Perioperative Patient Care for Total Hip Arthroplasty

Abstract Total hip arthroplasty (THA) is a lengthy surgical procedure that requires a personalized approach depending on the characteristics of the patient. For this reason, this surgery requires a meticulous preoperative planning, as well as a careful postoperative recovery protocol to promote the achievement of positive outcomes while simultaneously preventing the occurrence of any major complications that could negatively impact the well-being of the patient. In this article, we summarize some of the activities performed in the perioperative stages of THA as well as the attentive care of the patient throughout all the phases of the surgery.

1 Introduction

The term patient care encompasses all the activities and decisions, made by surgeons, nurses, and physical therapists, in the perioperative stages of the THA procedure, which ultimately aim at enhancing the well-being of the patient after the surgery. The patient care in the preoperative phases primarily include a thorough planning of the surgical procedure, based on the mental and physical state of the patient, as well as decisions regarding the use of the most suitable analgesics to reduce the postoperative pain, and decrease the convalescence period, whereas the decisions made during the intraoperative stage are related to the correct choice of anticoagulants to avoid complications such as deep vein thrombosis. Finally, the postoperative care for THA involves a variety of factors, including the constant communication of the patients with the healthcare workers—which has been proven to have significant positive effects on their mental and physical well-being—the role of the nursing staff in the management of the pain experienced by the patient after the surgery, and the extensive rehabilitation procedure led by physical therapists to ensure the recovery of the functionality of the patient. Throughout this article, we analyze some of the aforementioned procedures aimed at targeting the positive outcomes of the THA surgery.

E. Tokgöz, *Total Hip Arthroplasty*, https://doi.org/10.1007/978-3-031-08927-5_4

2 Active Communication of THA Patients with Healthcare Providers

THA is considered as an efficacious method for the treatment of patients suffering from severe hip pain, mobility discomfort, and rigidness [1, 2]; however, there are a variety of factors that substantially increase the likelihood of incurring in severe complications. Such factors include an increased length of surgery, a more sedentary lifestyle, and deficient environmental adjustability, and could potentially lead to a more elevated incidence of blood vessel and nerve lesions, dislocation, and loosening of the implant [3, 4]. Moreover, deep venous thrombosis (DVT) has been shown to be one of the most frequent complications following THA, with an overall incidence rate of 19.78%. It is a condition caused by anomalies correlated to the coagulation of blood in the deep veins of the lower limbs, which partially or entirely obstruct blood vessels and are reputed to be one of the main factors leading to sudden deaths following the surgical procedure. In addition, the occurrence of deep vein thrombosis is increased in elderly patients, especially the ones already presenting severe comorbidities, primarily because of the decreased elasticity of their blood vessels which ultimately result in frequent damages to their walls [4].

The estimated time of both physical and mental recovery following THA is particularly extended, and, during that time span, patients are particularly inclined to generate negative thoughts, which might ultimately lead them to the development of anxiety or to a state of depression. These negative feelings experienced by the patients presumably arise from the high expectations regarding a utopic rapid recovery of their normal range of motion, which is unlikely to occur because of the deficiency of medical expertise or because of the insufficient understanding of the complexity of the surgical procedure on the part of the patients. Therefore, it is of vital importance for recently operated patients to communicate with healthcare workers, leading to an improvement in their relationship, as results have shown that involvement can ensure their safety, alongside playing a key role in the execution of the postoperative rehabilitation protocol [5]. Active communication of patients with the healthcare providers has a positive impact on their psychological state, mitigating anxiety, increasing their confidence (especially regarding the decision-making process), and resulting in enhancements in patient satisfaction and better clinical outcomes [1].

3 THA Outpatient Self-Efficacy

Communication is a key aspect of everyone's life, allowing people to perform tasks via the direct exchange of information [7]. However, the communication between the doctor and the patient is not always equitable; in fact, the doctor could potentially be the only one engaging in the conversation, whereas the patient would consequently assume a more passive role, ultimately causing some sort of obstacle in the communication between the two parties [8].

The concept of self-efficacy refers to the belief that one individual holds regarding their capability of performing a specific task and achieving the desired goal. This perspective has been shown to have a positive impact on human behavior [9], increasing the functionality and well-being of the patients, alongside improving the outcomes of a wide variety of conditions in the elderly [10]. Therefore, communication self-efficacy is being increasingly used as a method to improve the satisfaction reported by the patient and reduce the incidence of medical errors [11].

Some of the main components of the THA postoperative period are the rehabilitation process and health education that primarily takes place during communications. The lack of valid tools to evaluate the communication self-efficacy performed by the patients throughout their medical experience led to the development of the Patient's Communication Perceived Self-Efficacy Scale (PCSS), an instrument used to assess the outpatient confidence regarding the ability of an individual to efficiently perform activities related to the communication with doctors [9]. Such instrument is composed of 16 items and is characterized by a structure that meticulously analyses three factors of self-efficacy, specifically self-efficacy in "Provide and Collect information," "Express concerns and doubts," and "Verify information" ultimately giving a rise to a reliable method for measuring the patient communication self-efficacy [12].

The study conducted in [6] aimed at evaluating the test-retest reliability, the structural validity, and the internal consistency of the PCCS to ultimately design the Bayesian network modeling of the PCSS adopted in China for a sample of outpatients previously subjected to total hip replacement (THR). The test-retest reliability is a key aspect that allows to measure the consistency of the results when performing a specific assessment at different points in time [107]; instead, the structural validity evaluates the adequacy of the scores in indicating the dimensionality of the measured aspect [108]. Finally, the internal consistency indicates the ability of all the elements of a scale to describe the same notion [109].

A total of 167 patients were included in the study performed in [6] to evaluate the structural validity of the PCSS adopted in China, displaying a median (IQR) score of 57. Out of the 167 previously recruited patients, 6 were excluded from further evaluations because of a lack of information due to the absence of follow-ups. Therefore, only 161 patients were included to evaluate the test-retest reliability and the Bayesian network concept is used for analysis.

The results gathered at the end of the study demonstrated a good fit index in terms of structural validity and internal consistency for the three-factor model adopted in the Chinese version of the PCSS, with the only exception consisting in the root mean square error of approximation. The test-retest reliability indicated a narrow limit of agreement between the two analyzed points in time, which ranged from −7.6 to 7.2. Moreover, the design of the Bayesian network indicated that one of the main predictors of good communication between the patients and their physicians was the level of education of the patients, alongside their ability to consistently interact with the doctors. In summary, the performed study demonstrated the structural validity and test-retest reliability of the PCSS adopted in China to ultimately carry out a reliable evaluation of the self-efficacy of the outpatients regarding their communication with the medical staff after total hip replacement.

4 Tools Used for Comorbidity Assessment in THA

The number of patients deciding to be subjected to THA is gradually increasing, concomitantly with the effectiveness of the surgical procedure [14], mainly attributed to the more meticulous evaluation of the state of health of the patients preoperatively, which then allows for the design of a more individualized procedure depending on the factors that could potentially cause severe harm. In fact, research indicated approximately 83% of the patients subjected to hip surgery also present concomitant conditions [16], which could negatively impact the results of THA in a variety of ways, in particular by increasing the incidence of complications, thus subsequently elevating the overall cost of the rehabilitation, and by decreasing the range of motion of the patient in the near future [17]. Considering the multiple negative effects that the occurrence of comorbidities could potentially have on the outcomes of the surgical procedure, a careful examination of such conditions is crucial to ensure the achievement of successful outcomes [18].

A total of 26 articles contained information on the instruments utilized to evaluate the comorbidities presented by the patients. Among the most commonly used indices, the Charlson Comorbidity Index (CCI) appeared in 18 out of the 26 analyzed publications, the Elixhauser Comorbidity Method (ECM) was presented in 6, and the modified frailty index (mFI) was used in 5. The CCI allows for the prediction of the future health status of patients presenting multiple comorbidities, as well as the incidence of mortality following hospital admission and potential rehospitalization [19]. The mFI, instead, indicated the decline in the physiological performance of patients, related to both aging and the presence of comorbidities, to aid in the recognition of patients at high risk of complications following the procedure. Finally, the ECM comprises 30 variables, each corresponding to a specific disease identified with an ICD (International Statistical Classification of Diseases and Related Health Problems) code, which facilitates the collection of data. The main results included the life quality, functionality, and mortality, (evaluated in 8 papers), complications (featured in 10), overall length of stay (indicated in 6), readmission (presented in 5), reintervention, satisfaction, and transfusion of blood (evaluated in 2). Instead, delays or cancellation of surgery, comprehensive expenses for the treatment and care, risks related to possible falls, and administration of painkillers were examined in 1 out of the 26 papers. An ulterior analysis of the selected publications led to the design of 11 indices to subsequently anticipate the outcomes of THA, which were further subdivided into four sections based on the scope of the utilized tools. Such subsections included diagnosis, medical and demographic factors, prescription, and general health status [13].

The American Society of Anesthesiologists (ASA) physical status classification and the CCI are the most widely employed comorbidity evaluations in patients undergoing THA. These tools provide a reliable prediction of the outcomes of the surgical procedure, including life quality, functionality, fatality rates, length of hospital stay, and readmissions; however, the ASA resulted more accurate in the prognosis of adverse events, as well as the length of stay, dismissal, and health status of

the patients following THA. Nonetheless, this tool could display inconsistency in the analyzed outcomes because of its subjective character [15], thus implicating the need for additional instruments to ensure accurate prediction of the results. The ECM is considered the third most frequently utilized comorbidity index, extremely useful in the prediction of severe complications [20], and more accurate than ASA in the anticipation of THA outcomes [21]. However, due to the high quantity of variables, the collection of data is particularly complex. Another commonly used tool is the mFI, characterized by an excellent predictive character, especially regarding the predicted length of stay, the incidence of complications, reinterventions, and fatalities following the surgical procedure [22], alongside long-term functional outcomes (WOMAC) [23]. The Functional Comorbidity Index (FCI) is less frequently employed, but it can successfully prognosticate the functionality and quality of life of the patients undergoing THA while simultaneously including factors such as obesity and mental state; however, it is not as efficient as the CCI in the prediction of fatality rates. The RxRisk-V performs an accurate calculation of THA outcomes based on the prescriptions taken by the patients, albeit potentially causing errors when one particular medication is employed to treat two comorbidities [24]. The Index of Coexistent Disease (ICED) includes both the physical and operational status of the patients; nonetheless, it is not as commonly used as other tools [25]. The Cumulative Illness Rating Scale (CIRS) can be convenient for research because of its analysis of individual anatomical systems [26]. Other tools, such as the RRATHR (Readmission risk after a total hip replacement) and CMS-HCC (Centers of Medicare and Medical developed Hierarchical Condition Category), are not employed because of their complicatedness and their poor predictive ability [27].

In summary, the CCI and ASA are the most frequently used comorbidity indices despite their imprecise determination of the health status of the patients. Their common use is attributed to their straightforwardness, which makes them easy to analyze, ultimately leading to a faster evaluation on the part of the clinicians [13].

5 Preventive Effectiveness of Anticoagulants on Venous Thromboembolism Following Total Hip or Knee Arthroplasty

Venous thromboembolism (VTE) is a frequent complication following surgeries involving prosthesis implantation and encompasses deep vein thrombosis (DVT)—consisting in the development of blood clots in the veins of the legs, which could either partially or entirely obstruct venous blood flow, as well as pulmonary embolism (PE)—in which previously formed blood coagula drift toward the blood vessels of the lungs, ultimately blocking them [29].

Among the most used anticoagulants, factor Xa inhibitors have proven their superiority compared to other ones as frequently used. More specifically, rivaroxaban has shown an inferior risk of incurring in deep vein thrombosis compared to

other medications when used in total hip or knee replacements; however, some studies have reported a relatively high intraoperative blood loss rate [30], whereas others have documented a negligible hemorrhage throughout the procedure [31, 32], thus generating controversies.

The objective of the study conducted in [28] was to perform a broad comparison of the most frequently used anticoagulants to subsequently establish which would have resulted more effective in the prevention of the formation of coagula of blood, thus indicating a lower incidence of DVT and PE.

After identifying enoxaparin as the reference group due to its reliability in preventing elevated bleeding rate alongside occurrence of venous thromboembolism, results have indicated the superiority of other anticoagulants, namely, apixaban, edoxaban, and darexaban, compared to the latter. Other low molecular mass heparins, in particular dalteparin and bemiparin, have also demonstrated positive outcomes relative to the prevention of pulmonary embolism, whereas tinzaparin and reviparin were extremely efficacious in the preclusion of increased bleeding rates. In addition, rivaroxaban and dabigatran successfully prevented venous thromboembolism effectively but displayed unfavorable results concerning the regulation of clinical hemorrhage. The three novel factor Xa inhibitors analyzed throughout the study, namely, fondaparinux, erixaban, and betrixaban, have been proven to be particularly efficacious. Additionally, betrixaban was classified first in the prophylaxis of both major and minor blood loss. In contrast, warfarin—a vitamin K antagonist—turned out to be inadequate for the prevention of VTE, as well as ximelagatran and acenocoumarol. According to the obtained data, the safest and most efficacious anticoagulants to be used during procedures such as total hip or total knee replacement are apixaban, edoxaban, and darexaban. Despite the increased rates of causing clinical hemorrhage, rivaroxaban is identified to be particularly efficacious in the prevention of VTE.

6 Anchor Strategy and PROM Utilization for Determining Clinically Important Differences in THA

One of the main obstacles faced by the investigators when analyzing the quality of life of patients in randomized trials is the determination of the relevance of any of the discovered differences. For this reason, the use of patient-reported outcome measures (PROMs) to achieve postoperative assessments is significantly increasing, as they appear to be extremely helpful in the provision of scores regarding the status of the patients to be later examined by clinicians [33]. In addition, the concept of minimal clinically important difference (MCID)—consisting of the smallest difference in PROM scores reputed important by the patients—is being incrementally used for questionnaire assessments due to its capability of interpreting the outcomes of a given surgical procedure, as well as establishing the differences and performing a comparison of one particular intervention as opposed to another [34, 35].

Two methods have been outlined to calculate the MCID, one consisting of the sole distribution of the responses, and a second one presenting an ulterior question, denominated "anchor," to allow for categorization of the obtained results and enable the differentiation between patients who have experienced changes—both positive and negative—in their status from those who have not experienced any differences [36, 37].

For the study performed in [33], patients were asked to complete the Hip Osteoarthritis Outcome Score (HOOS), as well as the Oxford-12 questionnaire—both before and at 6 and 12 months following the procedure—to ultimately establish whether the anchor could be represented by any of the items present within the questionnaire. Results have shown that the MCID outlined for French-speaking partakers was consistent with other literature data previously reported. Moreover, in order to represent the anchor, the chosen item had to be general enough to be able to determine hypothetical improvement; in fact, more specific questions were less prone to show progress compared to items targeting broader topics such as life quality or experienced pain.

7 Nurse-Led Pain Management Following Total Knee/Hip Replacement

The number of THR and total knee replacements (TKR) has been increasing significantly because of the increment in degenerative conditions. However, one of the most common symptoms experienced by patients following surgery is pain, presumably deriving from incorrect strategies employed to address its management and accounting for over 50% of patient dissatisfaction in THR and 75% in TKR [39]. Inadequate control of post-surgical pain is correlated with decreased exercise, malnourishment, difficulty sleeping, and delay in the healing process [40]. It is therefore important to maintain the perceived pain under control, to enhance a prompt recovery of the patient's body functions, as well as reduce the occurrence of potential complications including extended opioid use, elevated morbidity, and progression into chronic pain [40, 41, 44], which are some of the major complications that can occur due to the excessive pain. This could be achieved by meticulous postoperative acute pain management, which is divided into pharmacologic—which foresees the use of opioid analgesics [43] and presents many side effects such as bowel dysfunction, nausea, or vomit, particularly if administered for extended periods [44, 45]—and nonpharmacologic [42].

This second, less invasive, approach is solely conducted by nurses [46–49] and consists of a variety of methods aimed at reducing postoperative pain. Some of the aforementioned methods employed to ultimately decrease the pain experienced by the patients include massages, music therapy, relaxation therapy, and touch therapy. Further studies have shown that massages have a positive impact on the patient, ultimately decreasing the experienced pain by elevating the pain threshold through

a more elevated release of endorphins. Touch therapy is analogous to massage treatment, and its results include reduction of the intensity of pain, anxiety, as well as respiration rates. Finally, cognitive-behavioral treatments—such as music, relaxation, or distraction—were also included in the nonpharmacologic list of approaches conducted by nurses, as results have shown a substantial decrease in pain intensity through the use of a secondary stimulus that drew the patient's attention, temporarily distracting them from the source of pain [46].

The results gathered throughout the study conducted in [38] confirmed the positive outcomes hypothesized for nurse-led nonpharmacologic pain management, which was particularly effective following patient education, therefore indicating this procedure as optimal to reduce the postoperative pain experienced by patients through noninvasive intervention and with negligible risk of side effects. In conclusion, to achieve an optimal outcome in pain management, nonpharmacologic intervention should be complemented with the assumption of opioid analgesics.

8 Acute Pain Trajectory Design Following THA

Pain is defined as chronic when it perseveres past the conventional healing time—over 3 months postoperatively—and it may be related to psychological factors, such as anxiety or depression, or result from stress [54]. In order to ameliorate the outcomes following THA and augment the recovery of patients, appropriate pain management around the time of surgery is imperative [50]. This could be achieved by analysis of data-driven guidelines, which could furnish information relative to the comprehensive notions for adequate pain management, alongside a thorough explanation of relative advantages and limitations of analgesics and corresponding techniques. In addition, the number needed to treat (NNT) could also be employed to determine the effectiveness of different analgesics. It consists of the overall number of patients subjected to treatment with a specific analgesic necessary to reach a percentage greater or equal to 50% for pain relief experienced by a single patient, compared to the placebo. However, these two approaches present several limitations, which led to the development of procedure-specific pain management recommendations (PROSPECT), with the goal of providing suggestions to ultimately assist with the perioperative decision-making process [51].

In cases in which primary systemic analgesia does not generate the expected effects in terms of pain management, other multimodal methods—such as local infiltration analgesia (LIA) or peripheral nerve blocks—are integrated to achieve the optimal results [51–53]. However, there is uncertainty regarding the proper analgesic technique to use, as some of them do not often last throughout the entire length of the severely painful phase, or do not result beneficial for certain surgical procedures [51]. Therefore, the design of a suitable analgesic plan would allow for pain relief that aligns with both the timeframe and severity of the postoperative pain, and it could be achieved through the development of pain trajectories that identify the average pain progression following surgery, thus including reports about the

time of most acute pain experienced by the patients, as well as an indicative timeframe for when that pain subsides. This elaboration would also enable the detection of patients that deviate from the standard trajectory, ultimately indicating hypothetic complications or evolution into chronic pain, which could be treated with ulterior interventions [54].

The developed pain trajectories demonstrate that the average pain experienced by patients tends to diminish by 4–8 h upon the surgical procedure, following which the pain should reduce to tolerable levels even when subjected to a basic analgesic plan. The initial timeframe of intense pain could be potentially targeted with spinal anesthesia (SA)—as results have shown that patients subjected to this treatment experienced considerably less pain compared to other anesthetic measures—combined with either nerve blocks or LIA [50].

9 Impact of THA on Life Quality of Couples and Conjugal Relationship

Disorders correlated to arthritis cause severe pain in the affected individuals, thus potentially impacting the social interactions of the latter, especially with regard to their conjugal relationships [56]. Osteoarthritic individuals are more prone to develop health conditions in addition to experiencing a graduate worsening of their mental health [57], therefore influencing their relationship with their spouses [56] that are oftentimes feel forced to provide constant assistance and consequently structure their lives to comply with the daunting responsibilities that this role implicates. In fact, various studies have confirmed that the partners of individuals affected by chronic pain disclosed significantly inferior levels of conjugal satisfaction and life quality, alongside a higher incidence of depression [58, 59].

Joint replacement surgery constitutes a viable option to reduce the pain experienced by the patients, as well as their emotional suffering, while simultaneously improving their motor functionality that could potentially lead to an improvement in the quality of their marital relationship and the physical and mental health of the spouse.

The study conducted in [55] aimed, therefore, at establishing the perception of the spouse on the impairment and pain experienced by the patient both before and after hip replacement, as well as determining the positive outcomes of the surgery on the private and conjugal life of the spouse.

The study included 29 heterosexual couples, married for an average of 36.7 years; the mean age of the patients was 68 years old, while it was 67 years old for the spouses.

The information was gathered before the surgical procedure and after the patients fully recovered (signaled by a Harris Hip Score of 100) either over the phone or in the clinic. The interviews were conducted individually by separating the couples to ensure the collection of authentic data, and these interviews were structured to

address specific questions. Such questions included the perception of the acuteness of the pain experienced by the patient, which was rated on a numerical rating scale (NRS), and of the degree of disability, which is instead measured via the Pain Disability Index (PDI) and comprises seven distinct areas of everyday life. Out of these seven areas, items 1 through 5 corresponded to activities performed voluntarily, while items 6 and 7 were reputed imperative [60]. Both the NRS and the PDI were rated on a scale from 1 to 10, with 0 indicating no pain and 10 expressing intolerable pain for the NRS, whereas for the PDI, a value of 0 indicated no perceived disability, and 70 denoted complete disability [55]. The results gathered via the interviews indicated an inferior perception of the pain preoperatively on the part of the patients, which indicated an average of 7.4 points (out of 10) compared to the mean of 8.3 reported by their spouses. Similarly, the patients estimated their postoperative pain at 0.9 points, whereas their spouses indicated substantially higher scores, averaging 1.4 on the decimal scale used as reference. Instead, the mean score calculated for PDI preoperatively was 33.6, and the pain experienced by the patients primarily impacted activities performed voluntarily rather than the obligatory ones, in particular leisure activities [55]. As seen in the NRS for pain, patients' spouses reported higher preoperative PDI scores in all the seven areas of everyday life, excluding sexual behavior and activities aimed at self-care, for which they reported lower scores compared to the patients. Following the procedure, the patients indicated a substantial decrease in disability—20.7 for voluntary activities and 5.2 for obligatory tasks—whereas the spouses indicated an average improvement corresponding to 28.7 points, 23.6 for voluntary activities, and 5.1 for the obligatory ones. After THA, the patients indicated various factors that contributed to the improvement of their life quality, among which increased mobility (93%), decreased pain (72%), and improvement in their social interaction, especially with family (38%), are observed. Among the main benefits indicated by the spouses, the possibility to resume social activities with their partners was shared by 72% of the patients' spouses, alongside the fact that they didn't have to witness their partner in pain (52%), a reduced burden caused by the necessity to take care of their beloved one and a subsequent sense of independence (59%), an enhanced conjugal relationship (52%), as well as social life (28%) and, finally, possibility to travel (28%). In conclusion, the performance of total hip arthroplasty has positive outcomes in the lives of both the patients and their spouses, resulting in a substantial reduction in the pain affecting the patients and a subsequent improvement in their social interactions, alongside a decreased burden in the caregiving tasks performed by the spouses, ultimately improving their marital relationships [55].

10 Physical Therapy

As previously mentioned, THA is a surgical procedure aimed at decreasing the severe pain experienced by the patients and subsequently increasing their quality of life. However, aside from the surgery itself, the patients have to undergo an

extensive physical therapy cycle in order to ensure successful outcomes and proper recovery of their functionality [61].

The rehabilitation procedure begins the day after the surgical procedure with patient education—to instruct the patients on the proper methodology to initially perform daily activities, while simultaneously avoiding certain movements, including flexion of the hip past 90°, adduction past the midline, and both internal and external rotation [62]—and the slight mobilization via exercises performed directly in bed, with the goal of strengthening the hip and increasing its range of motion [61].

The length of stay after the surgical procedure is extremely subjective. In fact, some patients are discharged with assistive devices after one night, whereas others require 2 or even 3 days. In some cases, the discharged patients might experience some mobility limitations, which inevitably prevent them from returning home. In such instances, they will continue their physical therapy protocol at a subacute rehabilitation institution, until sufficient functionality is gained to allow them to return home safely. The rehabilitation cycle will then continue either directly at home—a choice that is mainly reserved for people that are unable to leave their home—or, in cases that the patient does not experience any limitations in terms of travel, it can be continued at an outpatient clinic. The extensive protocol initially foresees indications on how to perform daily activities safely—such as how to climb the stairs or how to properly move in and out of the bed—followed by the strengthening of the hip and maximization of balance and proprioception. These exercises aim at reinforcing the musculature around the operated hip, to allow the patient to slowly transition from the use of assistive devices to an unassisted ambulation by the end of the outpatient physical therapy cycle [61].

Impact of Progressive Resistance Training to Healing During Early Postoperative THA

Progressive resistance training (PRT) is among the most frequently used rehabilitation techniques after procedures involving joint replacement [63]; however, the efficacy and security of this physiotherapeutic approach are still at the center of debates [65]. The PRT protocol should be started shortly after the surgical procedure, considering the loss of muscle mass and strength experienced by the patients [66, 67].

The research carried out in [64] analyzed the effects of progressive explosive-type resistance training (RT) performed in osteoarthritic patients scheduled for THA. It included 80 patients, 3 of which were then lost during the follow-up protocol. Each of the sessions was conducted twice a week for a total of 1 h, and lasted for a total of 10 weeks [64]. The warm-up consisted of a 10-min-long exercise on the stationary bike, followed by a series of four random exercises executed unilaterally on exercise machines with maximal acceleration of the load. The pain experienced by the patients was measured using the visual analogue scale (VAS) ranging from 0 (no pain) to 10 (extreme pain) and was registered before and after each training session [64]. The participants reported a VAS score of ≤ 5 in 95% of the cases right after the training session, whereas the remaining 5% reported a score of ≥ 5. Instead, a score of ≥ 5 was reported in 1/3 of the cases the day after the session throughout the first 2 weeks of the protocol, correlated to the inevitable soreness

resulting from the exercises [64]. The remaining 2/3 of the patients indicated, instead, a VAS of ≤5 the day following the training. Progressive explosive-type RT substantially improved the preoperative pain level and the functionality of the OA patients attending the sessions while simultaneously increasing their muscle strength and, consequentially, their life quality [64].

The study performed in [66] analyzed, instead, the effects of PRT after the THA surgical procedure. A total of 73 patients were included and randomized into either intervention group (IG) or control group (CG); however, only 62 completed the 10-week-long protocol. The rehabilitation protocol designed for the IG consisted of unloaded exercises performed at home 5 days a week, and PRT carried out twice a week. Instead, the CG solely performed unsupervised home-based exercises every day of the week [66].

In terms of power achieved during leg extension, no significant differences were observed between the two groups, as the IG showed an improvement of 21%, while the CG enhanced their performance by 17% [66]. Instead, the IG displayed superior outcomes with regard to walking speed and stair climb efficiency, improving their isometric muscular strength by 18–26%, and by 21–26% in their functional performance assessments, whereas the CG only exhibited an improvement of 4–12% and 11–20%, respectively. No significant differences were observed in the 20 m walking speed and in the hip dysfunction and osteoarthritis outcome score questionnaire (HOOS) administered at the end of the rehabilitation protocol [66].

The research conducted in [68] analyzed the effectiveness of the home-based PRT protocol compared to the one performed at the hospital. In order to do so, 25 patients were assigned to the home-based PRT cohort, and 24 were randomized into the control group, which conducted the training session at the hospital [68]. The two cohorts were subjected to a variety of assessments, which included the maximal voluntary contraction (MVC) of the quadriceps femoris of the operated leg, the sit-to-stand score in 30s (ST), the timed up and go (TUG), the stair climb performance (SCP), the 6-min walk test (6MWT), and the evaluation of the lean mass of the operated leg via a dual-energy X-ray absorptiometry (DEXA) scanning [68]. The MVC was conducted while the patients were sitting on a medical table with their arms across the chest. The dynamometer (instrument used to measure the force, torque, or power [69]) was placed over the tibia, and the patients were then asked to energetically contract and straighten the leg. The ST score was calculated based on the number of times the patient was able to stand from a standardized chair in 30 s, with their arms across the chest [68]. Figure 1 illustrates the various phases of the sit-to-stand assessment.

The TUG analyzes the time (in seconds) it takes for the subjects to stand from a standardized chair, walk to a cone placed 3 m away at a comfortable speed, and walk back to ultimately sit on the chair. Figure 2 depicts the various steps that characterize the TUG test.

The SCP assessed the time it takes for the patients to climb 14 steps (20 cm in height) at a comfortable speed [68]. Figure 3 illustrates the technique adopted for the stair climb test performed on the patients

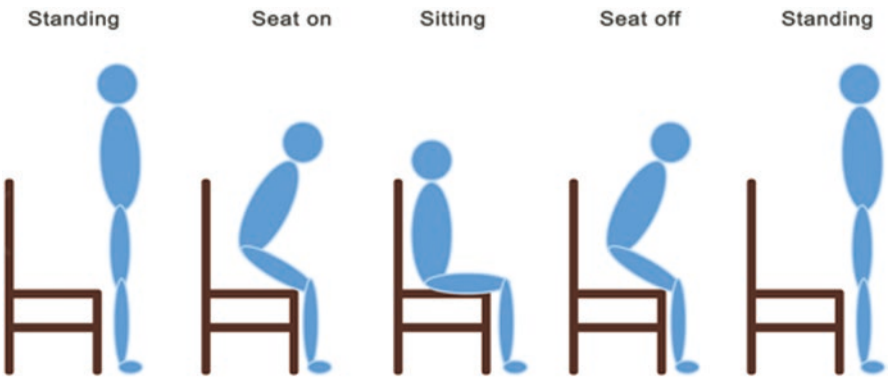

Fig. 1 ST assessment [111]

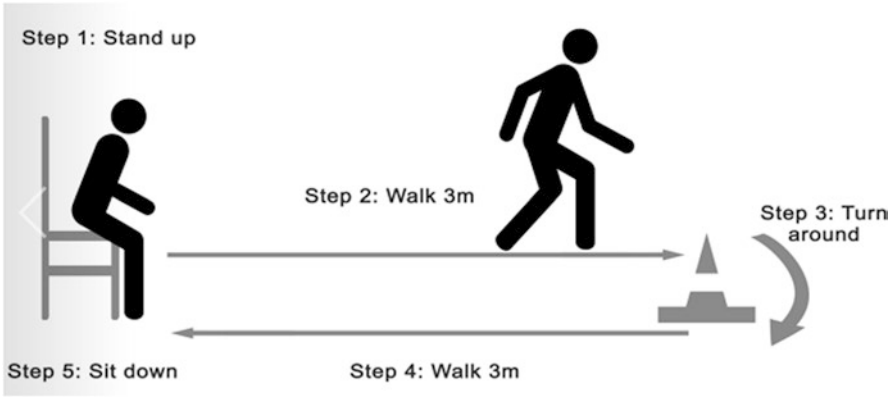

Fig. 2 TUG assessment [110]

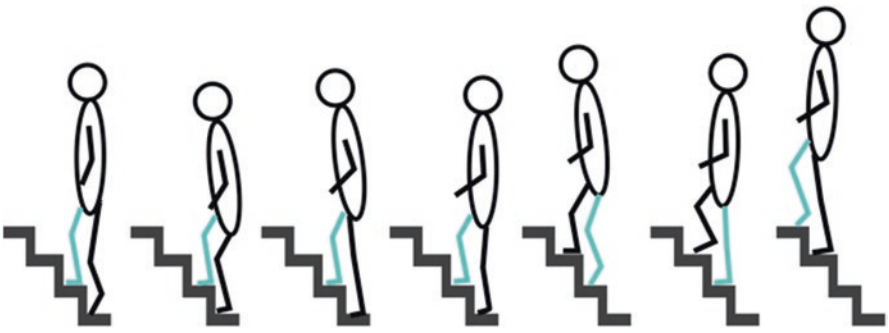

Fig. 3 SCP test [112]

The 6MWT measures the distance the patients are able to cover in a corridor over a 6-min time period. Finally, the DEXA was conducted using a pencil-beam scanner to ultimately calculate the total and regional bone mass and lean fat, to determine if the home-based protocol resulted in a more elevated muscular mass in the operated leg compared to the one performed in the hospital [68].

Only 26 patients completed the 1-year-long protocol, 13 of which were part of the home-based PRT cohort, while the remaining 13 were part of the control group [68]. Both groups showed significant improvements compared to the baseline values, and no significant differences between the two groups were observed for most of the conducted assessments, which included the MVC, the ST score, and the calculation of the lean mass of the involved leg [68]. However, differences were observed in the SCP and the 6MWT, throughout which the control group showed superior outcomes compared to the home-based PRT cohort. The obtained results demonstrate that the home-based PRT protocol could be potentially applied to THA patients, but without attaining the same results in terms of functionality as the inhospital protocol [68].

The study conducted in [70] aimed at evaluating the results of early maximal strength training performed after THA. The participants were randomized into a maximal strength cohort and a conventional rehabilitation group for a total of 4 weeks, after which they were all subjected to conventional rehabilitation [70]. The results obtained for work efficiency at the end of the designated 1-year period demonstrated superior outcomes in the maximal strength cohort, both at 6 and 12 months postoperatively, by 29% and 30%, respectively. Similarly, the values for the leg press assessment performed on the healthy leg and the force development of the involved leg were superior in the maximal strength cohort 12 months after the procedure, by 36% and 74%, respectively [70]. Additionally, the performed study indicates that the maximal strength training protocol should be conducted for a more extended period of time while simultaneously coupled with aerobic endurance training, to ultimately achieve complete recovery after the surgical procedure [70].

The research conducted in [71] evaluated the effects of resistance training in the elderly in the initial stages after the THA procedure. A total of 36 patients were initially included in the study, and subsequently randomized into three groups: the home-based standard rehabilitation (SR) group, the SR plus unilateral lower-limb resistance training (RT) cohort, and the SR plus unilateral percutaneous neuromuscular electrical stimulation (ES) group [71]. The research was designated to last for 12 weeks, during which the patients were tested twice, at week 5 and at the end of the protocol. The outcomes of interest were the length of stay (LOS), the functional performance, the muscle cross-sectional area (CSA), and the maximal strength of the quadriceps femoris muscle. The LOS was delineated as the period of time from the day of admittance into the hospital until the day of discharge. In terms of functional performance, the maximal gait speed was evaluated over a 10-meter distance, and the stair-climbing performance was assessed based on the time it took for the patients to climb ten steps (20 cm in height). Additionally, the sit-to-stand test consisted of five repetitions to evaluate the ability of the recently operated patient to stand from a conventional chair [71]. The muscle CSA of the quadriceps was

obtained via a computed tomography, which was performed for 5 seconds on a slice of 8 mm in thickness. Finally, the strength evaluation was calculated as the maximal moment of isokinetic extension of the knee during the concentric contraction of the quadriceps femoris muscle [71].

Only 30 patients completed the 12-week-long protocol. The average LOS was significantly shorter for the RT group (10 ±2.4 days) compared to the SR cohort (16 ± 7.2 days) [71]. Additionally, the aforementioned functional abilities improved in both the RT and in the ES groups at 3 months after the beginning of the training protocol. Maximal gait speed increased by 30% in the RT group, while it only increased by 19% in the ES group. The stair-climbing performance improved by 28% in the RT cohort and by 21% in the ES group [71]. Similarly, better outcomes were observed in the RT group for the sit-to-stand test, which improved by 30% compared to the improvement of 21% displayed by the ES group [71]. On the contrary, no improvements were observed in the SR group at the end of the protocol compared to the baseline values. The strength exerted by the quadriceps femoris muscle CSA decreased by 13% in the SR group at the fifth week postoperatively, remaining 9% below the baseline value at the end of the protocol. Instead, the CSA of the involved leg of the RT cohort increased 12% over the baseline value at week 12 [71]. Finally, the CSA performed on the ES group decreased by a value of 4% at the first follow-up, whereas it increased up to 7% at the end of the training sessions. The maximal strength increased by a value ranging from 22% to 28% in the RT cohort, while it remained unaltered in the remaining two groups. In summary, the performed study demonstrated the effectiveness and safety of resistance training when performed in the elderly in the first stages after THA, which resulted in an increase in the muscular mass, peak torque, and functional performance and a decrease in LOS [71].

The study conducted in [72] analyzed the effects of ulterior mobilization and strength training on the hip muscles of THA patients in the first week following the orthopedic procedure. A total of 39 patients were included in the research and subsequently subdivided into an intervention group (IG) and a control group (CG). The results of interest—calculated the day before and 6 days after the surgical procedure—included the range of motion of the hip, the circumference of the thigh, the muscle endurance of the gluteal muscles, the one-leg stance, and the 6-minute walk test. Additionally, a questionnaire was administered to the patients to evaluate the perceived pain at rest and during the exercise on a scale from 0 (best condition possible) to 10 (worst condition possible) [72].

Both groups demonstrated a decline in hip flexion compared to the value registered prior to the procedure; however, the results observed in the CG were inferior compared to the IG. In terms of hip extension and hip abduction, the IG showed increased motion compared to the CG [72]. The IG and CG showed a similar magnitude increase in the circumference of the thigh compared to the one assessed before the surgery; however, the muscle endurance of the gluteal muscles decreased to a similar magnitude in both groups [72]. With regard to the one-leg stand performance, a decrease in the holding period of the CG was observed, whereas no differences were seen in the IG compared to the values gathered before THA. Similarly,

the mean distance covered during the 6-min walk test decreased in the CG, while it remained unchanged in IG. Finally, the administered questionnaires demonstrated an improvement in both groups in terms of the pain scores obtained after the procedure compared to the preoperative ones [72]. According to the results of the conducted study, additional targeted mobilization and strength training are advised to achieve a faster improvement of the gait performance [72].

10.1 Rehabilitation Process and Operational Efficiency-Related Complications Following THA and TKA

Osteoarthritis (OA) is a condition that results in the gradual erosion of the cartilage of the joint and is categorized as one of the most relevant disturbances of the connective tissue and locomotor system—affecting approximately 9.6% of men and 18% of women over the age of 60—mainly attributable to the advanced age of the population, alongside decreased physical exercise and augmented obesity rates [74, 75]. While milder cases could potentially be addressed with local muscular tissue strengthening or weight loss, total replacement of the joint constitutes the proper approach for the treatment of grave instances of osteoarthritic hip or knee [76–78], which have a substantial influence on the execution of daily activities, as well as on the quality of life because of the joint pain and movement limitations experienced by the affected population [79].

The goal of the study conducted in [73] was to ultimately determine the results of the rehabilitation procedure following both total hip (THR) and total knee replacement (TKR).

The participants were requested to respond to a survey administered via phone in the form of a formalized recorded interview, which included questions relative to the assessment of the parameters used throughout the rehabilitation process and the subsequent outcomes of the latter. The verbal descriptor scale (VDS) was employed to assess the intensity of the chronic pain experienced by the patients, including categories ranging from “no pain” to “unbearable pain.” Evaluation of the data indicated that 70% of the participants were complacent with the management of the rehabilitation procedure of local health authorities, whereas about 20% resulted in disappointed, mainly because of the inadequate quality of the healthcare system or due to the unavailability of an orthopedic surgeon in close vicinity. The analysis of the results gathered via the verbal descriptor scale indicated that approximately 50% of the subjects, mainly belonging to the TKR group, endured moderate to severe pain. In addition, 57% of the participants were able to walk independently, whereas the remaining 43% was required to use an external support. In order to achieve better outcomes in terms of operational efficiency and rehabilitation adequacy, a constant assessment resulting from the communication of the main parties of the rehabilitation process should be performed, to ultimately supervise the results, from a medical and social standpoint, of delicate surgeries such as THR or TKR [73].

11 Analgesics

Both total hip and knee replacement surgeries generate severe pain in the patients subjected to the procedure, particularly after the sixth hour of the first postoperative day [83–85], once the effects of the analgesics administered intraoperatively have terminated. The triggering factor correlated to the pain onset is the incision, which directly affects the sensory receptors located around the surgical site, and subsequently causes a variety of inflammatory responses [83, 86, 87]. Additionally, other factors leading to severe pain might be strictly correlated to the implant, the remodeling of the bone, as well as potential nerve injuries [80].

A wide variety of methods have been therefore employed to decrease the pain experienced by the patients, including peripheral nerve blocks and intravenous analgesics; however, a high percentage of patients still necessitates the administration of other narcotic medicinal drugs to ultimately relieve the pain [84].

What follows next focuses on the outcome analysis relative to the experienced postoperative pain after the administration of methylprednisolone or local infiltration analgesia with bupivacaine.

11.1 Postoperative Pain Management and Convalescence of Elderly Through Elevated Dose Administration of Methylprednisolone Prior to THA

The study performed in [82] aimed at establishing the efficacy of perioperative administration of methylprednisolone in patients over 65 years undergoing total hip arthroplasty (THA).

A total of 92 patients over 65 years of age were selected for the analysis and to later receive unilateral THA in concordance with the protocol established by the ERAS, therefore through the use of multimodal analgesia to achieve a prompt recovery in the operated patients [81]. However, 15 patients were subsequently removed from the analysis because of comorbidities that restricted glucocorticoid usage.

Before the procedure, intravenous agents consisting of 2.0 g of cefazolin—to stop the blood flow—and 8 mg of ondansetron, to reduce nausea and vomiting, were administered. All the patients received spinal analgesia and successive compartment block at the fascia iliaca on the operated side, before being subjected to THA via the lateral approach. The VAS/NRS tools were used to determine the appropriate approach for optimal pain management every 6 h at rest. If the score was higher than 4 points, administration of oxycodone hydrochloride was performed with a subcutaneous dose of 0.1 mg for every kg of body weight. Instead, when the calculated score ranged from 2 to 4, paracetamol and metamizole were computed for 1 kg of the body mass [82].

The patients were later subdivided into two groups, and the study was performed in a double-blinded fashion. The M cohort consisted of 39 patients and was administered intravenously with methylprednisolone at a dose of 125 mg, whereas the control group (K) was characterized by 38 patients that received saline solution as the placebo. The effects of the fascia iliaca compartment block were significantly longer in the M cohort, and only 8 patients out of the 39 (20.51%) required the administration of oxycodone hydrochloride after obtaining a VAS/NRS score at rest greater than 4, compared to the 36 cases observed in the K group (94.73%). The average length of hospitalization after the surgical procedure was shorter in the M group (4.89 days) compared to the control cohort (5.47 days), ultimately leading to decreased risk of complications potentially caused by infectious agents [84, 88–94], as well as thrombosis, cardiocirculatory, and respiratory complexities. The averages were influenced by the longer length of stay observed in two patients—each belonging to one of the two designated groups—who experienced postoperative delirium, thus significantly increasing the complexity regarding the rehabilitation process. Laboratory analyses were conducted to establish the levels of inflammatory markers in the body, demonstrating a higher level of leukocytosis in the study group during the first postoperative day, which then abruptly declined by the third day following the surgery [82]. Instead, the same group was characterized by lower C-reactive protein (CRP) levels, whereas no differences were observed in the values collected for CRP in drainage fluids between the two cohorts. Moreover, the administration of methylprednisolone did not impact the glycemic curve of the patients, thus indicating the safety of the medication.

In summary, the administration of a single dose of methylprednisolone in patients over 65 years of age subjected to unilateral THA substantially reduces the experienced pain, as demonstrated by lower VAS/NRS scores obtained at rest. Moreover, the overall number of inflammatory markers in the M group was significantly inferior, in particular regarding the levels of CRP throughout the entire postoperative analysis, whereas it was initially higher for leukocytosis levels, and then followed by a sharp decline during the second and third day following the surgery [82].

11.2 Inability to Prevent Perioperative Blood Loss Following Local Infiltration Analgesia with Bupivacaine During THA

Total hip arthroplasty is a lengthy procedure, correlated to a wide variety of complications, some of which include severe pain and substantial intraoperative blood loss [96]. Various advancements have been therefore made in the techniques used to perform such procedures, as well as in the methodology employed for the perioperative management of the patients, to ultimately alleviate the trauma caused by the surgery and increase the positive outcomes relative to the rehabilitation protocol [96, 98, 99].

One of the most frequently used methods for the management of pain in the initial period following total hip and knee arthroplasty is local infiltration analgesia (LIA) [98, 100, 101], consisting of various solutions of local anesthetics diluted in standard saline [98], and could also include adrenaline, which has been demonstrated to provide additional advantages in the reduction of perioperative blood loss, as well as rates of blood transfusion in TKA [102], particularly when combined with tranexamic acid [103]. LIA is beneficial for pain management following THA [99, 104]; however, it doesn't appear to have any beneficial effects on the volume of blood lost perioperatively [97, 105, 106].

The study undertaken in [95] hypothesized that LIA performed with bupivacaine and adrenaline would substantially decrease the amount of blood lost perioperatively in patients undergoing THA and infiltrated with a solution of at least 350 ml, subsequently decreasing the volume of blood needed for transfusion. A total of 99 patients were included in the study and further subdivided into two cohorts presenting no significant differences in factors including age, weight, body mass index (BMI), or approximate volume of blood: a first infiltrated group, consisting of 55 patients, and a non-infiltrated group, composed of 44. The patients included in the study were subjected to THA via the standard lateral Hardinge approach, followed by standard spinal anesthesia [102]. The local analgesic mixture consisted of 100 ml of saline solution, 50 mg of bupivacaine, and 1 mg of adrenaline, and was administered after the finalization of the surgical procedure, but before the wound was sutured, thus allowing for injection into the soft tissues surrounding the acetabulum and encompassing the capsule, as well as the gluteus medius and vastus lateralis and the underlying subcutaneous tissue. Moreover, two drains were utilized to collect fluids for a period of 48 h after the surgery, one of which was inserted into the joint, and a second one inserted under the tensor fascia lata muscle following the saturation of the gluteus medius [95]. The drainage output was then used to record factors such as hemoglobin levels (Hb), hematocrit (HTC), and red blood cell count (RBC) upon 24 h and on the fourth day following the surgical procedure. All patients exhibiting parameters within the normal range were discharged after 4 days. In contrast, the ones displaying Hb levels inferior to 10g/100 ml after the first analysis or below 9 g/100 ml on the fourth postoperative day were signaled for blood transfusion, which subsequently delayed the discharge process by 48 h to allow for meticulous supervision of the parameters. The values gathered after the delay period then replaced the ones obtained during the second analysis, to provide more accurate results regarding the final levels obtained for the aforementioned parameters.

The operational time was similar for both groups, presenting an average of 90.81 min in the infiltrated cohort and a slightly inferior one of 90.56 min, in the group not subjected to infiltration. Moreover, the values obtained for Hb, HTC, and RCB levels in both groups at 24 h and 4 days postoperatively—or at the time of discharge in case transfusion was required—were considered statistically insignificant. After correction of the results due to the greater size of the acetabulum in the non-infiltrated group, the values indicated for drainage output on day 1, day 2, and total output failed to show any significant differences; however, a direct correlation was identified between the size of the acetabulum and blood loss. Patients belonging

to the infiltrated group necessitated an average transfusion of 1.53 units of blood, whereas the group not receiving the infiltration required a mean of 1.61 units. Additionally, transfusion was not needed in 18 out of the total 55 patients included in the infiltrated group, and in 12 out of the 44 comprised in the non-infiltrated cohort [95].

A similar procedure to the one indicated for the drainage output was performed for blood loss, thus adjusting the total estimated amount based on the size of the acetabulum, ultimately showing no significant difference between the two analyzed groups.

In conclusion, the data obtained throughout the study rejected the hypothesis speculating the potential advantages correlated to the injection of a solution—consisting of regional anesthetic and adrenaline—around the surgical site targeted by THA with the goal of decreasing the volume of blood loss perioperatively and subsequent transfusion rates. However, the size of the prosthetic component, in particular the acetabulum, has been proven to be a potential indicator of a greater volume of blood loss [95].

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