Systematic Review / Meta-analysis

ANNALS OF MEDICINE & SURGERY

OPEN

Long-term outcomes of converting fused hips to total hip arthroplasty are satisfactory: a systematic review and meta-analysis

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Background: Although conversion arthroplasty of fused hips can relieve pain and provide patient satisfaction, long-term outcomes of total hip arthroplasty (THA) after hip fusion remain a subject of debate. This meta-analysis aimed to assess the effectiveness of THA for fused hips over a long period with concerns over potential complications.

Methods: A systematic search of five databases from 2000 until 2023 identified English studies evaluating THA for fused hips with at least 100 months of follow-up. Meta-analyses were conducted using random-effect models via the comprehensive meta-analysis software. Sensitivity analysis, in-depth meta-regression, Egger's test, and the trim-and-fill method were performed appropriately

Results: The meta-analysis assessed 790 patients and 889 hips with a mean follow-up of 11 years. At the final follow-up, the mean Harris Hip Score (HHS) and leg length discrepancy (LLD) improved by 34.755 and 2.3 cm from the baseline, respectively. Regarding survival of hip fusion conversion to THA, most studies (88.8%) reported a 5-year implant survival rate of at least 90%, and the 15-year and 20-year implant survival rates, ranged between 80–90% and 70–90%, respectively. Subjective dissatisfaction with the conversion of hip fusion to THA was only 5.3%. Composite rates of revision, instability, and aseptic loosening were 13.6%, 3.8%, and 8.8%, respectively.

Conclusions: Conversion of fused hips to THA results in favourable long-term outcomes regarding HHS, LLD, survival rates, and subjective satisfaction, leading to improved quality of life in properly selected patients. However, the presence of complications should be considered when evaluating the overall success of the procedure.

Keywords: conversion, fused hips, long-term outcomes, total hip arthroplasty

Introduction

Historically, hip diseases, including infection, trauma, and arthritis, have all been treated by hip arthrodesis[1,2]. While hip fusion can offer stability and pain relief, it frequently leads to substantial functional restrictions, including decreased range of motion, alterations in gait, and compensatory modifications in the adjacent joints and lumbar spine[3,4]. To address these functional restrictions and enhance patients' overall quality of life, there has been an increasing interest in converting previously fused hips to total hip arthroplasty (THA)[5,6]. Additionally, spontaneous hip fusion can occur mostly following septic or autoimmune diseases, including ankylosing spondylitis and rheumatoid arthritis, developmental dysplasia, and post-trauma[1,5].

Although it is possible to convert a fused hip to THA, conversion THA (cTHA) is technically challenging and has higher costs, resources, and risk of complications than a primary THA (pTHA)[7,8]. Significant scar tissue, changed anatomy, and bone

HIGHLIGHTS

- Our findings indicate a high satisfaction rate among patients, with 95% expressing satisfaction with the outcomes of conversion THA during long-term follow-up.
- At long-term follow-up, a mean improvement of 34.755 for HHS from baseline was achieved based on our analysis.
- Composite rate of revision, dislocation, and aseptic loosening for conversion arthroplasty were 13.6%, 3.8%, and 8.8%, respectively.
- Properly selecting patients undergoing THA after hip fusion can lead to enhanced quality of life despite the presence of potential complications.

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article

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Annals of Medicine & Surgery (2024) 86:3391–3399

Received 12 February 2024; Accepted 23 March 2024

Supplemental Digital Content is available for this article. Direct URL citations are provided in the HTML and PDF versions of this article on the journal's website, www.lww.com/annals-of-medicine-and-surgery.

Published online 3 April 2024

http://dx.doi.org/10.1097/MS9.0000000000002024

loss might make exposure and implant location more challenging, requiring careful preoperative planning and meticulous surgical technique. Furthermore, some of the common complications include infection, instability, loosening, nerve injury, venous thromboembolism (VTE), and heterotopic ossification (HO)[9–13]

Long-term follow-up is required for THA, arthrodesis, and cTHA since they are all intended to provide long-term function, and it is necessary to evaluate their effectiveness while considering any complications that may arise. So, this systematic review and meta-analysis aimed to assess the long-term outcomes of cTHA of fused hips by summarizing the information on (1) patient satisfaction, (2) hip function, (3) range of motion (ROM), (4) leg length discrepancy (LLD), and (5) specific complications of the conversion of the fused hip to THA.

Methods

Search strategy and selection criteria

This systematic review and meta-analysis were designed based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines[14], Supplemental Digital Content 1, http://links.lww.com/MS9/A418, Supplemental Digital Content 2, http://links.lww.com/MS9/A419, and the study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with code CRD42023399330.

We searched PubMed, Scopus, the Cochrane Central Register of Controlled Trials, Embase, and Web of Science for English papers (Detailed search strategy in Supplementary file 1, Supplemental Digital Content 3, http://links.lww.com/MS9/A420) from 1 January 2000, until 18 May 2023. The following Medical Subject Headings and keyword search terms were used; "Hip" AND ("Fused" OR "Fusion" OR "Arthrodesis" OR "Arthrodesed" OR "Ankylosed" OR "Ankylosis" OR "Conversion"). The reference list of eligible studies and relevant reviews on the topic was also screened. The search strategy related to each database is presented in supplementary materials, Supplemental Digital Content 3, http://links.lww.com/MS9/A420.

The included studies for this meta-analysis met the following criteria: (1) English studies that reported outcomes of conversion of fused hips to THA in adults. (2) Mean duration of follow-up more than 100 months. Irrelevant and incomplete studies, case reports, letters to the editor, and conference abstracts were dismissed.

Outcomes

The outcomes of interest in this study were implant survival rate, ROM of the involved hip, LLD, and functional assessment via Harris Hip Score (HHS) as a valid tool for evaluating results of hip surgery[15], subjective dissatisfaction rate, and postoperative complication rate including, revision, instability, aseptic loosening, stem loosening, acetabular loosening, infection, wound complications, intraoperative fracture, nerve injuries, VTE, greater trochanter-related injuries, abnormal walking patterns, Trendelenburg sign, total HO and Grade 4 of HO.

Data collection

The process involved importing the findings of the systematic search into Endnote software version 20.0 (from Clarivate PLC in London, United Kingdom). Two independent authors, RA and AN, reviewed the study titles and abstracts, and any discrepancies were addressed by a third reviewer, MP. The selected studies were then retrieved in full, and data was extracted using a structured checklist was used for the data extraction including various details such as the name of the first author, study location, study type, sample size, baseline characteristics, radiographic and clinical assessment scores of interests, and the presence of complications.

Risk of bias assessment

The methodological quality of included articles was assessed using the NIH quality assessment tool for the before-after (Pre-Post) study without a control group, which consists of 12 questions and a final quality rating item, which is classified into poor, fair, and good[16]. Two authors (A.N. and C.A.) independently performed a quality assessment, and controversies were resolved by discussion between the authors and expert opinions (M.P.).

Quality assessment and level of evidence results

Regarding the level of evidence, most of the included studies were level IV (88.8%)[17–32], and two studies with a level of evidence of III[33,34] were also included.

The included 18 studies were assessed for bias using the NIH Quality Assessment tool for Before After studies with no control group. Only one article (5.5%) had poor quality[23], whereas 10 studies (55.5%) had methods of good quality. The results of the quality assessment are explained extensively in Table 1.

Statistical analysis

Statistical analyses centred on our primary outcomes, including final ROM, mean changes in HHS, LLD, and the rate of dissatisfaction. Secondary outcomes were complications, including the rates of revision, instability, aseptic loosening, infection, wound complications, intraoperative fracture, nerve injuries, VTE, greater trochanter-related injuries, abnormal walking pattern, Trendelenburg sign, total HO and Grade 4 of HO. Employing a random effects model, outcome rates were pooled to mitigate the impact of between-study heterogeneity[35]. In cases of high heterogeneity, first, a sensitivity analysis **was** performed to detect the outlier. If the heterogeneity remained high, in-depth meta-regression, utilizing random effects (method of moments), two-sided P value, Z-distribution, Rate, and 95% CIs were conducted on both quantitative and categorical variables. To address potential study bias, Egger's linear regression test was employed, applying the trim-and-fill method for correction where significant high publication bias was detected ($P < 0.05$)[36]. All analyses were performed using the comprehensive meta-analysis software (CMA; version 3.3).

Results

Searching results

The PRISMA flowchart illustrating the study selection process is shown in Fig. 1. We found 2175 potentially relevant records. Sixty studies with full-text availability were reviewed after excluding 1056 records for duplication and 1059 records for not meeting inclusion criteria based on title and abstract. Finally, this meta-analysis incorporated data from 18 studies published between 2001 and 2021[17–34].

Table 1

NIH quality assessment tool for before-after studies with no control group[19-36]

First author (year)	1	2	3	4	5	6	7	8	9	10	11	12	Quality rating
Grappiolo 2021[27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	Yes	No	NA	Good
Ayekoloye 2021[32]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	Yes	Yes	NA	Good
Dikmen 2019[30]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	No	Yes	NA	Good
Flecher 2018[28]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	No	Yes	NA	Good
Zahar 2015[17]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	Yes	No	NA	Fair
Wang 2014[18]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	Yes	No	No	NA	Good
Drexler 2012[29]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	Yes	No	No	NA	Fair
Richards 2011[34]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	Yes	No	NA	Good
Fernandez-Fairen 2011[33]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	Yes	Yes	No	NA	Good
Rutz 2009[20]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	Yes	No	NA	Fair
Rajaratnam 2009[21]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	No	Yes	NA	Fair
Peterson 2009[22]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	Yes	Yes	NA	Good
Sirikonda 2008[19]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	Yes	No	NA	Good
Bhan 2008[31]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	No	No	NA	Fair
Kim 2007[23]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	No	No	NA	Poor
Kim 2003[24]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	Yes	Yes	NA	Good
Joshi 2002[25]	Yes	Yes	Yes	Yes	Yes	No	Yes	NR	NR	Yes	No	NA	Fair
Hamadouche 2001[26]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR	NR	No	No	NA	Fair

1: Was the study question or objective clearly stated? 2. Were eligibility/selection criteria for the study population pre-specified and clearly described? 3. Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest? 4. Were all eligible participants that met the pre-specified entry criteria enroled? 5. Was the sample size sufficiently large to provide confidence in the findings? 6. Was the test/service/intervention clearly described and delivered consistently across the study population? 7. Were the outcome measures pre-specified, clearly defined, valid, reliable, and assessed consistently across all study participants? 8. Were the people assessing the outcomes blinded to the participants' exposures/interventions? 9. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis? 10. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided *P* values for the pre-to-post changes? 11. Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e. did they use an interrupted time-series design)? 12. If the intervention was conducted at a group level (e.g. a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?

NA, not applicable; NR, not reported.

Study characteristics

Study and patient characteristics are presented in Table 2. This study assessed 790 patients and 889 hips, including 490 surgical hip fusions, and 399 spontaneous hip fusions, with a mean follow-up of 11 years (range: 8.5–17). The majority of included articles were retrospective case-series studies[17–20,22–28,30–34], except for two studies by Rajaratnam and colleagues and Drexler and colleagues that had a prospective design[21,29]. Males represented 53.67%, while females represented 46.33%. Cemented arthroplasty was done for 443 hips, while cementless arthroplasty was performed in 446 hips. Regarding conversion age, the mean age ranged between (25.5 and 55.8) years old. Additionally, baseline ranges of LLD and HHS varied from 2.1 to 4.2 and 22 to 70, respectively. Based on available data, different surgical approaches were used for the conversion of hip arthrodesis to THA: lateral approach (LA) for 454 hips, Posterolateral approach (PLA) for 266 hips, anterolateral approach (ALA) for 44 hips, and direct anterior approach (DAA) for 35 hips.

Outcomes

Implant survival rate

Figure 2 depicts all included Kaplan–Meier implant survival rate diagrams considering revision as the endpoint in 10 studies[18,19,25–27,30–34]. As illustrated in Fig. 2 for all studies except for Ayekoloye's and Richards's studies[32,34], the survival rate after 5 years was more than 90%. Furthermore, at 10 years only Richards *et al.*[34] reported a survival rate below 80%, and most studies reported an implant survival rate of nearly 90%. Also, the 15 and 20-year implant survival rates, ranged between 80–90% and 70–90%, respectively.

Range of motion

ROM outcomes at final follow-up are presented in Table 3 and forest plots are depicted in supplementary materials, Supplemental Digital Content 3, http://links.lww.com/MS9/A420.

Flexion

The pooled mean and standard error (SE) of flexion were 87.746° and 3.840°, respectively.

Abduction

The pooled abduction ROM is a mean and SE of 34.363° and 3.243°, respectively.

Adduction

The pooled adduction ROM is a mean and SE of 26.274° and 3.741°, respectively.

Internal rotation

The pooled mean and SE were 28.098° and 6.298°, respectively.

External rotation

The pooled mean and SE were 32.261° and 5.294°, respectively.

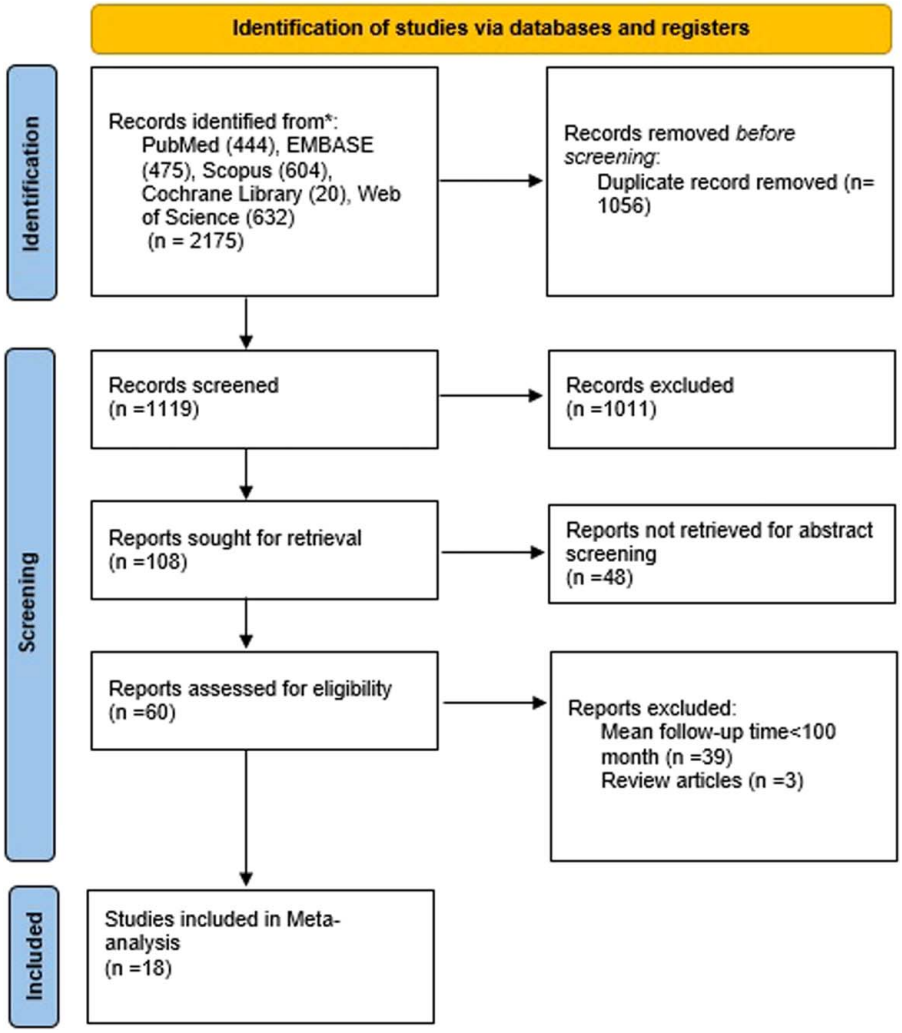

Figure 1. Flowchart of the study selection process.

Leg length discrepancy

A total of nine studies were included in the analysis. The random-effect model showed a mean of 1.088 cm of LLD (SE: 0.119) at the final follow-up with high heterogeneity (I^2:95%) (Fig. 3A). LLD decreased by a mean of 2.3 cm (SE: 0.258) from the time of cTHA but with high heterogeneity (I^2:89%) (Fig. 3B).

Harris Hip Score

A pooled analysis of 11 studies revealed that at the final follow-up mean HHS was measured 83.941 (SE: 1.094 and I^2:89%) (Fig. 3C). Additionally, a mean improvement of 34.755 (SE: 3.456) for HHS from baseline was achieved based on our analysis with high heterogeneity (I^2:99%) (Fig. 3D).

Subjective dissatisfaction

Subjective Dissatisfaction rate was reported in 10 included studies and varied from almost 0–19%. In general, the mean pooled dissatisfaction rate for conversion of hip fusion to THA was 5.3% (95% CI: 2.5–10.6%; I^2:44%). The forest plot is shown in supplementary materials, Supplemental Digital Content 3, http://links.lww.com/MS9/A420.

Complications

Regarding complications as illustrated in Table 4, mean pooled rates were as follows: revision (13.6%, I^2:43%), instability (3.8%, I^2:0%), aseptic loosening (8.8%, I^2:53%), stem loosening (4.3%, I^2:47%), acetabular loosening (7.5%, I^2:0%), infection (3.8%, I^2:25%), wound complications (3.2%, I^2:24%), intraoperative fracture(4%, I^2:42%), nerve injuries (5.6%, I^2:3%), VTE (3.5%, I^2:13%), greater trochanter-related injuries (5.3%, I^2:72%), abnormal walking patterns (40.8%, I^2:88%), Trendelenburg sign (33.1%, I^2:69%), and total HO (18.5%, I^2:77%) and Grade 4 of HO (2.5%, I^2:0%). Forest plots are presented in supplementary materials, Supplemental Digital Content 3, http://links.lww.com/MS9/A420.

Sensitivity analysis, meta-regression, and publication bias

For outcomes with significant heterogeneity ($I^2 > 50\%$), a sensitivity analysis was first conducted, revealing no impactful

Table 2

Characteristic and demographic information of included studies

Study	Country	Journal	Level of evidence	Hips	Surgical arthrodesis (%)	Male (%)	Fusion age (years)	Conversion age (years)	Cemented (%)	Approach	Mean follow-up (months)	Length of fusion (years)
Grappiolo *et al.* 2021[27]	Italy	J.Arthroplasty	4	59	100	29.8	18.1	55.1	0	PLA	156	36.8
Ayekoloye *et al.* 2021[32]	Canada	Bone Joint J	4	39	64.1	34.2	18.54	49.53	0	LA	146.4	
Dikmen *et al.* 2019[30]	Turkey	J Orthop Surg	4	29	62.0	38.5		43.3	0	LA	121.2	20.1
Flecher *et al.* 2018[28]	France	Int. Orthop	4	23	60.8	56.5%		49	0	ALA	180	32
Zahar *et al.* 2015[17]	Hungary	Hip Int	4	45	31.1	69.2%		48.3	75.5		104.4	18.2
Wang *et al.* 2014[18]	China	BMC Musculoskelet. Disord	4	26	0	84.6%		33.7	0	LA	128.4	
Drexler *et al.* 2012[29]	Canada	Semin Arthroplasty	4	25	0	57.1%		50.5	0	DAA	103.2	19
Richards *et al.* 2011[34]	Canada	J. Arthroplasty	3	26	100	76.9	29	49	30.7	LA	108	
Fernandez-Fairen *et al.* 2011[33]	Spain	Clin. Orthop. Relat. Res	3	48	62.5	70.8	26	52	45.8	Mix	204	26
Rutz *et al.* 2009[20]	Switzerland	J Orthop Sci	4	22	54.5	68.2		52.8	81.8	LA	158.4	32.5
Rajaratnam *et al.* 2009[21]	Australia	Hip Int	4	16	62.5	60		52	0	Mix	129	36
Peterson *et al.* 2009[22]	USA	Clin. Orthop. Relat. Res	4	30	83.3	40	19.9	52.5	40	Mix	124.8	32.6
Sirikonda *et al.* 2008[19]	UK	Hip Int	4	45	77.7	45.4	16.7	48.7	100		207.5	32.3
Bhan *et al.* 2008[31]	India	J. Arthroplasty	4	92	0	77.8		25.5	0	PLA	102	5.2
Kim *et al.* 2007[23]	South Korea	J. Arthroplasty	4	24	16.6	100		36	37.5	LA	132	11
Kim *et al.* 2003[24]	South Korea	Clin. Orthop. Relat. Res	4	87	43.6	55.8		46.7	48.2	PLA	119.9	28.2
Joshi *et al.* 2002[25]	UK	J Bone Joint Surg Am	4	208	76.9	46	21.33	51	100	LA	110.4	27
Hamadouche *et al.* 2001[26]	France	J Bone Joint Surg Am	4	45	44.4	42.2		55.8	100	LA	102	35.7

ALA, anterolateral approach; DAA, direct anterior approach; LA, lateral approach; PLA, posterolateral approach.

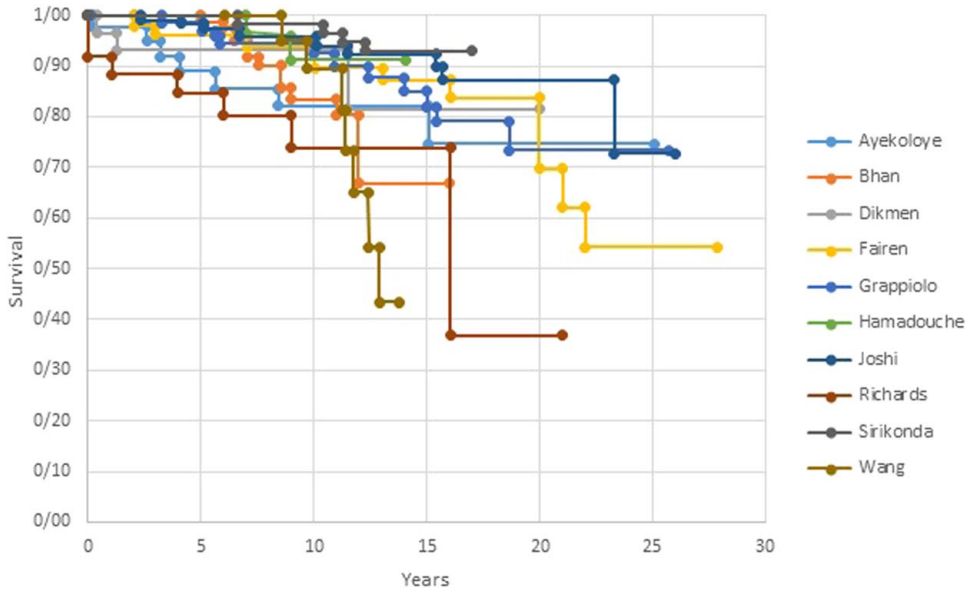

Figure 2. Kaplan–Meier curve for implant survival, considering revision as the endpoint.

outliers. The subsequent Egger test identified a publication bias, specifically in the aseptic loosening rate, which we adjusted using the trim-and-fill method (detailed in Table 5). Delving deeper through meta-regressions and subgroup analyses, we discerned potential factors behind this heterogeneity. Concerning LLD changes, studies using ALA displayed a smaller reduction compared to those with LA, and longer fusion durations correlated with a decreased LLD reduction. For GT injuries, findings suggested fewer injuries in studies characterized by a predominantly male demographic, younger participants, and a higher proportion of spontaneously fused hips. Studies with older participants also showed a rise in abnormal walking patterns.

Comparative studies

Only two studies were comparative. Richards *et al.*[34] compared cTHA to pTHA in patients who underwent cementless cTHA for surgical fusion, revealing that the cTHA group had notably lower survivorship and reduced patient-reported outcome measures (PROMs) in a 17 versus 34 sample size. In a separate comparison by Richards and colleagues involving cTHA and revision THA (rTHA) for cementless procedures, both groups (17 patients each) had relatively similar outcomes, with the cTHA showing a non-significant trend of reduced survivorship and PROMs. Additionally, Fernandez-Fairen's comparison of 48 cTHA patients to 50 pTHA patients found no significant differences in complication rates, THA survival, or patient satisfaction[33].

Table 3

Pooled mean and standard error of flexion, abduction, adduction, internal rotation, and external rotation[19-36]

ROM outcomes	No. studies	Mean (standard error)	*P*	I^2 (%)
Flexion	10	87.746 (3.840)	0.000	93
Abduction	8	34.363 (3.243)	0.000	98
Adduction	8	26.274 (3.741)	0.000	99
Internal rotation	7	28.098 (6.298)	0.000	99
External rotation	7	32.261 (5.294)	0.000	97

ROM, range of motion.

Discussion

The pursuit of orthopaedic interventions aims not only for immediate relief and restoration of function but also for sustainable long-term outcomes. In the backdrop of historical practices, where hip diseases were treated primarily by hip arthrodesis, our systematic review and meta-analysis have explored the evolving paradigm of converting fused hips to THA in order to achieve better functional results.

A standout feature of our study is the stringent inclusion criteria, focusing exclusively on studies with a long-term follow-up of more than 100 months. This deliberate emphasis ensures that the findings relayed are reflective of the durability and sustainability of the outcomes, thus making a significant contribution to the existing literature. It can be inferred from our results that the conversion of a fused hip to THA can offer promising long-term outcomes. Patients demonstrated improvements in hip function, ROM, and reduced LLD. Additionally, the rate of dissatisfaction was relatively low, suggesting that most patients experienced notable benefits post-procedure.

Our findings indicate a high satisfaction rate among patients, with 95% expressing satisfaction with the outcomes of cTHA during long-term follow-up. This notable level of patient satisfaction can likely be attributed to several key factors. Firstly, the enhanced ability to perform daily activities owing to the regained mobility in the hip joint played a crucial role. Additionally, the alleviation of pain in the joints surrounding the hip area contributed significantly to the overall satisfaction. Finally, the decrease in LLD was also a vital factor in achieving these positive patient outcomes.

However, the conversion process isn't without its challenges, which is evident from the technical intricacies highlighted and the array of potential complications, ranging from infection to

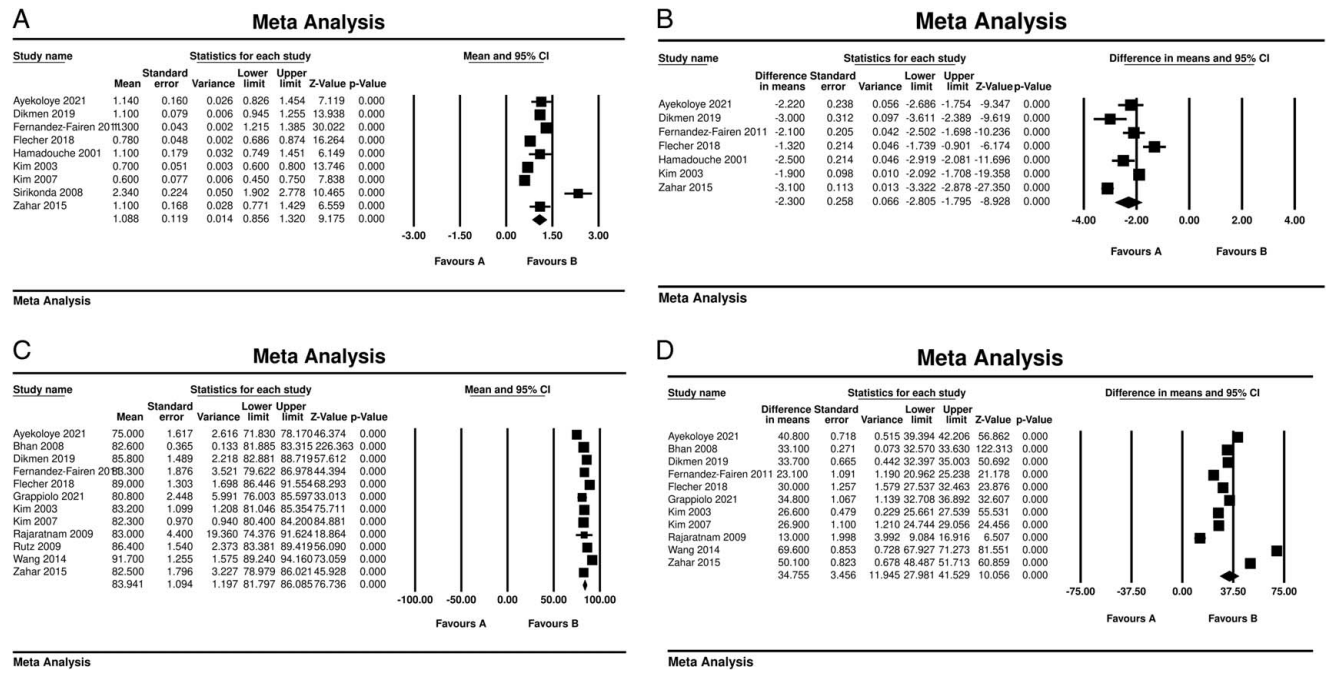

Figure 3. (A) Forest plot showing the observed outcomes and the estimate of the random-effect model for final leg length discrepancy. (B) Forest plot showing the observed outcomes and the estimate of the random-effect model for improvement of leg length discrepancy and Harris Hip Score, respectively. (C). Forest plot showing the observed outcomes and the estimate of the random-effect model for final Harris Hip Score, respectively. (D). Forest plot showing the observed outcomes and the estimate of the random-effect model for improvement of Harris Hip Score, respectively.

heterotopic ossification. Still, with meticulous surgical planning and technique, many of these challenges can be surmounted, leading to improved patient quality of life.

Our study revealed that the HHS for cases of cTHA after hip fusion is approximately 84. This finding is particularly noteworthy as it aligns closely with the outcomes observed in both revision THA and primary THA procedures. In extensive studies, the HHS for revision THA and primary THA typically ranges between 80 and 90, indicating a comparable level of effectiveness in terms of patient recovery and hip functionality post-surgery[37–40]. This similarity in scores underscores the efficacy of cTHA in fused hip cases, positioning it alongside established THA procedures in terms of successful outcomes.

Contrary to the assumption that cTHA on surgically fused hips is more challenging than on spontaneously fused hips, our meta-regression analysis found no evidence of higher complication rates in populations with a higher incidence of surgically fused hips[32]. This suggests that the complexity of cTHA in surgically fused hips does not necessarily lead to an increased risk of post-operative complications.

Jauregui and colleagues in 2017 provided an analysis of 27 studies which totalled 1,104 hips. Their findings emphasized the significant functional benefits of converting hip fusion to THA, but also highlighted the associated complications. Notably, their study reported an HHS improvement from 58.1 preoperatively to 80 postoperatively. Specific complication rates ranged across various metrics, including infections, instability, and loosening. Their study concluded by emphasizing the challenges of the takedown of a fused hip and the associated complications[4].

Jain and colleagues in 2013 took a different approach, evaluating outcomes post-arthrodesis and its subsequent conversion to THA. Their review of eight studies on primary hip arthrodesis showed variable outcomes in union rates, patient satisfaction, and adjacent joint pain. Interestingly, their analysis of 11 studies on conversion arthroplasty painted a more cautious picture, indicating inconsistent pain relief results and a high rate of

Table 4

Pooled rates of revision, instability, aseptic loosening, stem loosening, acetabular loosening, infection, wound complications, intraoperative fracture, nerve injuries, venous thromboembolism, greater trochanter-related injuries, abnormal walk[19-36]

Complications	No. studies	Pooled event rate (95% CI)	*P* value	I^2 (%)
Revision	18	0.136 (0.106–0.174)	0.000	43
Instability	18	0.038 (0.027–0.055)	0.000	0
Aseptic loosening	18	0.088 (0.061–0.124)	0.000	53
Stem loosening	15	0.043 (0.023–0.073)	0.000	47
Acetabular loosening	13	0.075 (0.053–0.105)	0.000	0
Infection	18	0.038 (0.024–0.059)	0.000	25
Wound complications	15	0.032 (0.018–0.054)	0.000	24
Intraoperative fractures	17	0.040 (0.023–0.069)	0.000	42
Nerve injuries	17	0.056 (0.040–0.077)	0.000	3
VTE	6	0.035 (0.017–0.069)	0.000	13
GT related injuries	8	0.053 (0.024–0.113)	0.000	72
Trendelenburg sign	11	0.331 (0.238–0.439)	0.000	69
Abnormal walking	12	0.408 (0.276–0.555)	0.000	88
HO	12	0.185 (0.121–0.272)	0.000	77
HO grade 4	12	0.025 (0.013–0.048)	0.000	0

GT, greater trochanter; HO, heterotopic ossification; VTE, venous thromboembolism.

Table 5

Sensitivity analysis, Publication bias, and meta-regression of outcomes with a high degree of heterogeneity

Outcome	Which studies removed	Egger publication bias	Rate after publication bias and sensitivity	Meta-regression
Flexion	None	0.615		None
Abduction	None	0.098		None
Adduction	None	0.412		None
Internal rotation	None	0.154		None
External rotation	None	0.325		None
Final LLD	None	0.676		None
Final HHS	None	0.515		None
Change in LLD	None	0.927		Approach (ALA had lower reduction compared to LA), fusion time (lower fusion time had higher reduction)
Change in HHS	None	0.697		None
Aseptic loosening	None	0.014	13.1% (95% CI: 9.0–18.7%)	None
Greater trochanter-related injuries	None	0.452		Sex (male had lower injuries), Surgical fusion had higher injuries, age (older had higher injuries)
Abnormal walking patterns	None	0.909		Age (older had higher abnormal pattern)
Total HO	None	0.337		None
Trendelenburg sign	None	0.123		None

ALA, anterolateral approach; HHS, Harris Hip Score; HO, heterotopic ossification; LA, lateral approach; LLD, leg length discrepancy.

complications, particularly mechanical failures, deep infections, and nerve palsies[3].

An essential element to highlight from our results is the predominance of studies with Level IV evidence, indicating that these are primarily case-series without comparator groups. While the information extracted from these studies is valuable, especially given the extended follow-up, the lack of comparison with primary THA or revision THA creates an inherent limitation. The absence of a comparative group limits the capacity to directly contrast the outcomes and efficiency of converting fused hips with other surgical procedures or interventions. Furthermore, comparing the outcomes of surgically fused vs spontaneously fused hips would provide us with important insights and lessons; however, the current literature and studies have not sub-grouped and reported the necessary data. It's vital to acknowledge the high heterogeneity in several outcomes, including ROM and HHS. This can be attributed to the differences in study populations, surgical techniques, prosthetic types, and the initial reasons for hip fusion. Sensitivity analyses and meta-regression attempted to explain this heterogeneity, revealing interesting insights such as a smaller LLD reduction in ALA approaches compared to LA.

In conclusion, the move towards converting fused hips to THA emerges as a feasible avenue for those seeking long-term alleviation and improved functionality. However, the predominance of Level IV evidence in our included studies emphasizes the need for more robust research designs in the future. Comparative studies would provide a clearer picture of the relative benefits and challenges of this conversion, ensuring that both orthopaedic surgeons and patients are equipped with the best information for clinical decision-making.

Ethical approval

Our article is a systematic review and all included studies were deposited in publicly available repositories and were ethically approved.

Consent

Our article is a systematic review and all included studies were deposited in publicly available repositories and were ethically approved

Source of funding

None.

Author contribution

R.A., M.P., M.F.R., A.N., and S.H.A. contributed to the study's conception and design. R.A. and M.P. analyzed the data. A.N. wrote the first draft of the manuscript. Supervising, editing, and introducing the concept were performed by S.H.A. All authors commented on previous versions of the manuscript and revised them. All authors read and approved the final manuscript

Conflicts of interest disclosure

None.

Research registration unique identifying number (UIN)

The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with code CRD42023399330.

Guarantor

Dr Seyed Hadi Aghili.

Data availability statement

Our article is a systematic review and all included studies were deposited in publicly available repositories and data sharing is not applicable.

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