dynamic balance [23,49].

In light of the impairments in postural stability and proprioception found in this study, it is essential to address clinical practice towards ongoing assessments of postural stability and proprioception in patients with knee OA, in particular in those patients who chose a conservative treatment rather than the surgical intervention for TKA, and in particular in female patients. The observation that the measures of postural stability and proprioception are related to clinical and functional scores further support these observations. It seems thus that the implementation of specific rehabilitation interventions should be paramount in order to improve postural stability and proprioception [50], and assess their effectiveness on clinical and functional scores.

Some limitations need to be mentioned for this study. The sample of patients included in the study is small. A high proportion of the patients who were asked to participate in the study at the pre-admission clinic refused to participate. Furthermore, a high number of the patients did not meet the inclusion criteria and thus they were excluded from the study since they had other medical conditions potentially affecting postural control and proprioception. While this gives the sample greater homogeneity, on the other hand the findings could be biased. Furthermore, it was not possible to carry out a priori a power analysis since, for the proprioceptive test used, mean and standard deviations values useful for performing a statistical analysis were not available. In fact, the device used in this study for postural control and proprioception assessments, to the best of our knowledge, has never been used in patients with knee OA. It should be noted however that the number of patients in this study is in the range of samples included in other studies [3,7,16,18]. Also, the contralateral limb was not assessed for OA. In most of the cases OA affects both limbs. Thus, the lack of difference between the affected and the contralateral limb reported in this study should be considered in light of this limitation. Future studies should consider OA assessment in both limbs. Another limitation of the study was the lack of a matched healthy control group assessed comparatively with OA patients, which we tried to overcome comparing data from literature on the device [21]. It was not possible to make further comparisons with previous studies, since participants in other studies using the same device were different from patients with knee OA, as they were affected by other orthopedic conditions [29,30] or were in other age ranges [27].

5. Conclusions

In conclusion, patients with OA showed postural instability during double stance, confirming the previous literature. Postural stability on a single-limb stance was decreased only in females. Postural stability was in general strictly related to the radiological severity of knee osteoarthritis and with clinical-functional tests. Results on the estimation of proprioception need to be corroborated by further studies with more refined and sophisticated methodologies of assessment of proprioception and postural stability, as well as on a wider sample of patients with a healthy matched control group of participants, in order to confirm findings of the present study and to make available a reference database for any outcome measure following rehabilitation or surgery on knee osteoarthritis. In addition, since proprioception and postural stability are related to clinical and functional performance outcomes, clinical management of patients with knee OA should include their ongoing assessment and training during rehabilitation.

Author Contributions: M.G.B., L.B. and S.Z. contributed to the study conception and design. Material preparation, data collection and analysis were performed by L.L., G.B. and M.G.B. All authors contributed to the interpretation of the data. L.L. wrote the first draft of the manuscript, which M.G.B. critically revised. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the IRCCS – Istituto Ortopedico Rizzoli (N PG0007673, 28 July 2017).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

In Appendix A are represented Tables A1 and A2 reporting Spearman's and Kendall's correlation analysis results, respectively.

Table A1. Spearman's correlations.

		Age	BMI	KSS-C	KSS-F	SPPB
PI OE	Rho	−0.173	−0.125	0.199	0.147	−0.052
	p	0.314	0.467	0.246	0.393	0.765
PI CE	Rho	−0.114	−0.186	−0.067	0.058	−0.044
	p	0.509	0.276	0.697	0.735	0.800
SI OE-KOA limb	Rho	0.145	−0.204	0.143	0.492	0.518
	p	0.384	0.219	0.393	0.002	0.001
SI CE-KOA limb	Rho	−0.019	−0.142	−0.098	0.137	0.048
	p	0.912	0.396	0.557	0.413	0.776
SI OE-CONTRALATERAL limb	Rho	0.181	−0.131	−0.027	0.246	0.121
	p	0.277	0.433	0.870	0.137	0.469
SI CE-CONTRALATERAL limb	Rho	−0.162	−0.357	−0.064	0.226	0.207
	p	0.330	0.028	0.702	0.172	0.213
SI Average (KOA limb and contralateral) OE	Rho	0.212	−0.185	0.090	0.456	0.380
	p	0.201	0.265	0.591	0.004	0.019
SI Average (KOA limb and contralateral) OC	Rho	−0.153	−0.319	−0.145	0.174	0.096
	p	0.360	0.051	0.385	0.295	0.565

BMI = body mass index; KSS-C = Knee Society Score-Clinical; KSS-F = Knee Society Score Functional; SPPB PI-OE = Postural Instability open eyes. PI-CE = Postural Instability closed eyes; SI = Stability Index; SI OE = Stability Index open eyes; SI CE = Stability Index closed eyes; AU OE = Autonomy open eyes; AU CE = Autonomy closed eyes; AU = Autonomy; KOA = Knee Osteoarthritis.

Table A2. Kendall's correlations.

Kellgren-Lawrence Score		
PI OE	tau	0.218
	p	0.117
PI CE	tau	0.150
	p	0.278
SI OE-KOA limb	tau	−0.277
	p	0.039
SI CE-KOA limb	tau	−0.160
	p	0.235
SI OE-CONTRALATERAL limb	tau	−0.237
	p	0.078
SI CE-CONTRALATERAL limb	tau	0.004
	p	0.975
SI Average (KOA limb and contralateral) OE	tau	−0.313
	p	0.020
SI Average (KOA limb and contralateral) OC	tau	−0.069
	p	0.606

PI-OE = Postural Instability open eyes. PI-CE = Postural Instability closed eyes; SI = Stability Index; SI OE = Stability Index open eyes; SI CE = Stability Index closed eyes; AU OE = Autonomy open eyes; AU CE = Autonomy closed eyes; AU = Autonomy; KOA = Knee Osteoarthritis.

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