


BMJ Open Hip abductor muscle strength in patients after total or unicompartmental knee arthroplasty for knee osteoarthritis or avascular necrosis: a systematic review and meta-analysis protocol

Peter Kvarda ^{1,2}, Corina Nüesch,^{1,3,4,5} Christian Egloff,¹ Christian Appenzeller-Herzog,⁶ Annegret Mündermann,^{1,3,4,5} Petros Ismailidis^{1,4}

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For numbered affiliations see end of article.

Correspondence to

Dr Peter Kvarda;
kvardamed@gmail.com

ABSTRACT

Introduction Reduced hip abductor strength may indirectly lead to changes in knee kinematics and functional impairment and has been reported in patients with patellofemoral pain and knee osteoarthritis (OA). Limited information is available regarding hip abductor strength following total or unicompartmental knee arthroplasty (TKA/UKA). The aims of this systematic review are to synthesise the evidence of hip abductor muscle strength deficits in patients following TKA/UKA and to determine influencing factors for these deficits.

Methods and analysis Embase, Medline, SportDiscus, the Web of Science Core Collection and Scopus will be searched for human-based clinical studies investigating hip abductor muscle strength after TKA/UKA for knee OA or avascular necrosis (AVN). Articles studying hip abductor strength after knee arthroplasty for post-traumatic OA will not be considered. No restriction on study design, prosthesis design, surgical approach, patient characteristics or severity of OA/AVN will be applied. We will search articles published between 1 January 1990 and the date of our last search. Only articles in English or German language will be considered for inclusion. Studies reporting manually measured muscle strength or measurements performed at hip abduction angles other than 0° will be excluded. References will be screened by two reviewers independently. Where necessary, a third author will make the final decision. The assessment of quality and risk of bias will be performed with the modified Newcastle-Ottawa scale. Data will be extracted and presented in a tabular form. Depending on availability, comparable subgroup and meta-analyses will be conducted. Patient characteristics such as age, sex and surgical approach or rehabilitation programme will be analysed, if sufficient data are available.

Ethics and dissemination No ethics approval is required. The results will be published in a peer-reviewed journal and as conference presentation.

INTRODUCTION

Degenerative diseases of the musculoskeletal system such as osteoarthritis (OA) are one of the leading burdens on the healthcare system,

Strengths and limitations of this study

- To our knowledge, there is no published systematic review investigating hip abductor muscle strength following total or unicompartmental knee arthroplasty.
- The subject and inclusion/exclusion criteria are clearly stated to obtain and present comparable data.
- Possible limitations are the restricted time period of publication and language restriction to English or German.
- Possibility of limited and heterogeneous data availability to perform a meta-analysis.

social security system and certainly on individuals. Prevalence of knee OA is estimated to be approximately 10% in men and 13% in women at the age of 60 years or older.¹ OA is estimated to be the fourth-leading cause of disability by the year of 2020, and the most common indication for performing knee arthroplasty.^{2,3}

Different static and dynamic biomechanical components influence the functional knee mechanics. Static elements are alignment and bony geometry. A neutral mechanical axis of the lower limb during standing passes through the centre of the tibial plateau in the frontal plane. This axis is altered in valgus or varus deformity.^{4,5} Physiologically, during the stance phase of walking, the centre of load is located over the medial condyle creating an external knee adduction moment.^{6,7} Ligaments and muscles of the joint form the group of dynamic stabilisers and mainly resist the adduction moment.⁷

As the adjacent proximal articulation, the hip joint contributes to knee

biomechanics. The hip abductor muscles abduct the femur, facilitate pelvic stability during single leg stance and walking, and directly affect the tibiofemoral and patellofemoral joint kinematics. Moreover, the hip abductor muscle group controls the internal rotation of the femur.⁸ In case of hip abductor muscle strength deficit, the contralateral pelvic side drops while walking, a condition known as ‘trendelenburg gait’⁹ because the external hip adduction moment cannot be sufficiently balanced by the internal hip abduction moment primarily generated by hip abductor muscles. This can be compensated by leaning the trunk towards the support limb and shifting the centre of mass over the support limb and reduce the hip adduction moment.⁸ The protective effect of greater internal hip abduction moment has also been reported in terms of reduced medial tibiofemoral OA progression.¹⁰ Moreover, patellar tracking can be also altered and cause knee pain.^{11–13} Isokinetic measurements have shown that hip abductor muscle weakness is present in patients with knee OA.^{14 15} In a recent systematic review, Deasy *et al* reported hip abductor weakness in patients with knee OA.¹⁶

Current non-surgical treatment modalities aiming alleviate and control symptoms, nonetheless today the only treatment for severe knee OA is total or unicompartmental knee arthroplast (TKA/UKA).^{17 18} Reduced hip abductor muscle strength can implicate compromised functional and performance-based outcome after TKA/UKA, and hence maintaining and strengthening of the hip abductor muscles are clinically relevant factors in patients undergoing TKA or UKA.^{19–21} However, to date, studies investigating hip abductor muscle strength in patients undergoing TKA or UKA are scarce. In addition to outcome evaluations, quantitative assessment of muscle strength is important to understanding factors influencing surgical outcome. In contrast to knee flexor/extensor muscle strength, the impact of hip abductor muscle strength deficit in patients with TKA/UKA is currently poorly understood. The following questions remain unanswered:

- ▶ Do patients after unilateral TKA/UKA experience a muscle strength deficit in their operated compared with their unoperated side?
- ▶ How long after TKA/UKA does this deficit persist?
- ▶ Does the strength deficit after knee arthroplasty differ between patients with total vs unicompartmental arthroplasty?
- ▶ Are hip abductor muscle strength deficits after TKA/UKA influenced by preoperative and postoperative knee alignment, patient characteristics or rehabilitation programmes?

Therefore, the aim of the proposed systematic review is to synthesise the evidence of hip abductor muscle strength deficits in patients following TKA/UKA and to determine influencing factors for these deficits. The results of the proposed systematic review will provide extended information for physicians in

Table 1 The Population, Intervention, Comparison, Outcome, Study design process²⁴

Item	Specification
Population or participants and conditions of interest	Patients with OA or AVN of the knee (any age, gender and severity)
Interventions	TKA/UKA
Comparisons or control groups	For comparison between limbs of the same subject: asymptomatic contralateral hip and knee For comparison between patients and healthy individuals: asymptomatic control subjects
Outcomes of interest	Muscle strength of hip abductors
Study designs	Any study design, published studies, conference abstracts to be considered

AVN, avascular necrosis; OA, osteoarthritis; TKA/UKA, total or unicompartmental knee arthroplasty.

the interest of improving patient management and outcome.

METHODS AND ANALYSES

The protocol was developed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA) guideline²² (online supplementary file A). Bibliographic database searching was initiated on 19 December 2019. The review was submitted for registration prospectively in PROSPERO on 5 January 2020 and the expected completion date is 1 July 2020.²³ We designed the study question using the Population, Intervention, Comparison, Outcome, Study design strategy (table 1).²⁴

Eligibility criteria

Inclusion criteria

Human-based clinical studies reporting on hip abductor muscle strength after primary TKA/UKA will be considered for inclusion. Case studies will not be considered for inclusion. No other restriction regarding the study design will be applied to broadly capture all possible appropriate studies. No restriction on operative approach, prosthesis design, age and sex of the patients or severity of OA/AVN will be placed. In order to avoid capturing irrelevant, methodologically inappropriate studies the date of publication will be limited to a time period from 1 January 1990 to the date of our last search. The limit of follow-up will be set to 24 months postoperatively.

Exclusion criteria

Studies published before 1 January 1990 or in a language other than English or German, not reporting absolute values of hip abductor muscle strength or torque ratios or reporting hip abductor strength measured with hand-held manometer/dynamometer or at a hip abduction

angles other than 0° will be excluded. Articles reporting post-traumatic indications for TKA/UKA or reporting measurements following revision TKA/UKA will not be considered for inclusion.

Methodological considerations

Studies reporting isokinetic or isometric measurements of hip abductor muscle strength at a 0° hip abduction angle using a dynamometer will be considered for inclusion. Manual measurements are not reliable and not directly comparable with measurements taken by electronic dynamometers. Measurements at hip abduction angles other than 0° do not represent relevant muscle function/strength during walking and standing. Moreover, the exclusion of these studies will allow to collect standardised, comparable data facilitating meta-analysis.²⁵

Information sources and search strategy

Text word synonyms and database-specific subject headings for knee OA, knee arthroplasty and hip abductor function will be used. We will search the electronic databases Embase via embase.com, Medline via Ovid, SportDiscus via EBSCOHost, the Web of Science Core Collection and Scopus (online supplementary file B). In the primary search no language restrictions will be applied. Time period of the search will be limited to articles published after 1 January 1990. References will be exported to Endnote X9 (Clarivate, London, UK) and deduplicated. The detailed search strategy can be found in the supplementary document.

Study records: data management, selection process and data extraction

Titles and abstracts of all retrieved references will be independently reviewed and screened by two reviewers (PK and PI) to identify studies that potentially meet the inclusion criteria. All potentially relevant references will be collected in full text and independently assessed by two reviewers (PK and PI). Any disagreements regarding eligibility will be resolved by consensus and by necessity, a third review author (AM) will make a final decision. To find possible additional studies, we will screen the bibliographic references of all included articles as well as the citations of those that are indexed in Scopus or Web of Science. The study selection process will be presented in form of a PRISMA diagram.²² Data from the full texts will be extracted and entered into a standardised excel data entry form by PK and PI based on piloting extractions. The information to be extracted can be found in [table 2](#). We will contact corresponding authors when the necessary data are missing or unclear. Potential conference abstracts will be considered for inclusion only if appropriate data are available for the outcomes of this study. We will contact principal investigators and/or corresponding author(s) twice by email in case of conference abstracts to collect their results. The data extraction will be cross-checked independently.

Table 2 Data that will be extracted from every study included in the review

No	Description
1	Authors and year of publication
2	Country of origin of the study
3	Type of study
4	Study population
5	Study completion rate
6	Diagnosis
7	Surgical approach: medial parapatellar; modified medial parapatellar according to Insall; subvastus; midvastus; trivector retaining; lateral; lateral with tuberositas osteotomy ²⁸
8	Study population demographics
9	Preoperative and postoperative frontal and sagittal plane knee alignment
10	Measurement methods
10a	Isometric/isokinetic strength measurement
10b	Angle of isometric measurement/velocity of isokinetic measurement
10c	Patient position during the measurement (lying supine/side-lying/standing)
11	Comparators: healthy individuals; asymptomatic contralateral side; no comparator
12	Total duration of follow-up (weeks/months after the operation)
13	Measurement stages (preoperative, follow-up in weeks/months after the operation)
14	Information regarding the rehabilitation protocols
15	Outcome (mean values, standard deviations (SDs) and confidence intervals (CIs))
15a	Absolute values of hip abductor torque in patients after TKA/UKA, or in asymptomatic control groups
15b	Torque ratio (operated side/contralateral hip) of hip abductors in patients after TKA/UKA
15c	Change in hip abductor torque / hip abductor torque ratio from baseline to each follow-up
15d	Differences in hip abductor torque / torque ratios between patients after TKA/UKA and healthy control groups.
16	Authors conclusions
17	Information regarding risk of bias

TKA/UKA, total or unicompartmental knee arthroplasty.

Outcomes and prioritisation

The main outcomes will be

1. Absolute values of isometric/isokinetic hip abductor torque in patients following TKA/UKA, or in asymptomatic control groups.
2. Torque ratio (ipsilateral hip/contralateral hip) of hip abductors following TKA/UKA.
3. Change in hip abductor torque/hip abductor torque ratio from baseline to each follow-up.



4. Differences in hip abductor torque/torque ratio between patients after TKA/UKA and healthy control groups.

The secondary outcomes will be

1. Surgical approaches/methods of TKA/UKA.
2. Preoperative and postoperative knee alignment.
3. Patient characteristics.
4. Rehabilitation programmes after TKA/UKA.

Risk of bias in individual studies

To minimise bias, articles meeting the inclusion criteria will be assessed by two reviewers (PK and PI) independently using a modified version of the Newcastle-Ottawa Scale (NOS)²⁶ (online supplementary file C). According to the modified NOS, each study will be valued with 1–6 stars where higher scores indicate higher level of quality. No separate tool will be used to assess the risk of bias of randomised control trials because we do not extract estimates of treatment differences from RCTs but use these as a source for cohort data.

Data synthesis

We will extract any quantitative and descriptive data from all eligible studies according to the main outcomes (mean, median, etc), on the population (SD, IQRs, percentile), on measurements (standard errors, CI, p values, sample size), as well as the secondary outcomes for both purposes (systematic review and meta-analyses). Furthermore, all details specific to the review question will be extracted. If the information is available for several time points, the data will be extracted for all time points. The data will be presented in tabular format. Visual inspection of the forest plots and I^2 test will be used to assess heterogeneity between studies. Depending on availability of appropriate data for comparable specific patient groups with same measurement method in different studies, meta-analyses will be performed on these data. Meta-analysis will be based on random effects and the results will be illustrated by forest plots. Where statistical pooling is not possible, the findings will be presented in narrative form. Meta regression and subgroup-specific meta analyses will be conducted to investigate the effect of time since TKA/UKA and measurement type (isokinetic or isometric) on different outcomes. In case that outcomes are not reported directly but indirect information is available on side specific or time point-specific results, the available information will be transformed accordingly. In case of sufficient information, these analyses will be extended to patient characteristics, surgical approach, subtype of prostheses or rehabilitation programme.

Meta-bias(es)

Funnel plots will be used to assess publication bias in our meta-analysis, presenting effect sizes plotted against their SEs or precisions. To avoid subjective visual inspection of the graph, Egger's regression test will be used to assess the asymmetry. Egger's test regresses the standardised

effect sizes on their precisions. In the absence of publication bias, the regression intercept is expected to be zero.

Confidence in cumulative evidence

Grading of Recommendations Assessment, Development and Evaluation system will be applied.²⁷ The confidence of evidence of the investigated study can be downgraded according to the following factors: study limitations, inconsistency of results, indirectness of evidence, imprecision, publication bias. Criteria for upgrading are the following: large magnitude of effect, evidence of a dose-response effect and all possible confounding factors taken into account. After the grading process, the quality of evidence for each outcome will be rated as high, moderate, low or very low.

Ethics and dissemination

This study is a protocol for a systematic review and meta-analysis. No human participants will be recruited. No ethics approval is needed. The study results will be published in a peer-reviewed journal and as conference presentation.

Author affiliations

¹Department of Orthopaedics and Traumatology, University Hospital Basel, Basel, Switzerland

²Department of Orthopaedic Surgery and Traumatology, Kantonsspital Baselland, Bruderholz, Basel-Landschaft, Switzerland

³Department of Clinical Research, University of Basel, Basel, Switzerland

⁴Department of Biomedical Engineering, University of Basel, Basel, Switzerland

⁵Department of Spine Surgery, University Hospital of Basel, Basel, Switzerland

⁶University Medical Library, University Library of Basel, Basel, Spiegelgasse, Switzerland

Twitter Peter Kvarda @Kvarda

Contributors The following work has been developed in contribution of each coauthor. The manuscript underwent several revisions with substantial contributions provided by each coauthor. PI, PK and AM will perform this systematic review and meta-analysis. The protocol has been registered in PROSPERO by PK. The search strategy was designed by CA-H. CN reviewed the protocol and was responsible for the strategy of data synthesis. CE cooperated in study design development, as well as in manuscript editing. All authors gave final approval of the manuscript prior to submission.

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ORCID iD

Peter Kvarda <http://orcid.org/0000-0002-1623-4712>

REFERENCES

- 1 Zhang Y, Jordan JM. Epidemiology of osteoarthritis. *Clin Geriatr Med* 2010;26:355–69.
- 2 Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. *Bull World Health Organ* 2003;81:646–56.
- 3 Carr AJ, Robertsson O, Graves S, *et al.* Knee replacement. *Lancet* 2012;379:1331–40.
- 4 Cooke TDV, Sled EA, Scudamore RA. Frontal plane knee alignment: a call for standardized measurement. *J Rheumatol* 2007;34:1796–801.
- 5 Egloff C, Hügler T, Valderrabano V. Biomechanics and pathomechanisms of osteoarthritis. *Swiss Med Wkly* 2012;142:w13583.
- 6 Morrison JB. The mechanics of the knee joint in relation to normal walking. *J Biomech* 1970;3:51–61.
- 7 Shelburne KB, Torry MR, Pandy MG. Contributions of muscles, ligaments, and the ground-reaction force to tibiofemoral joint loading during normal gait. *J Orthop Res* 2006;24:1983–90.
- 8 Powers CM. The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. *J Orthop Sports Phys Ther* 2010;40:42–51.
- 9 Gandbhir VN, Rayi A. *Trendelenburg gait*. Treasure Island (FL): StatPearls Publishing, 2019.
- 10 Chang A, Hayes K, Dunlop D, *et al.* Hip abduction moment and protection against medial tibiofemoral osteoarthritis progression. *Arthritis Rheum* 2005;52:3515–9.
- 11 Piva SR, Goodnite EA, Childs JD. Strength around the hip and flexibility of soft tissues in individuals with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther* 2005;35:793–801.
- 12 Ireland ML, Willson JD, Ballantyne BT, *et al.* Hip strength in females with and without patellofemoral pain. *J Orthop Sports Phys Ther* 2003;33:671–6.
- 13 Mascal CL, Landel R, Powers C. Management of patellofemoral pain targeting hip, pelvis, and trunk muscle function: 2 case reports. *J Orthop Sports Phys Ther* 2003;33:647–60.
- 14 Costa RA, Oliveira LMde, Watanabe SH, *et al.* Isokinetic assessment of the hip muscles in patients with osteoarthritis of the knee. *Clinics* 2010;65:1253–9.
- 15 Hinman RS, Hunt MA, Creaby MW, *et al.* Hip muscle weakness in individuals with medial knee osteoarthritis. *Arthritis Care Res* 2010;62:1190–3.
- 16 Deasy M, Leahy E, Semciw AI. Hip strength deficits in people with symptomatic knee osteoarthritis: a systematic review with meta-analysis. *J Orthop Sports Phys Ther* 2016;46:629–39.
- 17 Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: pathophysiology and current treatment modalities. *J Pain Res* 2018;11:2189–96.
- 18 McGrory BJ, Weber KL, Jevsevar DS, *et al.* Surgical management of osteoarthritis of the knee: evidence-based guideline. *JAAOS - J Am Acad Orthop Surg* 2016;24.
- 19 Loyd BJ, Jennings JM, Judd DL, *et al.* Influence of hip abductor strength on functional outcomes before and after total knee arthroplasty: post hoc analysis of a randomized controlled trial. *Phys Ther* 2017;97:896–903.
- 20 Piva SR, Teixeira PEP, Almeida GJM, *et al.* Contribution of hip abductor strength to physical function in patients with total knee arthroplasty. *Phys Ther* 2011;91:225–33.
- 21 Alnahdi AH, Zeni JA, Snyder-Mackler L. Hip abductor strength reliability and association with physical function after unilateral total knee arthroplasty: a cross-sectional study. *Phys Ther* 2014;94:1154–62.
- 22 Shamseer L, Moher D, Clarke M, *et al.* Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ* 2015;350:g7647.
- 23 National Institute for Health Research. PROSPERO. International prospective register of systematic reviews. Available: <https://www.crd.york.ac.uk/PROSPERO/>
- 24 Methley AM, Campbell S, Chew-Graham C, *et al.* PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Serv Res* 2014;14:579.
- 25 Chamorro C, Armijo-Olivo S, De la Fuente C, *et al.* Absolute reliability and concurrent validity of hand held dynamometry and isokinetic dynamometry in the hip, knee and ankle joint: systematic review and meta-analysis. *Open Med* 2017;12:359–75.
- 26 Wells G, Shea B, O'Connell D, *et al.* The Newcastle-Ottawa Scale (NOS) for assessing the quality of case-control studies in meta-analyses. *Eur J Epidemiol* 2011;25:603–5.
- 27 Guyatt GH, Oxman AD, Vist GE, *et al.* GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;336:924–6.
- 28 Vaishya R, Vijay V, Demesugh DM, *et al.* Surgical approaches for total knee arthroplasty. *J Clin Orthop Trauma* 2016;7:71–9.