Lateral trunk sway measured with an accelerometer in patients before and after TKA

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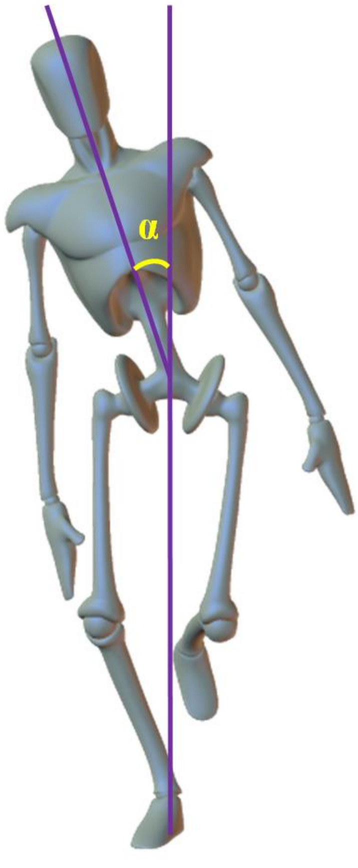

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Preface

In front of you is my thesis I wrote during my study Human Movement Technology at The Hague University of Applied Science. After a lot of blood, sweat and tears this is the result of five months hard working.

I am thankful to all the people who helped me during the whole process which has led to this thesis. First, I would like to thank Hubert as my first supervisor, he kept telling me to not lose myself in detail and keep going with the important subjects. Furthermore, I want to thank Caroline as my second supervisor. She helped me a lot to improve the quality of my article with her to-the-point feedback.

Since I worked at the Reinier de Graaf Gasthuis during the whole process I would also like to thank my external supervisors. Nina, who was always there to help. When there was a lot of chaos in my head, she helped to organize my thoughts and gave feedback on my thesis many times. Laura, who helped me with writing the Matlab scripts. I want to thank her for her patience in explaining the complicated issues in a clear way. Last, but not least, I want to thank Nicole for her pleasant cooperation during the inclusion of the patients. I learned a lot about her professional attitude towards patients.

I hope you will enjoy reading my thesis.

Kind regards,
Ruth Elzinga

Table of contents

1. Abstract

Introduction Lateral trunk sway has never been assessed with an accelerometer in patients before and after total knee arthroplasty (TKA). Therefore, the purpose of this study is to determine the effect of a TKA-implant on lateral trunk sway amplitude with an accelerometer before and six weeks after TKA.

Method 11 patients were assessed before and six weeks after TKA. During gait analysis, patients walked 50 meters twice. The lateral trunk sway amplitude was determined by using a DynaPort Hybrid. In this way, accelerometer and gyroscope data were collected. Data analysis was performed with Matlab (R2010a, MATLAB©, Mathworks).

Results No significant difference was found in lateral trunk sway before and six weeks after TKA. In three patients, the lateral trunk sway angle decreased six weeks after surgery.

Conclusion No significant difference is found in lateral trunk sway before and six weeks after TKA. Further research is needed wherein knee adduction moment, muscle strength of the hip abductors and lateral trunk sway should be assessed.

Inleiding Laterale romp beweging is nog niet eerder onderzocht met een accelerometer bij patiënten voor en na totale knie arthroplastiek (TKA). Daarom is het doel van deze studie het bepalen van het effect van een TKA-implantaat op de amplitude van de laterale romp beweging, gemeten met een accelerometer voor en zes weken na TKA.

Methode Er werd bij 11 patiënten metingen gedaan voor en zes weken na TKA. Tijdens de loopanalyse liepen patiënten twee keer 50 meter. De amplitude van de laterale romp beweging werd bepaald met een DynaPort Hybrid. Daarbij werd accelerometer en gyroscoop data verzameld. Data-analyse werd uitgevoerd met Matlab (R2010a, MATLAB©, Mathworks).

Resultaten Er is geen significant verschil in laterale romp beweging voor en zes weken na TKA. Zes weken na de operatie was bij drie mensen de laterale romp beweging afgenomen.

Conclusie Er is geen significant verschil gevonden in laterale romp beweging voor en zes weken na TKA. Vervolgonderzoek is nodig waarbij het knie adductie moment, spierkracht van de heup abductoren en de laterale romp beweging wordt bepaald.

2. Introduction

Osteoarthritis (OA) is the most common joint disease in the world (1) by which the knee joint is most commonly affected (2). In the UK 18.1% of the adults of 55 years and older are clinically diagnosed with OA of the knee (1). People with OA suffer from a variety of physical impairments such as pain, stiffness, and chronic fatigue, which leads to restrictions in self-care and mobility (3). When patients suffer from severe OA, the surgical treatment of choice is often total knee arthroplasty (TKA) (4). In 2014, 26.754 TKAs were performed in the Netherlands according to the national registry of orthopedic implants for the Netherlands (5). The population of elderly people in the Netherlands is growing, which increases the probability of growth in number of TKAs.

OA of the knee is characterized by degeneration of the articular cartilage (6). As a result of abnormal high knee joint loading the articular cartilage is damaged. Cartilage has limited self-repair ability and therefore the risk of OA increases (6;7). Due to this damage of the articular cartilage, most patients have knee pain (6). Lateral trunk sway reduces the forces on the medial side of the knee joint (7). By moving the trunk laterally, the center of mass of a subject shifts laterally, in the direction of the rotation center of the knee joint. This will decrease the lever arm of the ground reaction force (Fg) and thereby reduce the knee adduction moment (KAM) (Fig 1) (7).

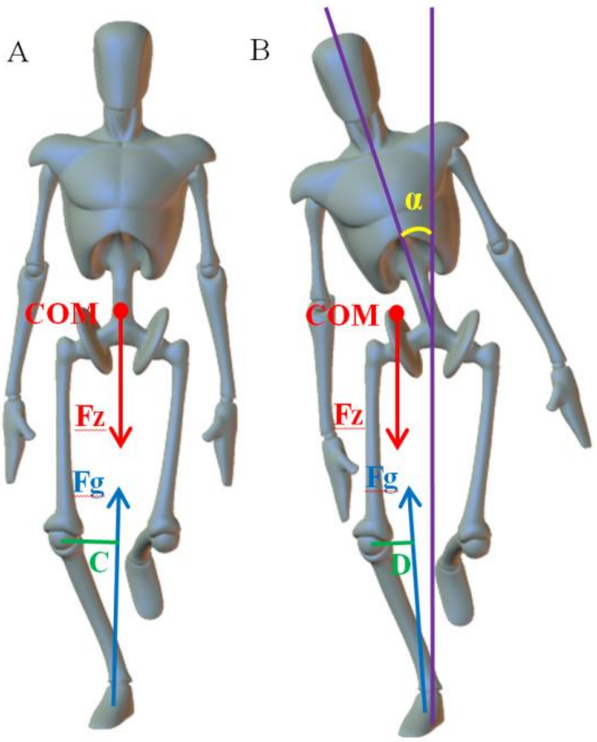

Figure 1 COM: center of mass, Fz: gravity, Fg: ground reaction force, α: half of the lateral trunk sway angle, C and D: Lever arm of Fg. (A) unconstrained walking, ground reaction force is situated on the medial side of the knee causing a moment around the knee (B) walking with lateral trunk sway, the COM shifts laterally and thereby the moment arm of the knee reduces (D<C). This causes a reduction of the moment around the knee in the coronal plane (8;9).

The KAM is defined as the product of the ground reaction force in the frontal plane and its lever arm with respect to the knee. In patients with OA an increased KAM is present when compared to healthy subjects (10;11). Lateral trunk sway can be used to decrease the KAM (7;12). This mechanism is relevant because an increased KAM is a risk factor of progression of OA (10). After TKA the KAM decreases due to the recovery of the knee alignment (13). Because of this, it is expected that lateral trunk sway decreases after TKA.

Besides lateral trunk sway, a pelvis drop because of reduced hip abductor strength can also influence the lateral trunk sway (14). When this occurs the lateral trunk sway increases. However, hip abductor strength needs at least 7 month to recover after TKA (15). Therefore, this factor will not change significantly within the timeline of this study.

The lateral trunk sway amplitude is defined as the angular displacement of the trunk relative to the vertical whereby the movement to the left and the right are summed. As measured in previously conducted studies, the angular displacement of the trunk is larger in patients with OA compared to control subjects(11;16). In control subjects the average range of motion of the lateral trunk sway is 3.2° (16;17). The average lateral trunk sway angle in patients with OA is 7.2° (8;18). In these studies, lateral trunk sway is captured with a 3D camera motion capture system.

Measurements with a 3D camera motion capture system can only be performed in a laboratory setting and over a short walkway or on a treadmill. As such, in order to perform measurements in a clinical settings and over a longer walkway, an accelerometer will be more appropriate. According to Zijlstra et. al. (2008) trunk movement can easily be measured in a hospital environment by using an accelerometer (19). Furthermore, this method is used in patients before and after hip arthroplasty and there found to be reliable to measure gait improvement (20). However, no studies are known regarding the trunk movement in patients before and after TKA that are measured with an accelerometer.

Therefore, the purpose of this study is to determine the effect of a TKA-implant on lateral trunk sway amplitude measured with an accelerometer before and six weeks after TKA.

It is hypothesized that the lateral trunk sway amplitude will decrease after surgery compared to pre-surgery because lateral trunk sway is seen as a compensatory mechanism to reduce the KAM. After TKA the KAM is reduced and therefore it is expected that the lateral trunk sway will also be reduced.

3. Method

Subjects

For this retrospective cohort study, 11 consecutive patients who received a TKA were willing to participate in this study. The patients were included between July 7th 2015 and April

18th 2016. Patients were included if they were between 18 and 75 years old. Patients were excluded if they had osteoporosis, skeletal immaturity, neuropathic arthroplasty or if they were participating in any other surgical intervention study or pain management study. The patient's demographic characteristics are presented in Table 1. The study was approved by the local medical ethics committee. All patients signed written informed consent.

Table 1 Demographic characteristics of study patients. In gender and side of TKA the number of patients and percentage of total is shown.

		Group 1 (n=11) Mean (SD)
Age (year)		67.0 (6.0)
Length (m)		1.70 (0.07)
Weight (kg)		92 (18.3)
BMI (kg/m^2)		32 (5.4)
Gender	Female	9 (81.8%)
	Male	2 (18.2%)
Side TKA	Left	5 (45.5%)
	Right	6 (54.5%)

Procedure

The data were collected in the Medisch Centrum Alkmaar, a hospital in the Netherlands. Patients were assessed before and six weeks post-surgery. To measure the lateral trunk sway amplitude, the patients walked 50 meters twice with a DynaPort accelerometer at a self-selected speed. The accelerometer was attached to the waist of the subject with an elastic Velcro strap, positioned at the level of the sacrum (Fig. 2). The trial was performed in the hallway of the hospital on a smooth, horizontal surface. During the gait analysis, patients wore their own footwear.

During the measurement, accelerometer and gyroscope data was collected with a DynaPort Hybrid (DynaPort Hybrid, McRoberts B.V., The Hague, The Netherlands).

The data was recorded with a sample frequency of 100Hz. Data collection was performed by two investigators.

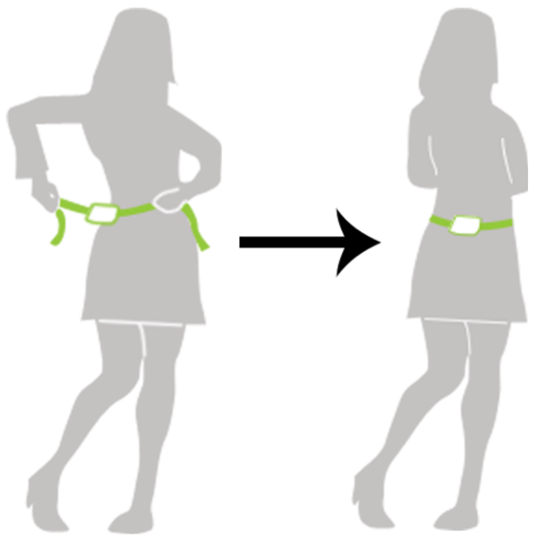

Figure 2 Position of the DynaPort during the twice 50-meter walking trial

Data analysis

The second 50-meter walk was selected for analysis of the data. Signal processing was performed with Matlab (R2010a, MATLAB©, Mathworks). To analyze a steady gait, the first few and last few steps of each trial were removed during data analysis with Matlab.

Lateral trunk sway amplitude

The lateral trunk sway amplitude was determined according to the method of Zijlstra et. al. (2008) (19). To determine the lateral trunk sway, the gyroscope data of the anterior-posterior axis was used. Since the gyroscope signal is sensitive to drift, the gyroscope signal was high pass filtered with a fourth order Butterworth filter with a filter frequency of 0,30 Hz (19). Furthermore, to determine the lateral trunk sway, the gyroscope signal of the medial lateral axis was integrated. Lateral trunk sway is a low-frequent movement and by filtering, the low frequent part of the data was lost. This loss of the low frequency spectrum of the gyroscope signal decreased the validity of the results. To compensate for this loss, the low pass filtered medio-lateral accelerometer signal (fourth order Butterworth filter, filter frequency 0.30 Hz) was added to the gyroscope signal (19). In order to determine the extreme values of this summed signal, a peak detection was used. The difference between a consecutive maximum and minimum is the range of motion of the lateral trunk sway during walking. Subsequently, the average range of motion of the lateral trunk sway during ten stride cycles was determined.

Statistics

To perform statistical analysis, IBM SPSS Statistics (version 21) was used. The non-parametric Wilcoxon signed ranks test was used because of the small number of measurements. A $p < 0.05$ was considered statistically significant.

4. Results

Fig. 3 shows an example of the integrated gyroscope signal and accelerometer signal whereby lateral trunk sway angles are determined. The maximum and minimum points of the summed gyroscope and accelerometer signal are shown by red circles. The difference between those two points is the lateral trunk sway amplitude.

No significant differences in lateral trunk sway were found before and six weeks after TKA (Table 2).

In fig. 4 the results of the lateral trunk sway angles, pre-surgery and post-surgery, of all eleven patients are shown. In three patients there was a decrease of lateral trunk sway six weeks after surgery when compared to pre-surgery. All other eight patient values were equal or increased six weeks after surgery.

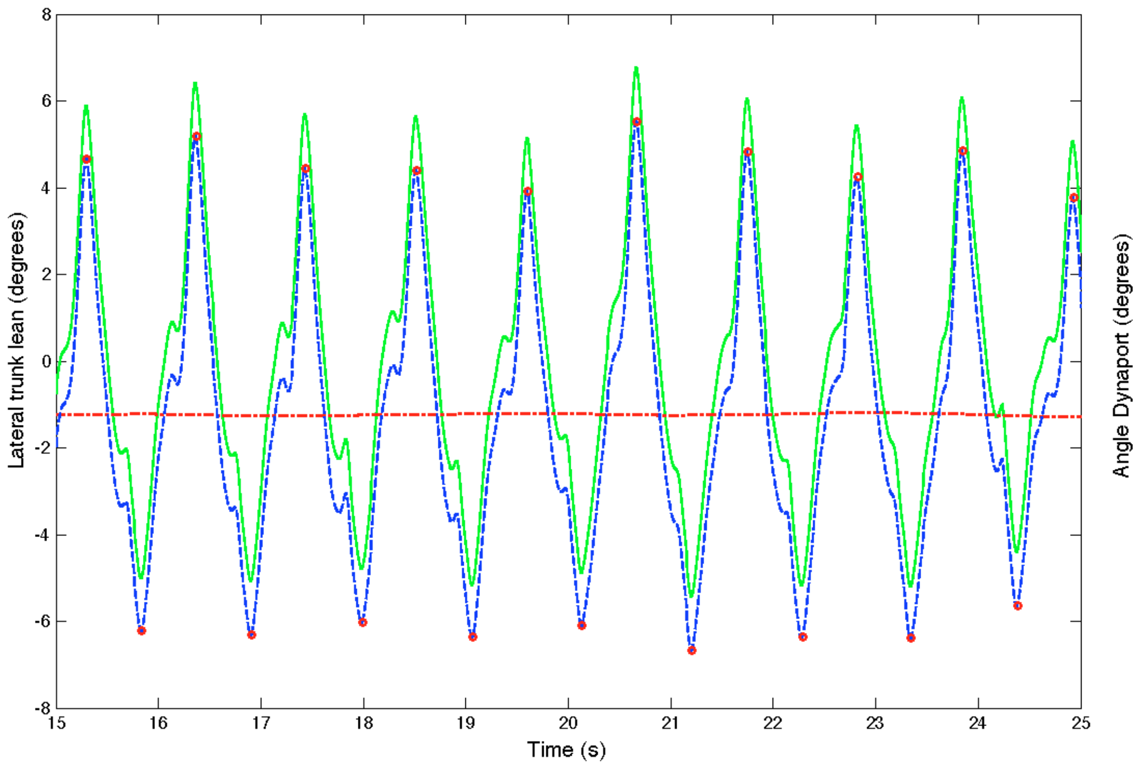

Figure 3 An example of ten seconds of the analyzed data from the DynaPort Hybrid of one patient (305) six weeks post-surgery during the 50-meter walking trial. Red line: Angle DynaPort, Green: gyroscope signal, Blue: summed signal of angle DynaPort and gyroscope signals Red circles: maxima and minima. Amplitude of the lateral trunk sway ranges from a maximum to a minimum.

Table 2 Results group 1 of pre- and 6 weeks post-surgery. The data was analyzed with Wilcoxon signed ranks test. n= 11 *: Significant at p<0.05 IQR: interquartile range

	Pre-surgery		6 weeks post-surgery		
	Median (IQR)	Range	Median (IQR)	Range	P-value*
Lateral Trunk Sway (°)	6.19 (3.01)	4.20-11.08	6.15 (4.53)	2.84-10.84	0.722

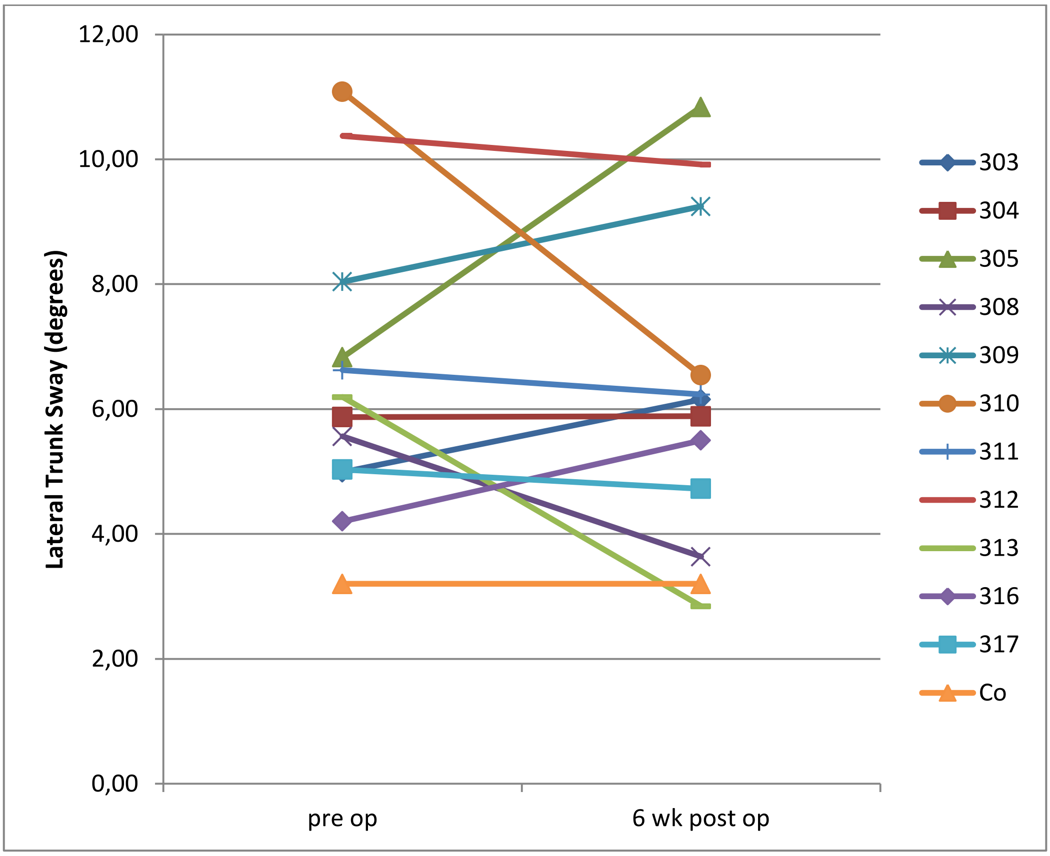

Figure 4 Lateral trunk sway angles of all 11 patients of group 1 pre-surgery and 6 weeks post-surgery. Co: value of healthy control subjects from literature (16).

5. Discussion

This retrospective cohort study evaluated the lateral trunk sway before and six weeks after TKA.

In this study no difference regarding lateral trunk sway is found six weeks after TKA compared to pre-surgery. Before surgery, all eleven patients showed increased trunk sway angles compared to the healthy subjects from literature (16) (Fig. 4). Post-surgery, 81.8 % (nine patients) of the patients still showed an increased lateral trunk sway compared to the healthy subjects from the literature (16).

Several studies show that lateral trunk sway is larger in patients with OA compared to control subjects (11;16). In control subjects the average range of motion of the lateral trunk sway is 3.2° (16;17) and 7.2° in patients with OA (8;18). This is in accordance with the results of this study. However, the magnitude of the lateral trunk sway angle varied greatly between patients. It ranged between 2.84° and 11.08°. This corresponds to the results of Tazawa et. al. (2014) (21). This article shows standard deviation values that are almost equal to the mean lateral trunk sway. This implies a large variation between measurements. Because the great variation between measurements in both this study and literature, it is likely that other factors than lateral trunk sway have an influence on the measurements.

Many studies demonstrate a relation between lateral trunk sway and KAM (7-9;12). Lateral trunk sway is seen as a compensatory mechanism due to the increased KAM in patients with OA (22). If lateral trunk sway is caused by an increased KAM, the lateral trunk sway should reduce after TKA because the KAM decreases after TKA due to the recovery of the knee alignment (13). However, the average lateral trunk sway angle in this study did not change. This result implied a one-way causality between KAM and lateral trunk sway. Lateral trunk sway can reduce the KAM, but a reduced KAM might not reduce the lateral trunk sway. Hence, the lateral trunk sway might be caused by another factor than the KAM.

Tazawa et. al. (2014) presented a theory that lateral trunk sway is caused by muscle weakness of the hip abductors (21). This mechanism is confirmed by the research of Takacs and Hunt (2012) (14). Muscle weakness is still present in patients four to six weeks after TKA because muscle strength needs seven months to two years to recover (15). To evaluate the effect of the hip abductor strength, patients need to be evaluated at least 7 months after TKA.

In future research, the KAM, muscle strength of the hip abductors and lateral trunk sway should be assessed. Furthermore, patients should be assessed longer after TKA, at least 7 months after it.

To evaluate lateral trunk sway, accelerometry was used. This is a method which has not been used before for gait analysis in patients who underwent TKA. However, accelerometry is commonly used in other patient groups. It is a reliable method to analyze gait in patients before and after hip arthroplasty (19;20). Additionally, Zijlstra et. al. (2008) found high correlation (≥0.87) between measurements with a 3D camera motion capture system and with a body fixed sensor in healthy subjects and hip arthroplasty patients (19). Therefore, this method is reliable to use in patients before and after TKA.

Several limitations of this study should be mentioned.

With the current method, it was not possible to measure the difference between the lateral trunk sway to the right and to the left. It was only possible to measure the total range of motion of the lateral trunk sway. This was because of the unknown position of the DynaPort relative to the patient. It was not possible to place the DynaPort in the exact same position on the back of the patient every time. Nor was it known when the patient was standing in the perfect upright position. These two unknown variables make that the discrimination between the movement to the left and right was impossible with the method used in this study. However, when the lateral trunk sway to the left or right changes, the range of motion will change too as this the sum of the lateral trunk sway in both directions. Therefore, with this method, a change in lateral trunk sway can be found.

Secondly, lateral trunk sway was determined in only eleven patients. From such a small set of measurements, no conclusion can be drawn with confidence. In future research a larger group of patients should be included.

Another limitation was the use of the same filter frequency for all measurements in determining lateral trunk sway. The accelerometer signal consists of two components, one relative to gravity and one depending on linear acceleration (19). In the method used, only the component relative to gravity was considered. Therefore, the accelerometer signal needs to be filtered until no sinusoid of the gait is visible in the graphs of the data. For each measurement this filter frequency is different. To get the most accurate results, a filter frequency that resulted in the smallest standard deviations should be used. A single filter frequency, which was on average seen the most suitable was used for all measurement. This means that in some cases the filter frequency was too high and in other cases too low. This can have had influence on the results of this study. However it is unknown how the results were affected.

6. Conclusion

No significant differences were found in lateral trunk sway before and six weeks after TKA. Further research is needed where a greater number of patients with OA are included and KAM, hip abductor strength and lateral trunk sway are measured. Patients should also be assessed at least 7 months after surgery.

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Appendix 1

Table 1 Lateral trunk sway angles of all eleven patients pre-surgery and 6 weeks post-surgery

PP	pre op (°)	6 wk post op (°)
303	4,99	6,15
304	5,87	5,89
305	6,83	10,84
308	5,56	3,64
309	8,04	9,25
310	11,08	6,54
311	6,62	6,23
312	10,37	9,92
313	6,19	2,84
316	4,20	5,50
317	5,03	4,72

Appendix 2

Projectplan thesis

1. Introduction

Osteoarthritis (OA) is the most common joint disease in the world (1) of which the knee joint is most commonly affected. (2) In the UK 18,1% of the adults of 55 years and over are clinically diagnosed with OA of the knee.(1) People with osteoarthritis suffer from a variety of physical impairments such as stiffness and chronic fatigue, which leads to restrictions in self-care and mobility.(3) These physical impairments are associated with an impairment of physical health and thereby a lower quality of life. (3) In patients who suffer from mild to moderate OA, the treatment of choice is exercise therapy and pharmacological intervention.(4)

When patients suffer from severe OA and conservative treatment is not sufficient to reduce the symptoms, the surgical treatment of choice is often Total Knee Arthroplatsy (TKA). (5) In 2014, 26.754 TKAs were performed in the Netherlands according to the national registry of orthopedic implants for the Netherlands.(6) The population of elderly people in the Netherlands is growing, which causes a growing number of TKAs. (6)

The Knee Adduction Moment (KAM) is the medial-lateral component of the ground reaction force during the stance phase. This is an important factor in progression of knee OA.(7;8)Normal mechanical knee joint loading is essential for healthy use of the articular cartilage.(9) In patients with knee OA an increased KAM is found.(9;10) In biomechanical terms the difference of the KAM between healthy people and patients with OA of the knee can be explained with lateral trunk lean. Trunk movement can be used to shift the center of mass of a subject which reduces the KAM.(9)

In previously conducted studies, lateral trunk lean is captured with a camera motion capture system. These studies concluded that lateral trunk lean is present in patients with OA.(8;11;12) The measurements with a camera motion capture system can only be performed in a laboratory setting and over a short walkway. With an accelerometer it is possible to perform measurements in a clinical settings and over a longer walkway. However, no studies are known regarding the trunk movement in patients before and after TKA, measured with an accelerometer.

When the spatiotemporal parameters are assessed in patients with severe knee OA, a significant difference is found in cadence, velocity, step length and step time compared to a healthy control group. (13) Not much is known about the improvement of these parameters before and 3 months after TKA. Alice et. al. found some small, but not significant differences in gait velocity and step length. (14) To our knowledge, no research has been done that might confirm these findings.

Therefore, the purpose of this study was to evaluate the effect of TKA on gait in patients before and six weeks or three months after TKA.

What is the effect of a TKA-implant on lateral trunk lean before and six weeks after TKA?

What is the effect of a TKA-implant on spatiotemporal parameters before and six weeks or three month after TKA?

2. Method

Subjects

For this study, all consecutive patients who will receive TKA and who met the inclusion and exclusion criteria will be included in this study.

In order to be eligible to participate in this study, a subject has to meet all of the following inclusion criteria:

1. Patient is 18 to 75 years of age.

2. Patient qualifies for a primary total knee arthroplasty based on physical exam and medical history, including diagnosis of severe knee pain and disability due to at least one of the following:
    a. Rheumatoid arthritis or osteoarthritis or traumatic arthritis or polyarthritis
    b. Collagen disorders and/or avascular necrosis of the femoral condyle
    c. Post-traumatic loss of joint configuration, particularly when there is patellofemoral erosion, dysfunction or prior patellectomy
    d. Moderate valgus, varus, or flexion deformities
    e. The salvage of previously failed surgical attempts that did not include partial or total knee arthroplasty of the ipsilateral knee
3. Patient is willing and able to complete scheduled study procedures and follow-up evaluations
4. Independent of study participation, patient is a candidate for commercially available Zimmer Persona knee implants implanted in accordance with product labeling

A potential subject who meets any of the following criteria will be excluded from participation in this study:

1. Patient is currently participating in any other surgical intervention studies or pain management studies
2. Previous history of infection in the affected joint and/or other local/systemic infection that may affect the prosthetic joint
3. Insufficient bone stock on femoral or tibial surfaces
4. Skeletal immaturity
5. Neuropathic arthropathy
6. Osteoporosis or any loss of musculature or neuromuscular disease that compromises the affected limb
7. Stable, painless arthrodesis in a satisfactory functional position
8. Severe instability secondary to the absence of collateral ligament integrity
9. Rheumatoid arthritis accompanied by an ulcer of the skin or a history of recurrent breakdown of the skin
10. Patient has a known or suspected sensitivity or allergy to one or more of the implant materials
11. Patient is pregnant or considered a member of a protected population (e.g., prisoner, mentally incompetent, etc.)
12. Patient has previously received partial or total knee arthroplasty for the ipsilateral knee.

All patients signed written informed consent. Thereby, this study was approved by the local medical ethics committee.

Design

The data will be collected in two hospitals in the Netherlands: Reinier de Graaf Gasthuis in Delft and Medisch Centrum Alkmaar in Alkmaar. Each hospital will include 50 consecutive patients. The data will be collected pre-surgery and at the hospital in Alkmaar six weeks post-surgery and in Delft three month post-surgery. Data collection will be performed by three different investigators.

To measure gait speed, the patient will be asked to walk 4 times 10 meters at self-selected speed. The duration will be measured with a stopwatch.

To measure spatiotemporal parameters, a DynaPort accelerometer will be used. (McRoberts B.V., The Hague, The Netherlands) The data will be recorded with a sampling frequency of 100Hz. With the accelerometer data, step length, cadence, step time will be measured. (15-18) The patient has to walk two times 50 meters with a DynaPort accelerometer at a self-selected speed. The accelerometer will be attached to the waist of the subject with an elastic Velcro strap, positioned at the level of the sacrum. To measure lateral trunk lean, gyroscope data will be collected with the accelerometer from all patients in Alkmaar.

Data analysis

Processing of the DynaPort signal will be performed with Matlab (Version R2010a).

According to the study of Zijlstra et. al. it is possible to measure lateral trunk lean with a body fixed sensor. (17) To determine the orientation of the accelerometer, the gyroscope signal will be integrated. To correct for internal drift, the raw gyroscope data will be high-pass filtered. Filtering a signal will cause loss of a part of the data, which can cause an underestimation of the angle of the accelerometer. To compensate for this loss, the accelerometer signal will be added to the filtered gyroscope data. (19)

To determine step time, the forward acceleration data will be used. During the transition from single to double support the forward acceleration changes into a deceleration. Therefore, the turning point between forward acceleration and deceleration is the point of foot contact.(18) The time between the moments of foot contact is the step time. To determine the difference between left and right step the medio-lateral acceleration signal will be used.

With the step time the cadence, number of steps per minute will be calculated.To determine the walking speed, the average of the four trials will be calculated. Subsequently the walking speed in meters per second will be calculated. Step length will be determined using the cadence and walking speed.

Statistics

To perform statistical analysis, SPSS will be used. To determine whether the sample data is normally distributed the Kolmogorov-Smirnov test will be used. As the data distribution is normal, parametric test will be used, i.e. a paired sample t-test. When the data is not normally distributed a nonparametric test, the Wilcoxon signed rank test, will be used. A $p< 0,05$ will be considered statistically significant.

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4. Planning

	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24
Begin en einde afstuderen																		
Metingen doen	3	3	3	3	3	3	3	3	3	3	3							
Literatuur onderzoek	10	10	10	10														
Matlab script schrijven					26	25	26	25	26	25								
Data analyse											20	22	23					
Schrijven Artikel	10	10	10	10	2	2	2	2	2	2	8	8	8	30	31	30	31	30
Contact 1e begeleider				1		1		1		1		1		1		1		1
Contact met Nina	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Totaal aantal uren	24	24	24	25	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Totaal te werken uren*	532																	
Ingeplande uren vanaf week 7	545																	

*: te werken uren is gebaseerd op 14 weken afstuderen met een belasting van 38 uur in de week

Appendix 3

Persoonlijke leerdoelen afstudeerfase

Leerdoel 1

Ik wil mijzelf ontwikkelen in het doen van onderzoek en het schrijven van een artikel in het Engels.

Dit leerdoel valt binnen het facet van het schrijven van het artikel. Ik ga dit artikel geheel in het Engels schrijven en zal daarin concreet feedback vragen over de schrijfstijl van mijn Engels aan mijn begeleider vanuit het Reinier de Graaf Gasthuis en de begeleider van school

Evaluatie
Over de ontwikkeling naar aanleiding van dit leerdoel ben ik tevreden. Zoals gezegd heb ik heel mijn artikel geheel in het Engels geschreven en mij daarmee ontwikkeld op het gebied van communicatie. Daarnaast heb ik feedback gekregen over de schrijfstijl van mijn Engels door docenten, extern begeleiders en anderen met veel kennis van de Engelse taal. Om een voorbeeld te geven: van mijn tweede begeleider, Caroline Doorenbosch, heb ik feedback ontvangen over de volgorde in een zin. Zij gaf aan dat het belangrijk is om de boodschap van een zin vooraan te zetten. Dit heb ik vervolgens in mijn verdere schrijfproces kunnen toepassen.
Daarnaast heb ik tijdens dit onderzoek mijzelf kunnen ontwikkelen op het gebied van ICT. Voor de analyse van de DynaPort bestanden moest ik mijn eigen Matlab script schrijven. Door hier veel tijd in te steken en feedback te vragen aan begeleiders is dit uiteindelijk gelukt. Hier heb ik veel van geleerd. Door fouten te maken en deze vervolgens op te lossen door uit te zoeken wat er precies fout gaat. Specifieke vragen stellen aan begeleiders heeft mij ook veel geholpen hierbij. Tijdens dit proces ben ik tegen een aantal ingewikkelde problemen aangelopen waar mijn begeleiders niet direct een antwoord op wisten. Dat heeft mij ook geleerd om als ik zelf het antwoord niet meer weet toch verder te gaan. Ik heb daarbij ook andere mensen om hun ideeën gevraagd en dat was erg leerzaam.
Naast deze algemene beroepsgerichte competenties heb ik mij op bewegingstechnologie gebied ontwikkeld in de bewegingsanalyse en testen en uitvoeren.
Voor de competentie bewegingsanalyse heb ik vooral geleerd hoe lastig de keus is voor een bepaalde manier van registreren. Elke methode heeft voordelen en nadelen. Doordat deze keus al voor het begin van mijn afstuderen was gemaakt kon ik aan de keuze niks veranderen. Echter, de problemen waar ik tegenaan liep daardoor werd mij nog duidelijker dat de keuze voor meetmethode essentieel is voor het slagen van een onderzoek.
Op het gebied van testen en onderzoeken heb ik me met name ontwikkeld door het opzetten van dit onderzoek. Tijdens onderzoek doen loop je tegen allerlei problemen aan en door deze op te lossen heb ik erg veel geleerd over hoe een onderzoek op een goede manier opgezet kan worden.

Leerdoel 2

Ik wil mijzelf ontwikkelen in het mondeling communiceren over mijn onderzoeksonderwerp met mensen met een medische achtergrond.

Dit leerdoel wil ik behalen door tijdens mijn stage een presentatie te geven over mijn onderzoek en hierover feedback te vragen aan de toehoorders.

Evaluatie
Dit leerdoel vind ik zelf erg belangrijk omdat zonder goede communicatie het lastig is om in een bedrijf aan de slag te gaan. Daarom heb ik ervoor gekozen om me extra te focussen op de ontwikkeling van mijn communicatie.
Voor de ontwikkeling van dit leerdoel zijn vooral de research bijeenkomsten van het Reinier de Graaf Gasthuis belangrijk geweest. Tijdens deze bijeenkomsten komen we samen met alle studenten die onderzoek doen bij de afdeling orthopedie. We vertellen elkaar over hoe het met ons onderzoek gaat

en geven feedback aan elkaar. Dit is erg leerzaam. Hierbij heb ik een aantal keer over mijn onderzoek verteld en een presentatie gegeven. Daarnaast ga ik in de week voor de eindpresentatie een presentatie geven voor alle arts-assistenten van de afdeling orthopedie.

Leerdoel 3

Ik ben me erg bewust van mijn eigen handelen waardoor ik snel ga piekeren of ik de communicatie met andere mensen wel goed aanpak. Tijdens mijn afstuderen wil ik hier beter mee om leren gaan zodat ik minder ga piekeren.

Als ik aan het piekeren ben bij mezelf nagaan of de gedachten reëel zijn. Indien ik er zelf niet uitkom feedback vragen aan degene waarbij ik me onzeker voelde.

Evaluatie
Naast de beroepsgerichte competenties is het ook belangrijk om mezelf te blijven ontwikkelen in persoonsgebonden competenties. Door te gaan piekeren vind ik dat ik minder goed ga communiceren. Tijdens het afstuderen is gelukt om nauwelijks te gaan piekeren. Als het wel gebeurde lukte het om het zelf te relativeren of om anderen om hulp te vragen. Af en toe gebeurde het wel dat ik behoorlijk gestrest was maar het lukte dan ook om daar op een constructieve manier mee om te gaan.
Daarnaast heb ik tijdens mijn stage moeten veranderen van werkplek binnen het Reinier de Graaf Gasthuis. In het begin had ik daar niet zo’n goed gevoel over. Echter, toen ik een paar dagen daar aan het werk was, is het gelukt om mezelf aan te passen aan de nieuwe situatie. Uiteindelijk was de veranderde situatie ook beter omdat we meer met de onderzoeksstudenten bij elkaar zaten.