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SYMPOSIUM: ADVANCED TECHNIQUES FOR REHABILITATION AFTER TOTAL HIP AND KNEE ARTHROPLASTY

Factors Influencing Early Rehabilitation After THA

A Systematic Review

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Abstract A wide variation exists in rehabilitation after total hip arthroplasty (THA) in part due to a paucity of evidence-based literature. We asked whether a minimally invasive surgical approach, a multimodal approach to pain control with revised anesthesia protocols, hip restrictions, or preoperative physiotherapy achieved a faster rehabilitation and improved immediate short-term outcome. We conducted a systematic review of 16 level I and II studies after a strategy-based search of English literature on OVID Medline, PubMed, CINAHL, Cochrane, and EMBASE databases. We defined the endpoint of assessment as independent ambulation and ability to perform activities of daily living. Literature supports the use of a multimodal pain control to improve patient compliance in accelerated rehabilitation. Multimodal pain control with revised anesthesia protocols and accelerated rehabilitation speeds recovery after minimally invasive THA compared to the standard approach THA, but a smaller incision length or minimally invasive approach does not demonstrably improve the short-term outcome. Available studies justify no hip restrictions following an anterolateral approach but none have examined the question for a posterior approach. Preoperative physiotherapy may facilitate faster postoperative functional recovery but multicenter and well-designed prospective randomized studies with outcome measures are necessary to confirm its efficacy.

Level of Evidence: Level II, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Introduction

Total hip arthroplasty (THA) is commonly performed for hip arthritis with the goal of achieving pain relief and improvement of function. Clinical parameters that affect the immediate recovery of the patient include postoperative pain and ability to participate in a rehabilitation program aimed at teaching postoperative restrictions and independent walking. One study suggests an accelerated postoperative rehabilitation protocol can improve patients' perception of well-being and their short-term functional outcome [10].

Minimally invasive THA has potential but unproven benefits [24]. The potential benefits of this surgical approach include decreased surgical trauma, less postoperative pain, and faster rehabilitation [25]. Patients tend to show interest in minimally invasive THA [13]. The influence of surgical approach, standard versus minimally invasive, is a debatable topic among arthroplasty surgeons [36].

Postoperative pain may influence the patient's ability to participate in rehabilitation. A trend towards shorter postoperative hospital stays has shortened the window of opportunity for in-hospital rehabilitation, increasing the importance of postoperative pain management. Multimodal analgesia along with revised anesthesia protocols has reduced the use of parenteral opioids, thus improving patient satisfaction [23].

To avoid hip dislocation and protect soft tissue repair, various hip restrictions are applied after THA [8, 32].

Postoperative hip restrictions can be a cause of discontent for the patients and could interfere with rehabilitation [47]. A few studies have examined the usefulness of hip restrictions [47, 60].

Preoperative classes help educate patients and expedite their postoperative rehabilitation learning process [19]. Patients with arthritis have poor muscle function [3]. Preoperative pain and function is an important predictor of these variables postoperatively [17, 22]. The preoperative exercise programs are designed to enhance physical function, range of motion, and muscle strength. There is, however, limited evidence in favor of preoperative physical therapy.

We searched the English literature to find level I or II evidence-based answers pertaining to these factors affecting the immediate rehabilitation after THA [6]. We hypothesized the return to independent ambulation and achieving ability to perform activities of daily living after THA is improved by (1) minimally invasive surgical exposure; (2) aggressive pain management with a multimodal approach and revised anesthesia protocols [40, 45]; (3) use of postoperative restrictions to reduce hip dislocations; and (4) preoperative physical therapy. The endpoint of assessment was defined as the return to independent ambulation and achieving ability to perform activities of daily living.

Materials and Methods

We restricted our search to literature published in the English language and on human subjects between 1950 and 2008. Keywords used in the search were: total hip arthroplasty, hip replacement, hip prosthesis, rehabilitation, physical therapy, perioperative pain control, preoperative exercise program, postoperative pain control, pain management, preoperative exercises in total hip replacement, postoperative hip restrictions, minimally invasive total hip arthroplasty, minimally invasive total hip replacement, mini-incision total hip arthroplasty, postoperative rehabilitation, preoperative rehabilitation, preoperative physical therapy, and small-incision total hip replacement. These keywords were used individually for search on the PubMed Medline. The search was run on the OVID Medline (Appendix 1) and EMBASE (Appendix 2) databases respectively, with many studies reviewed at each step (Figs. 1, 2). Only studies qualifying as levels of evidence I and II addressing the subject matter of our hypothesis were included for the review. The inclusion criteria were: English language, human subjects, age older than 19 years, level I and II studies between 1950 and 2008 on the hypothesized categories affecting rehabilitation after THA. Exclusion criteria were: non-English language studies, animal studies, level III, IV and V studies, nonindexed and unpublished data. The population was defined as human subjects over 18 years old undergoing THA between 1950 and 2008. The various interventions studied in the review were: impact of minimally invasive surgical technique, multimodal approach to pain control, postoperative hip restrictions and preoperative physiotherapy, on rehabilitation and immediate short-term outcome after THA. Although it is well-known that THA improves patient functional status [53], there has been limited analysis and lack of standardization of perioperative anesthetic or rehabilitation protocols resulting in variance among different centers and surgeons. OVID Medline (Web-based) database (1950–2008), Pub Med (1966–2008), CINAHL, EMBASE (1980 and 2008), and the Cochrane Controlled Trials Register queries were performed with the assistance of a research library scientist (EF) to identify the articles. No information was obtained from any funding agencies, pharmaceutical companies, personal files, or registries. We identified the titles and abstracts of the retrieved studies. Bibliographies of retrieved studies were also searched for relevant articles. We applied the inclusion and the exclusion criteria to the titles and abstracts. The initial search yielded 3335 titles and abstracts (Figs. 1, 2). The initial screening of the titles and abstracts was performed by two of the authors (VS and PMM). We obtained full articles for the eligible titles and abstracts. The inclusion and exclusion criteria were then reapplied to full articles. The second-stage screening of the full-text articles, and selection according to Cochrane criteria [66] as described below, was independently performed by individual authors (VS, PMM, and EYC). Sixteen full articles met the inclusion and exclusion criteria and were included in the review. All authors were in agreement and any minor differences were resolved after discussion. A systematic review [64] was performed, using the Cochrane guidelines [66], due to the heterogeneous nature of the subject matter and the dissimilarity of the articles with respect to the methodology and outcome measures. The studies were selected by their levels of evidence (Fig. 3). Only level I and II studies were included in the review [6]. The quality of included studies was judged by their level of evidence, randomization of subjects, method of intervention allocation, blinding process, outcome assessments and followup of patients. Selection of only prospective studies eliminated the selection bias to some extent. The Level I studies were assessed for adequate details of the randomization process. The methods of intervention were not blinded to patients in most studies; however, in order to report unbiased results, the patient's study group assignments were blinded to the outcome assessors. The subjects and the controls were reviewed to ensure comparable age groups. The length of followup of the patients was judged for adequacy with

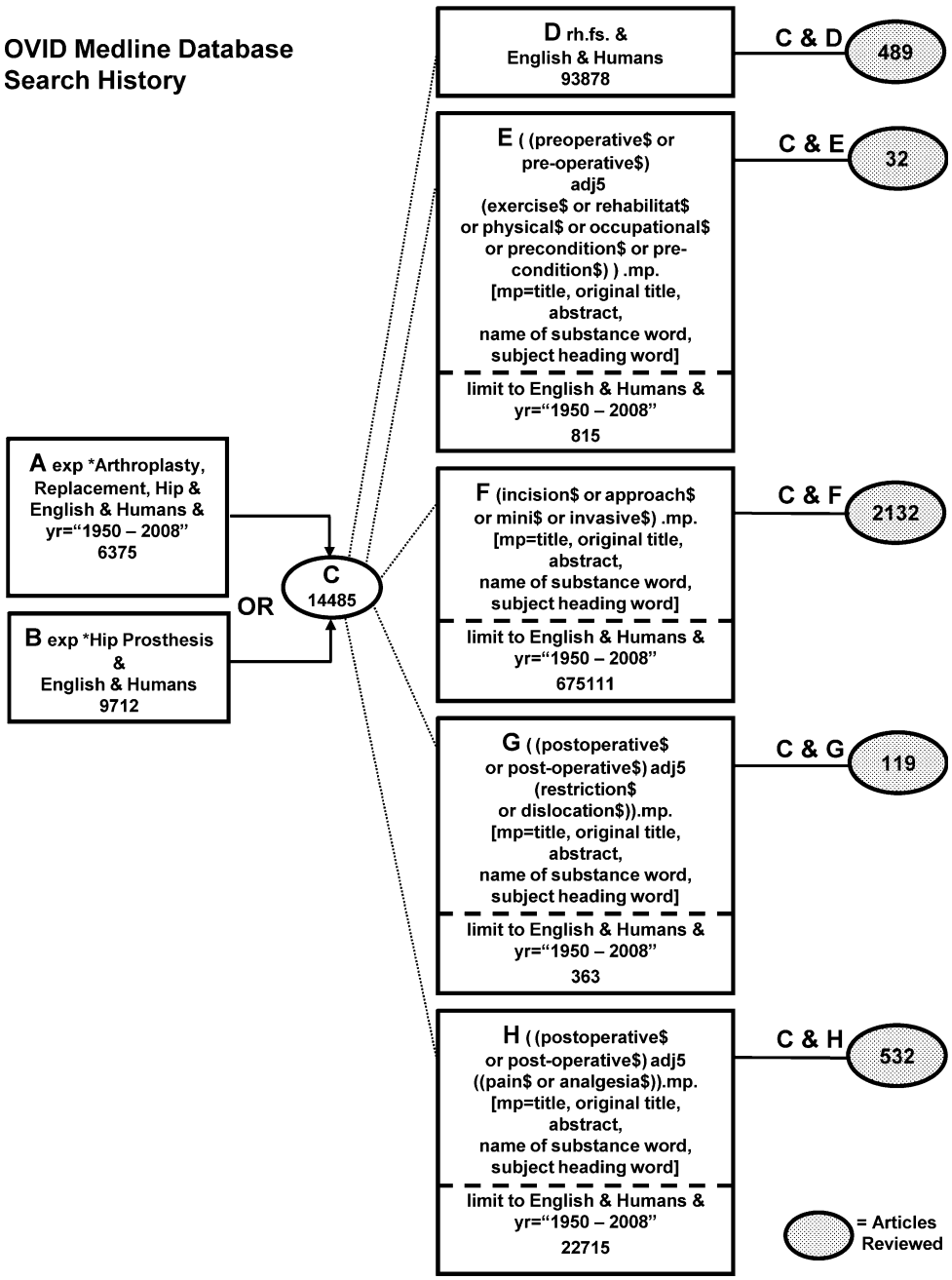

Fig. 1 The flowchart of search history on OVID Medline database using the keywords for the four primary search questions is shown.

respect to the hypothesis and subsequent attrition of patients. Most studies lacked comparable validated outcome scores. A brief description of the studies included in the review is discussed in the subsequent paragraphs.

Surgical Exposure

We identified five studies pertaining to the effect of the minimally invasive approach on THA rehabilitation. Minimally invasive THA was defined as THA performed by a technique either a reported minimally invasive surgical approach or smaller incision length (< 10 cm). In a prospective randomized trial of 231 patients comparing the posterior minimally invasive total hip arthroplasty to conventional total hip arthroplasty, Dorr et al. reported better pain control, earlier discharge to home, and less use of assistive devices with a minimally invasive approach [12]. Pagnano et al. reported a randomized trial of 72 patients and found faster recovery in terms of discontinuation of walking aids and return to daily activities with mini-posterior-incision THA than two-incision THA [43].

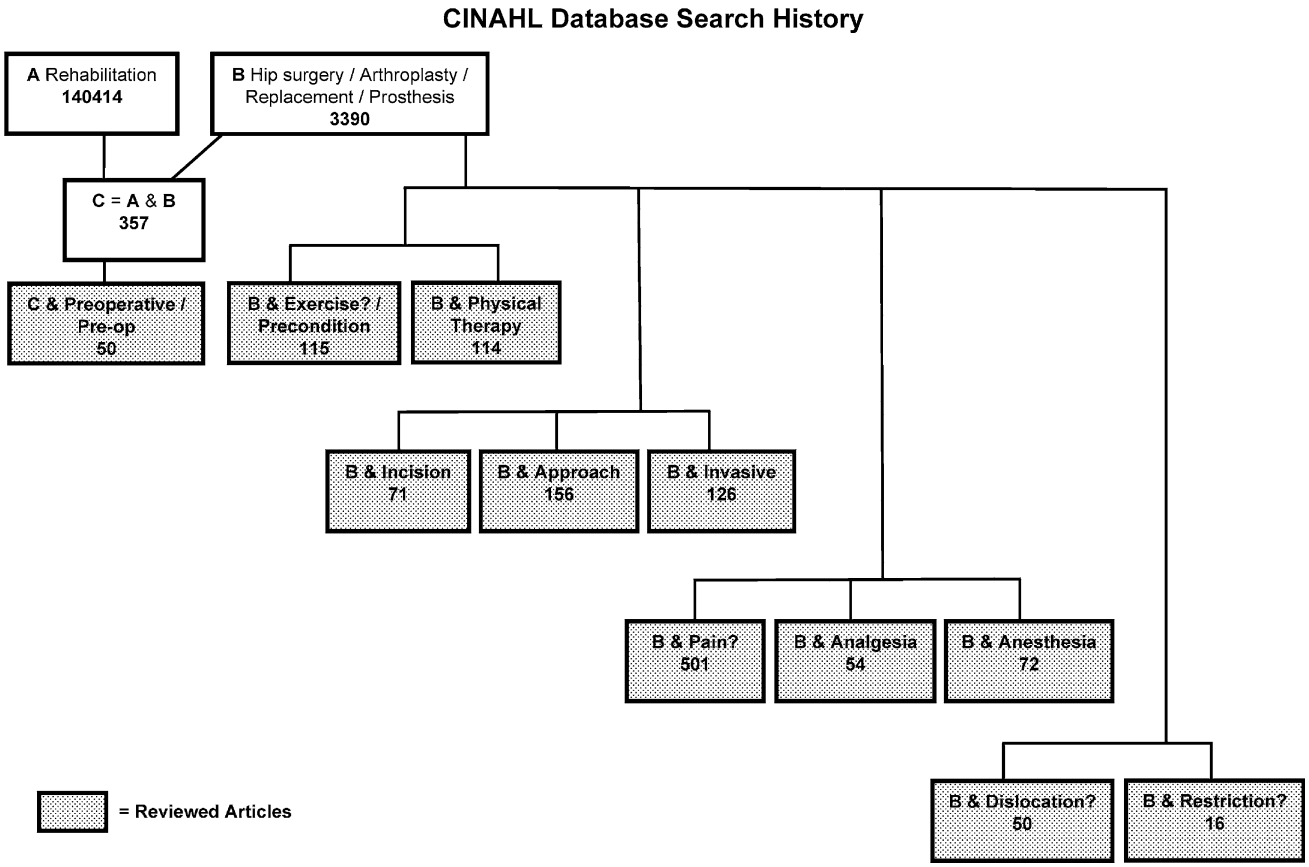

Fig. 2 The flowchart of search history on CINAHL database using the keywords for the four primary search questions is shown.

Gait analysis has also been used to assess the outcome of minimally invasive THA. A study of 69 patients comparing the objective outcomes using gait analysis as a measure of functional recovery in patients treated with three different minimally invasive surgical approaches and a traditional posterior approach suggested faster improvement in gait velocity for the minimally invasive approaches [63]. However, there were no differences between groups for velocity, cadence, stride length, single-limb support time, or double-limb support time at 6 weeks or 3 months postoperatively. A prospective randomized controlled trial of 219 patients by Ogonda et al. comparing the minimal-incision technique and the conventional total hip arthroplasty found no difference in early walking ability, length of hospital stay, or functional outcome scores at 6 weeks [28, 41]. Pour et al. [50] reported a randomized study of 100 patients undergoing THA by the anterolateral approach. They divided patients in four groups depending on the length of incision (greater than or less than 10 cm) and rehabilitation protocol (standard or accelerated). They excluded patients with BMI over 30. They measured the early postoperative functional outcome by the Harris Hip score, the SF36, the WOMAC, the LASA, Lower Extremity score, and walking status at discharge. They reported patients participating in the accelerated rehabilitation protocol regardless of the size of the incision had a better outcome with respect to postoperative mental health element ($p = 0.03$) of the SF-36 and selected components of the linear analog scale assessment (energy level, $p = 0.01$; daily activity, $p = 0.007$; and quality of life, $p = 0.02$); could walk independently and longer distances at discharge, and had a shorter hospital stay [50]. Accelerated rehabilitation encourages early weight-bearing and transfers starting POD#0.

Aggressive Pain Management with Multimodal Approach and Revised Anesthesia Protocols

We included five studies on the effect of multimodal pain management on THA rehabilitation. In a randomized controlled trial of 45 patients, Singelyn et al. [59] compared the effects of three pain control regimens: (1) intravenous morphine patient-controlled analgesia (PCA); (2) continuous epidural analgesia; and (3) continuous femoral nerve sheath block (cFNB) on rehabilitation after

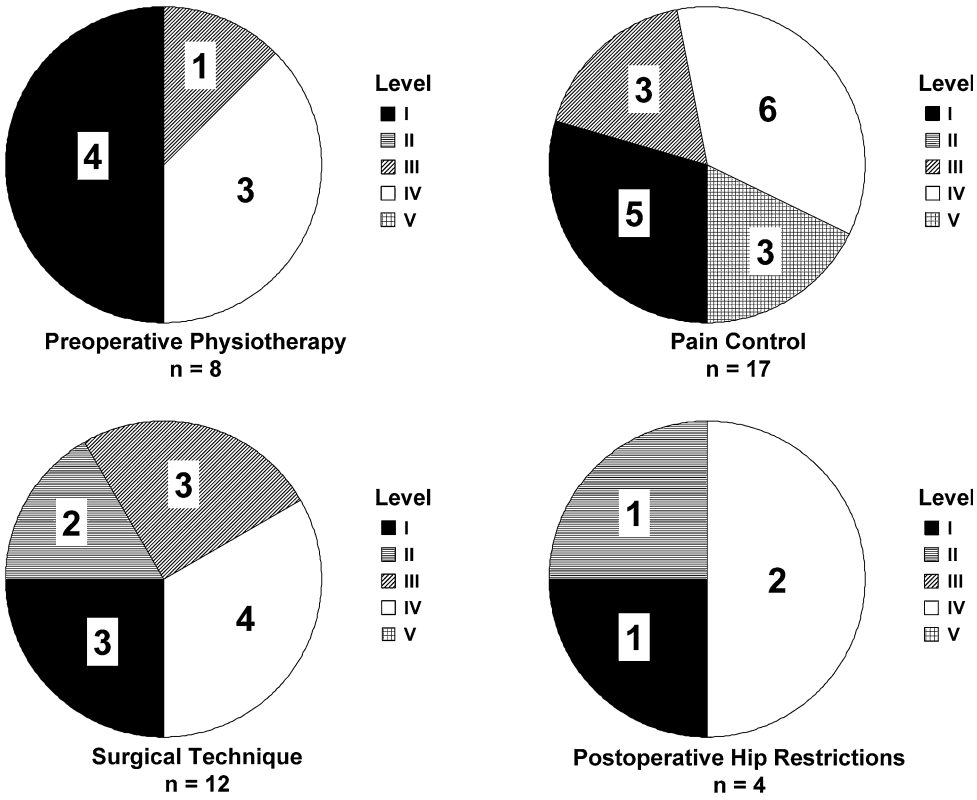

Fig. 3 The pie charts show distribution of the articles in each sub-category by their Level of Evidence.

THA. They reported a similar pain relief with all three modalities. However, the authors concluded that due to fewer systemic side effects the use of cFNB was superior [59]. Parvataneni et al. [44] in a prospective randomized study compared local periarticular injections with PCA on THA patients. They had 35 patients in the study group and 36 patients in the control group. They reported improved pain scores ($p = 0.0067$) and faster functional recovery in terms of active straight leg raise in the study group. However, the ambulation and functional ability were similar between groups at 6 weeks and 3 months after surgery [44]. Becchi et al. [4] reported a prospective randomized study of 73 patients undergoing THA to compare opioid-free continuous psoas compartment block (cPCB) with an opioid/nonsteroidal antiinflammatory drugs continuous intravenous infusion. Both groups received spinal anesthesia for surgery. Pain scores at rest and after mobilization, amount of rescue analgesia, nausea/vomiting, and hemodynamic parameters were recorded. The patients receiving cPCB did better in all the parameters [4]. Siddiqui et al. [58] published a prospective study of 34 patients undergoing THA under general anesthesia who were randomized to continuous lumbar plexus block (cLPB) combined with PCA or PCA alone for postoperative pain. Patients in the cLPB group required less morphine (12 mg) (95% CI, 12.9 to 3.9), had on average less pain (2.1 units on a 0–10 scale) (95% CI, 3.8 to 1.1), were more satisfied with their analgesic technique, and experienced less nausea and vomiting [58]. Andersen et al. [2] studied 80 patients undergoing elective THA under spinal block who were randomly assigned to receive either (1) continuous epidural infusion or (2) infiltration around the hip joint with a mixture of 100 mL ropivacaine 2 mg/mL, 1 mL ketorolac 30 mg/mL, and 1 mL epinephrine 0.5 mg/mL at the conclusion of surgery combined with one postoperative intraarticular injection of the same substances through an intraarticular catheter. The local infiltration group had lower VAS scores, shorter hospital stays, and reduced nausea and vomiting [2].

Postoperative Hip Restrictions

We identified two studies on postoperative hip restrictions after THA. Talbot et al. [60] prospectively studied 499 cases of primary THA through an anterolateral approach. Patients observed no postoperative hip restrictions and no special devices were used. There were three dislocations in the initial postoperative period (6 weeks). All were reduced closed and managed nonoperatively. All the cases in the study were performed by an anterolateral approach that makes the hip susceptible to anterior dislocation [30, 60].

In a prospective study, Peak et al. [47] randomized 265 patients (303 hips) into two groups. All the patients underwent uncemented total hip arthroplasty by the anterolateral approach. All the patients were told to avoid more than 90° of flexion and 45° of internal and external rotation, and to avoid adduction in the first 6 weeks after surgery. In the restricted group, further precautions were used with abduction pillows, elevated toilet seats, elevated chairs, avoiding sleeping on the side, and no driving. All were followed up for 6 months. There was only one dislocation reported and this was in the restricted group during transfer. The patients in the unrestricted group had faster return to normal activities and better satisfaction. The authors therefore advocated against the use of postoperative restrictions [47].

Preoperative Physical Therapy

We identified four studies on the effect of preoperative physical therapy on rehabilitation after THA. Wang et al. [62] performed a randomized controlled trial looking at the effectiveness of perioperative exercise programs in improving early return to ambulatory function after THA. Twenty-eight patients were randomized in two groups. The exercise group had 15 patients and the control group had 13 patients. The exercise group performed two clinic-based sessions and two home-based sessions per week starting 8 weeks prior to the scheduled surgery. All patients had postoperative physical therapy. The outcome was assessed at 8 weeks and 1 week presurgery and 3, 12 and 24 weeks postsurgery. All had the 25-meter walk test and the 6-minute walk test. The 6-minute walk test was obtained only postoperatively at weeks 12 and 24. In the 25-meter walk test they tested cadence, stride length, and gait velocity. The exercise group was better in all variables and the difference was most marked at 3 weeks postsurgery. The exercise group also had greater mean walking distance at both times in the 6-minute walk test. The subjects in the study were, in general, younger patients with less medical comorbidities. The functional outcome assessment in this study was limited to gait and stamina rather than activities of daily living or functional scores [62]. Gilbey et al. [18] performed a prospective randomized study of 76 patients that examined the effectiveness of preoperative exercise programs. They measured the outcomes at intervals similar to those of Wang et al. [62] and measured strength of thigh flexors, extensors and abductors, and range of motion of the hip. The results were based on 57 patients: 32 in the exercise group and 25 in the control group. The exercise group had improvement in all variables 1 week before and up to 6 months after surgery [18]. Gocen et al. [20] reported a prospective randomized study of 60 patients with osteoarthritis undergoing THA. Subjects in the study group received preoperative physiotherapy designed to strengthen the muscles of the upper and lower limbs and to improve range of motion of the hip, beginning 8 weeks before the operation. Although patients in the study group performed transfer activities earlier than the control group, there were no differences between the groups at discharge with regard to the improvement in Harris hip score ($p < 0.48$) and hip adduction ($p < 0.97$) and visual analogue scale at rest ($p < 0.54$) and activity ($p < 0.89$). At the latest followup (2 years) both groups had similar improvement in Harris hip score ($p < 0.05$) [19]. Rooks et al. [56] studied 108 patients undergoing THA (63 patients) and TKA (45 patients) who were randomized into two groups. The study group received 6 weeks of preoperative physical therapy. Analyses examined differences between groups over the preoperative and immediate postoperative periods and at 8 and 26 weeks postsurgery. In THA patients, the intervention improved the preoperative, the WOMAC and the SF-36 scores but had no effect on outcomes 8 and 26 weeks postoperatively. However, exercise participation prior to total joint arthroplasty substantially reduced the risk of discharge to a rehabilitation facility [56].

Results

The various minimally invasive surgical approaches, along with aggressive pain control, help in faster recovery of patients after THA by improving the patient compliance in accelerated rehabilitation; however, this does not appear to affect the short-term or intermediate-term endpoint after the THA as defined by use of walking aids, Harris hip score, WOMAC, Oxford hip score, SF-12 and SF-36 at six weeks from the surgery [28, 41, 50] (Table 1). There is evidence aggressive postoperative pain control improves patient compliance in immediate postoperative rehabilitation. This subsequently improves pain control and hastens the functional recovery in patients. The revised anesthetic protocols with regional and local analgesia may reduce the consumption of narcotics thereby reducing nausea and vomiting, improving patient satisfaction and participation in physical therapy and a shortening the postoperative hospital stay (Table 2). The reviewed studies report data justifying the removal of any postoperative hip restrictions for THA via an anterolateral approach; however, none examine this issue for THA performed via a posterior approach (Table 3). There is evidence in the literature supporting the use of preoperative physical therapy to expedite postoperative recovery; however, we need larger studies with outcome measures in order to make this a part of the standard rehabilitation protocol (Table 4).

Table 1. Studies on THA surgical technique

Study	Level of evidence	Number of patients	Assessment points	Conclusion
Ogonda et al. [41] (2005)	I	219	Compared THA via mini-incision versus the conventional approach	Quicker recovery in terms of discontinuation of walking aids and return to daily activities with mini-posterior-incision THA
Dorr et al. [11] (2007)	I	231	Compared THA via posterior mini-incision to conventional posterior approach	Better pain control, earlier discharge to home, and less use of assistive devices with minimally
Pour et al. [50] (2007)	II	100	Compared THA via mini-incision to conventional anterolateral approach	No difference in SF-36, Harris Hip Score, WOMAC Score, or lower extremity score due to incision length
Pagnano et al. [43] (2008)	I	72	Compared the posterior mini-incision to two-incision THA	Quicker recovery in terms of discontinuation of walking aids and return to daily activities with mini-posterior-incision THA
Ward et al. [63] (2008)	II	69	Used gait analysis to compare conventional versus minimally invasive THA	Faster improvement in gait velocity with similar outcomes at 3 months

Table 2. Studies on THA pain control

Study	Level of evidence	Number of patients	Assessment points	Conclusion
Talbot et al. [60] (2002)	II	499	Studied the dislocation rate after anterolateral approach THA with no hip restrictions or special devices	Low dislocation rate without the postoperative hip restrictions after anterolateral approach THA
Peak et al. [45] (2005)	I	265	Compared the dislocation rate with or without the postoperative hip restrictions after anterolateral approach THA	Unrestricted group had faster return to normal activities and better satisfaction with no dislocations

Table 3. Studies on hip restrictions after THA

Study	Level of evidence	Number of patients	Assessment points	Conclusion
Singelyn et al. [59] (2005)	I	45	Compared I.V. PCA, continuous epidural catheter and continuous femoral nerve block (cFNB)	Similar efficacy but fewer systemic side effects with cFNB
Andersen et al. [2] (2007)	I	75	Compared local infiltration analgesia (LIA) with epidural infusion	Lower VAS scores, shorter hospital stay and reduced nausea and vomiting with LIA
Parvataneni et al. [44] (2007)	I	131	Compared local periarticular injections to PCA ± FNB	Lower VAS pain scores, faster recovery with local periarticular injections
Siddiqui et al. [58] (2007)	I	34	Compared lumbar plexus block (LPB) to I.V. PCA	Lower VAS pain scores, reduced opioid requirement and less nausea, vomiting with LPB
Becchi et al. [4] (2008)	II	73	Compared continuous psoas compartment block (cPCB) to I.V. morphine/Ketorolac PCA	Lower VAS pain scores and less nausea, vomiting with cPCB

Table 4. Studies on preoperative physiotherapy with THA

Study	Level of evidence	Number of patients	Assessment points	Conclusion
Wang et al. [62] (2002)	I	48	Assessed effect of preoperative physical therapy on gait after THA	8-week preoperative physical therapy showed faster improvement in cadence, stride length, greater mean walking distance and gait velocity
Gilbey et al. [18] (2003)	I	76	Assessed the effect of preoperative physical therapy on strength of thigh flexors, extensors and abductors, and range of motion of the hip after THA	Exercise group did significantly better in both parameters
Gocen et al. [20] (2004)	I	60	Assessed the functional outcome after THA with preoperative physical therapy	8-week preoperative physical therapy had no effect on the Harris Hip Score, VAS pain score, and range of abduction with a followup up to 2 years
Rooks et al. [56] (2006)	I	63	Assessed the functional outcome and frequency of home discharge after THA with preoperative therapy	6-week preoperative physical therapy had no effect on WOMAC and SF-36 scores up to 26 weeks followup, but the frequency of home discharges was higher for the exercise group

Discussion

Available literature lacks standardization of rehabilitation protocol for THA. Multiple variables like surgical approach, pain management, postoperative hip restrictions and preoperative physiotherapy have been described to influence recovery after THA. Rehabilitation after THA is aimed at achieving patient independence in routine activities of daily living. We hypothesized the immediate rehabilitation and recovery after THA is improved by (1) minimally invasive surgical exposure; (2) aggressive pain management with a multimodal approach and revised anesthesia protocols; (3) use of postoperative restrictions to reduce dislocations; and (4) preoperative physiotherapy. The end point for assessment was defined as return to independent ambulation and achieving ability to perform activities of daily living.

To study this hypothesis a systematic review was performed due to the heterogeneous nature of the subject matter and the dissimilarity of the articles with respect to the methodology and outcome measures. These factors precluded performance of a meta-analysis. Study limitations include exclusion of non-English language, unpublished, and nonindexed studies. While the exclusion of non-English language studies may be a limitation, many of the higher quality foreign journals publish English translations and were included. If there was no English translation, we did not have the resources to translate foreign journals. Although it is possible that a foreign language paper might have been excluded solely due to language, we believe it is unlikely that this occurred often enough to influence our results substantially. Notable shortcomings in the literature are a paucity of level I or II studies with large patient groups, cost-benefit analysis, validated outcome scores assessing rehabilitation protocols, placebo controlled studies, and the impact of medical comorbidities. We believe this review is representative of the scientific reasoning for the study hypothesis.

Postoperative pain and prolonged recovery after THA affect patient decision [26]. They can adversely affect the short-term outcome and patient satisfaction. Postoperative pain may cause discrepancies in self-reported and performance-based physical functioning [61]. Pain may increase with rehabilitation, thus limiting patient participation [51]. However, physiotherapy is necessary to improve muscle strength and stiffness [34]. Therefore, efforts are being made to improve the efficiency of rehabilitation and increase patient participation. Surveys indicate members of The Hip Society favor implementation of a multimodal approach to improve recovery after THA [27, 46].

Smaller surgical incisions may decrease postoperative pain [11, 24, 57], without apparent difference in functional outcome. Improved pain control, less use of assistive devices, faster return to daily activities and early hospital

discharge with posterior mini-incision approach compared to conventional [12] or two-incision approach [43]. However, it is unclear if the length of the incision improves the functional outcome. Surgical approach has not affected outcome of hip resurfacing [33]. Aggressive rehabilitation and not incision length apparently shortens recovery [48]. Multimodal pain management and aggressive rehabilitation achieve comparable early outcome with standard incision as with mini-incision arthroplasty [40]. Minimally invasive approaches do not apparently make a difference in gait parameters at 3 months after surgery [63]. The current literature suggests that accelerated physiotherapy and revised pain protocols have made differences in recovery independent of the length of surgical incision [40, 48, 50].

Multimodal pain management has improved pain scores related to activity, decreased narcotic consumption, and enhanced physical therapy participation [16, 29, 49]. Postoperative rehabilitation is affected by motivation and adequate pain control [51]. Preemptive analgesia decreases pain by decreasing sensitization of pain pathways activated by operative trauma [9, 51]. Early rehabilitation decreases postoperative pain and improves function and self-efficacy [10, 39]. Revised anesthesia protocols with emphasis on regional and local approach in the form of peripheral nerve blocks, PCB, LPB, and local infiltration techniques have reduced nausea and vomiting and shortened hospital stay [2, 4, 21, 42, 44, 58]. Aggressive pain control with revised anesthesia protocols improves participation in postoperative rehabilitation [45]. This hastens the functional recovery, but does not influence the short-term outcome. A cost-benefit analysis justifying their usage is lacking. Use of multimodal approach to pain control allows greater compliance with accelerated rehabilitation; however, its effect on the outcome scores has not been demonstrated.

The cause for the hip dislocation after THA is multifactorial. Important factors include component position, surgical approach, and soft tissue repair. A major part of preoperative education is dedicated to prevention of dislocation. To avoid vulnerable positions and protect soft tissue repair, patients are placed in postoperative restrictions. Protocols for the restrictions vary among surgeons [65]. Some patients find these restrictions interfere with their recovery. Most surgeons agree on hip precautions of restricting flexion of the hip beyond 90°, no adduction past neutral, and no internal rotation past neutral for 6 weeks after surgery [14]. These have not been guided by surgical approach [65]. However, various positions putting the hip at risk for dislocation vary with surgical approach. Hip restrictions following THA via anterolateral approach have been found unnecessary [47, 60]. Anterolateral approach has less incidence of postoperative dislocation compared to posterolateral approach [7, 52], so the conclusion cannot be applied to THA via posterior approach.

Physical exercise programs improve endurance and reduce physical disability in degenerative joint disease [15, 37]. Preoperative pain and function are the best predictors of these variables at 6 months postoperatively [17, 38, 54]. Preoperative counseling reduces unrealistic expectations regarding pain and improves patient satisfaction [5, 31, 35]. Although preoperative education seems useful for patients [19], few studies examine the effect of preoperative physiotherapy on early rehabilitation after THA. Preoperative physiotherapy reportedly improves muscle strength and gait, allowing early return to ambulatory function [18, 55, 62]. However, limitations of the studies on preoperative physiotherapy include small numbers of patients, variability in outcome measures, and lack of the cost-benefit analysis. Evidence suggests positive impact of preoperative exercises on the speed of recovery; however, its impact on short-term outcome is debatable [1]. We need better prospective, randomized studies with larger numbers of patients, assessing outcome scores to include preoperative physical therapy in the standard rehabilitation protocols.

Existing literature attributes the faster functional recovery in minimally invasive surgical approach to a combination of reduced surgical trauma, multimodal approach to pain control with revised anesthesia protocols, and accelerated rehabilitation. The length of the surgical incision or minimally invasive surgical approach does not appear to independently improve patient recovery. Use of multimodal approach to pain control allows greater participation in accelerated rehabilitation; however, its effect on the outcome scores has not been demonstrated. Multicenter prospective studies with cost-benefit analysis are needed to compare the outcomes from various center-based surgical techniques and their respective pain control protocols. There is evidence against use of postoperative hip restrictions in THA via anterior approach but none showing their effect on posterior surgical approach. Literature supports the use of preoperative physical therapy; however, we need larger, well-designed prospective studies with outcome measures and cost-benefit analysis to include this in the standard rehabilitation protocol.

Some of the Level I studies, particularly those pertaining to minimally invasive THA, have disclosed financial interests by the authors. This may have a bias on the study results. Future studies should attempt to standardize the rehabilitation protocol for THA in order to decrease variables in the outcome assessment.

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Appendix 1. The search strategy terms for OVID Medline database

exp *Arthroplasty, Replacement, Hip/ or *Hip Prosthesis/
((hip or hips) adj3 (replace$ or arthroplast$ or prosthe$)).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
exp rehabilitation/ or rehabilitat$.mp. or rehabilitation.fs. [mp = title, original title, abstract, name of substance word, subject heading word]
(((preoperative$ or pre-operative$) adj4 (exercise$ or rehabilitat$ or physical or occupational)) or (precondition$ or pre-condition$)).mp.
(incision$ or minimally invasive).mp.
((postoperative$ or post-operative$) adj3 restrict$).mp.
((manage$ or control$) adj3 pain$).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
(1 or 2) and 3 and (4 or 5 or 6 or 7)
limit 8 to (english language and humans)

Appendix 2. The search strategy terms for EMBASE database

HIP ARTHROPLASTY/DE* OR ARTHROPLASTY, REPLACEMENT, HIP!/DE* OR HIP PROSTHESIS/DE*
((HIP OR HIPS) (3 N) (REPLACE? OR ARTHROPLAST? OR PROSTHE?))
REHABILITATION! OR REHABILITAT? OR RH/DE
((PREOPERATIVE? OR PRE(W)OPERATIVE?) (4 N) (EXERCISE? OR REHABILITAT? OR PHYSICAL OR OCCUPATIONAL)) OR PRECONDITION? OR PRE(W)CONDITION?
INCISION? OR (MINIMALLY(W)INVASIVE)
(POSTOPERATIVE? OR POST(W)OPERATIVE?) (3 N) RESTRICT?
(MANAGE? OR CONTROL?) (3 N) PAIN?
(S1 OR S2) AND S3 AND (S4 OR S5 OR S6 OR S7)
S8/HUMAN
S9/ENG

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