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Rehabilitation of gait in patients after total hip arthroplasty: Comparison of the minimal invasive Yale 2-incision technique and the conventional lateral approach

Harald Böhm [a,*], Daniel Hagemeyer [b], Yvonne Thummerer [c], Robert Kipping [b], Ulrich Stöckle [d], Konrad Scheuerer [b]

[a] *Orthopaedic Hospital for Children, Behandlungszentrum Aschau, Germany*
[b] *Wolfart Clinic Gräfelfing, Department Orthopaedics and Endoprothetics, Germany*
[c] *Social-pediatric center in Munich, Germany*
[d] *Siegfried Weller Institute for Trauma Research, BG Trauma Center Tübingen, Eberhard Karls University of Tübingen, Germany*

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A B S T R A C T

The minimal invasive anterolateral Yale 2-incision approach for total hip arthroplasty aims minimizing damage to the muscles for faster recovery of function. Therefore the hypothesis was investigated, that during the rehabilitation process the Yale approach shows a faster return to natural gait than a conventional lateral approach.

Nineteen patients had the Yale, 16 the conventional Bauer approach. Instrumented gait analysis was performed 3 days, 3 and 12 month post operatively. Velocity, cadence, step length, weight bearing, thorax lean, Trendelenburg limp, hip abduction moments, and hip muscle activation times were evaluated.

Three days post-surgery a significantly greater loading of the treated limb and increased hip abduction moment were observed in the Yale group. In addition, the Yale group showed its greatest improvement in walking speed and step length between at 3 days and 3 months, whereas the conventional group showed an additional significant gain between 3 and 12 month to reach a similar walking speed as the Yale group. For all hip muscles investigated, only muscle tensor fasciae latae in the conventional group showed a significant increase in activation time between 3 days and 3 months.

This study showed significantly faster return to natural gait in the Yale compared to the conventional approach, which could be biomechanically related to less impairment of abductor muscles in the Yale approach.

1. Introduction

Osteoarthritis or inflammatory arthritis of the hip is the highest-ranking disease among the musculoskeletal diseases [1]. It is caused by the wear and tear of aging that degenerate the cartilage covering the joint surfaces, resulting in pain and stiffness. Total hip arthroplasty (THA) is one of the most successful and cost effective interventions [2–4]. THA offers reliable relief of pain and considerable improvement in mobility and function [5–7]. In recent decades there has been a considerable effort to improve the surgical techniques for THA. Classically a lateral approach (CON) allowed for good visibility of anatomical landmarks and vital structures [8]. However it has the drawback of increased soft tissue trauma of the abductors that stabilizes the pelvis during stance phase of gait. Therefore minimally invasive surgery (MIS) was introduced that aims at decreasing the surgical incision and minimizing damage to the underlying soft tissues to accelerate postoperative recovery (less pain shorter hospital stay and quicker return to function). Based on a literature review [9] it has been shown that conflicting evidence exist for the effect on MIS THA on pain in the early postoperative period and moderate evidence exists for shorter hospital stay. In order to evaluate physical functioning after THA subjective physician-based or self-reported questionnaires are frequently in use. An objective assessment of function can be done by instrumented gait analysis [10–17]. Contrary to what the supporters of MIS THA stated, it was reviewed [9] that MIS THA has no effect on physical

Abbreviations: THA, Total hip Arthroplasty; HC, Healthy controls; MIS, Minimal invasive surgery; CON, Conventional surgery.

* Corresponding author. Tel.: +49 8052 171 2016.
E-mail addresses: h.boehm@bz-aschau.de (H. Böhm), ustoeckle@bgu-tuebingen.de (U. Stöckle).

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functioning, as measured by questionnaires, scores and instrumented gait analysis. However, one of the main purported benefits of the new technique of minimally invasive hip replacement surgery is that it provides for improved ambulation in the immediate post-operative period and allows for early hospital discharge by the second postoperative day [11,18]. However, most of the quantitative gait studies have provided six weeks up to 12 months post-operative data [10–19]. Only two studies measured gait in addition shortly after surgery, which was 2 days [10] and 10 days [13] post-operatively. However none of the studies shortly or longer postoperatively found a significant difference in function of MIS THA compared to conventional methods. However both of the shortly postoperative studies were using a MIS single incision approach. The advantage of any minimally invasive surgery is less injury to the body. However with more radical approaches, such as MIS-2 incision, that use an anterior incision for acetabula cup placement and a posterior incision for femoral stem insertion there is reduced trauma to the deep muscle tissues and underlying structure of the hip [20,21]. The anterior incision may lead to a better functional outcome in the long term than the lateral incision [19], and it may in particular improve hip abduction moments shortly after surgery, that was one of the main impairments of gait following THA, reported in a recent review [22].

Therefore the goals of this study are to compare the MIS Yale technique, a 2 incision approach [20,21] to a conventional lateral approach [23] and to investigate the recovery of function immediately 3 days post-operative and follow up to 3 and 12 months. We hypothesized that patients who underwent THA by means of the MIS Yale 2 incision approach would show a faster recovery and a faster return towards normal gait compared to patients with the CON approach.

2. Methodology

2.1. Participants and surgical procedure

In this controlled prospective study, thirty five patients volunteered to participate. Patients provided written informed consent to participate in this study, as approved by the local ethics committee. Patients underwent THA in the Wolfart - Hospital, Gräfelfing, Germany between February 2008 and September 2009. Exclusion criteria were BMI > 32, previous surgeries of the affected hip and inflammatory polyarthritis. Prior to surgery, patients were informed about the benefits and risk of the CON and MIS approaches and could choose between one of both procedures. In the CON group, the transgluteal approach with a single lateral skin incision described by Bauer [23] was used for implantation. In the MIS two incision Yale-approach [20,21], patients were fixed in a lateral position, a small entry incision was made in the vessel free interval between the tensor fasciae latae and the sartorius muscles and the prosthesis socket were put in place. Via a second dorsal incision, after releasing the external rotators (without the m. priformis), the prosthesis stem and ball were implanted and the two parts of the prosthesis were attached. In contrast to the 2-incision approach of Berger [24], fluoroscopy was not required for implant positioning. In this study identical cementless hip implants (Corail shaft und Pinacle Cup, De Puy-Synthes Germany) were implanted by two experienced senior orthopaedic surgeons. Nineteen patients had the MIS, 16 the CON approach.

Preoperatively anthropometric data, Kellgreen Lawrence Score [25] and Merle d'Aubigné-Scores [26] and the American Society of Anaesthesiologists physiological status (ASA) score [27] were not significantly different between patients groups (Table 1). Also there was no significant deviation in BMI and age between the groups. To estimate the recovery towards normal gait, gait of 18 age-matched healthy controls was reported.

Mobilization started on the first day after surgery with use of two forearm crutches. Patients were allowed to dispense with the crutches for full weight-bearing as soon as possible, depending on the individual level of mobilization and pain. During their hospital stay all patients underwent the same physiotherapy routine. After the discharge from the hospital the patients were free to choose between inpatient and outpatient physiotherapy. Both followed similar regime as specified in the guidelines [28,29] depending on the individual progress of the patients.

2.2. Gait analysis

Patients had instrumented gait analysis 3 days, 6 month and 12 month postoperatively. Gait was captured with an 8 Camera system (MX, Vicon Inc. Oxford, UK) operating at a sampling rate of 200 Hz and 2 force plates (AMTI, Watertown, MA) collecting data at 1000 Hz. Electromyography (Noraxon, Scottsdale, USA) of m. gluteus medius, gluteus maximus and tensor fasciae latae was measured following the SENIAM guidelines. The Vicon Plug-in-Gait marker set and model was used to generate kinematic and kinetic data [30]. The participants were asked to walk barefoot at a comfortable speed down the 10 m walkway. Kinematics, kinetics and EMG were collected in the course of 10 successful trials. During the gait tests patients were asked to walk without assistive devices. However, in the first gait analysis 3 days postoperative, patients were allowed to use two forearm crutches whenever they did not feel comfortable walking without assistance. Patients that were using crutches were instructed not to put any weight on them. At 3 and 12 months gait analysis no assistive devices were used.

2.3. Data analysis

Kinematic and kinetic data were smoothed with Woltring filter and using a smoothing spline [31]. Spatiotemporal parameters that indicated the gait performance were walking speed, step length and cadence in non-dimensional units that corrects for different leg lengths of the participants [32]. Kinetic data included the partial weight bearing towards the involved side, calculated as side difference of the mean ground reaction force during stance phase

Table 1
Pre-operative anthropometric data, American Society of Anesthesiologists physiological status (ASA), Kellgren & Lawrence grade of hip Osteoarthritis (K&L) and Merle-Aubigne (MA) score. Mean standard deviation was shown in round bracket, range in square brackets.

group	Age [years]	Males	BMI [kg/m^2]	ASA	K&L grade TEP leg	K&L grade contralateral leg	MA pain	MA mobility	MA ability to walk
MIS	62.1 (7.8) [46,73]	9/19	27.(3) [23,31]	1.84 (0.60) [1–3]	3.7 (0.5) [3,4]	2.3 (1.2) [1,4]	2.6(0.5) [2,3]	2.8(0.7) [2,4]	3.1(0.1) [3,4]
CON	63.4 (8.1) [47,76]	9/16	28(3) [24,31]	1.75 (0.58) [1–3]	3.5 (0.5) [3,4]	1.9 (1.0) [1,4]	2.7(0.5) [2,3]	2.9(0.6) [2,4]	3.2 (0.2) [3,4]
HC	61.7 (8.9) [45,72]	10/18	24(3) [20,27]	–	–	–	–	–	–
t-test MIS vs. CON	$p = 0.61$	–	$p = 0.06$	$p = 0.51$	$p = 0.39$	$p = 0.33$	$p = 0.41$	$p = 0.46$	$p = 0.79$