Article published online: 2023-08-21

Total Hip Arthroplasties in Polio Survivors: A Systematic Review

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J Hip Surg 2023;7:126–132.

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Abstract

There is a paucity of evidence regarding outcomes of post-polio patients following total hip arthroplasty (THA). This systematic review examines the evidence regarding implant choice, surgical planning, outcomes, and complications for post-polio patients undergoing THA. A multidatabase literature search was performed. Included articles were assessed for methodological quality using the abridged Downs and Black's criteria. Data was extracted regarding patient demographics, intraoperative details, outcome measures, and postoperative complications. Six articles were included in this review; all were retrospective case series. One hundred and six hips in 97 patients underwent THA. There was no consensus regarding the optimal approach or implant fixation. Patient-reported outcome measures (PROMs) showed a demonstrable improvement following THA. Postoperative dislocation was more common compared with patients without post-polio syndrome. Patients with post-polio syndrome who undergo THA have beneficial outcomes as determined by improvements in PROMs. Higher quality research may not be possible due to the increasing rarity of patients suffering from polio.

Keywords
- total hip arthroplasty
- total hip replacement
- polio
- poliomyelitis
- Harris Hip Score

Polio or poliomyelitis is a highly infectious viral disease that can result in severe disability, meningitis, paralysis, or death.[1] Vaccination programs have largely eradicated polio transmission in the developed world.[2]

Most people infected with poliovirus follow an asymptomatic course.[3] Approximately 24% of patients experience prodromal symptoms such as fever, headache, and sore throat following a 7- to 10-day incubation period.[3] The final target for the virus is the anterior horn cells of motor neurons, which is reached by invading the central nervous system either indirectly via peripheral nerves or directly after crossing the blood–brain barrier. Paralytic poliomyelitis, experienced by less than 1% of those infected, occurs when the virus replicates in, and destroys, motor neurons which innervate skeletal muscle resulting in paralysis.[4]

Polio paralysis and paresis is most commonly experienced in the lower limbs.[5] Proximal muscles are more often affected than distal ones. The anterior horn cells of L2 and L3 are often targeted by the virus, which primarily innervate the quadriceps.[6] Motor segments distal to this, such as L5 that innervates the distal muscles of the leg (e.g., tibialis anterior), tend to have shorter motor cell columns than their more proximal counterparts. There is a negative correlation between the length of the motor cell columns and the frequency of paralysis; resulting in proximal muscles being more often affected by paresis, distal muscles by paralysis.[6]

Muscles which demonstrate clinical activity during the first 6 months of paralysis will recover further.[7] Such activity demonstrates the presence of intact motor nerve cells. It is estimated that approximately 40% of such patient recover full muscle strength while the other 60% experience variable outcomes ranging from residual paresis, paralysis, or death.[8] If all motor nerve cells have been destroyed and there is no clinical evidence of activity after 6 months, recovery is not

received
August 27, 2021
accepted after revision
May 19, 2023
article published online
August 21, 2023

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Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

DOI https://doi.org/10.1055/s-0043-1771246.
ISSN 2472-8446.

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expected. Post-polio syndrome is a phenomenon where symptoms of paresis can return or deteriorate many decades after the original infection had burnt out.

Patients with residual paralysis of the hip extensors and abductors can suffer from hip instability, subluxation, and flexion contractures.[9] These occur due to an imbalance of strength between opposing muscular groups (hip flexors and adductors having normal strength and being stronger) across the joint, thus restricting movement and resulting in significant physical impairment.[9] It is argued that this muscular imbalance contributes to degenerative changes at the hip.[10]

Degenerative changes at the hip are also theorized to be related to the age patients contract polio. If affected prior to walking, hip bony maturation does not occur due to the lack of stimuli from lack of weight bearing, resulting in acetabular dysplasia, femoral anteversion, and coxa valga.[11] Hip dysplasia is a well-documented cause of secondary osteoarthritis.[12] Hip osteoarthritis can occur in the nonparalytic limb too, causes for this are attributed to the side effects of leg length discrepancy, pelvic obliquity, or other deformities of the symptomatic limb on the contralateral side.[13]

Total hip arthroplasty (THA) is the treatment of choice for polio patients with significant symptomatic degenerative hips. Complications of THA in non-polio patients are well known and include dislocations, aseptic loosening, as well as limb length discrepancy, among others.[14] Polio patients are more prone to dislocations following THA than their non-polio counterparts; rates have been quoted between 10 and 16.7%[10,13,15] compared with the non-polio average of 1 to 3%[10] This is believed to be secondary to flaccid paralysis and reduced muscle tone leading to reduced stability of the joint.[13]

Williams et al summarized that constrained liners are a reasonable option in revision THA in those with instability or deficient hip abductors.[16] Faldini et al advised against the use of constrained devices during primary arthroplasties due to the risk of implant loosening and disenagaement.[17] There is no real consensus regarding the preferred type of implant, level of constraint, or the frequency of complications encountered following THR in polio patients. The aim of this systematic review is to assess the evidence regarding preoperative risk stratification, intraoperative decisions regarding implants, and postoperative outcomes.

Method

Search Strategy

A search was conducted using the online Cochrane Library, Medline, and PubMed databases, using the following terms: polio[All Fields] AND hip[All Fields] AND (replacement[All Fields] OR arthroplasty[All Fields]). No limitations were placed on gender, date, or language. References and bibliographies of all articles were reviewed to identify possible further relevant articles (see ►**Fig. 1**).

All articles were assessed against the following inclusion criteria:

- Primary THA performed on patients affected with lower limb post-polio syndrome.
- Prospective study or retrospective study.

Exclusion criteria were as follows:

- Primary THA in patients without lower limb post-polio syndrome.
- Primary THA for fractured neck of femur.
- Revision THA.
- The lack of reported meaningful radiological, kinematic, or clinical outcomes.
- Review articles, case reports, or case series with five patients or less.
- No full text in the English language or easily translatable format.

Data Extraction

All papers included underwent detailed review with the following data sets assessed: number of patients, number of hips operated on, whether the limb was the affected side with post-polio syndrome or not, gender of patients, mean age of patients, age range of patients, body mass index (BMI), preoperative clinical scores, intraoperative details, postoperative clinical outcomes, radiological outcomes, complications, and implant survivorship,

Assessment of Methodological Quality

Methodological quality of the articles was assessed using an abridged Downs and Black's criteria.[18] Fifteen criteria are used to score a study; a positive criteria result scoring one mark and a negative criteria result scores zero. The papers were independently assessed by two of the authors (C.S. and F.W.), with the senior author (J.D.) settling any disagreement. The level of evidence was also determined.

Results

Search Results

The database search identified 32 articles, with no further found on reviewing their bibliographies or references. Screening the abstracts against the inclusion criteria reduced this number to 17 eligible articles. Eleven studies were removed following review of the full article and application of the exclusion criteria (revision arthroplasty $n = 1$, correction to previous article $n = 1$, case report or case series with five patients or fewer $n = 3$, arthroplasty due to trauma $n = 3$, review articles $n = 2$, and lack of meaningful data $n = 1$), leaving six studies included in the final review (►**Fig. 1**). Details of the six studies are shown in ►**Table 1**.

Methodological Quality

The analysis of the six studies using the Downs and Black criteria is displayed in ►**Table 2**. One study scored 11 out of 15,[17] one study scored 12 out of 15,[19] three studies scored 13 out of 15,[20–22] and one studies scored 14 out of 15.[10] No study performed a power calculation. Four studies failed to present appropriate statistical calculations. One study failed

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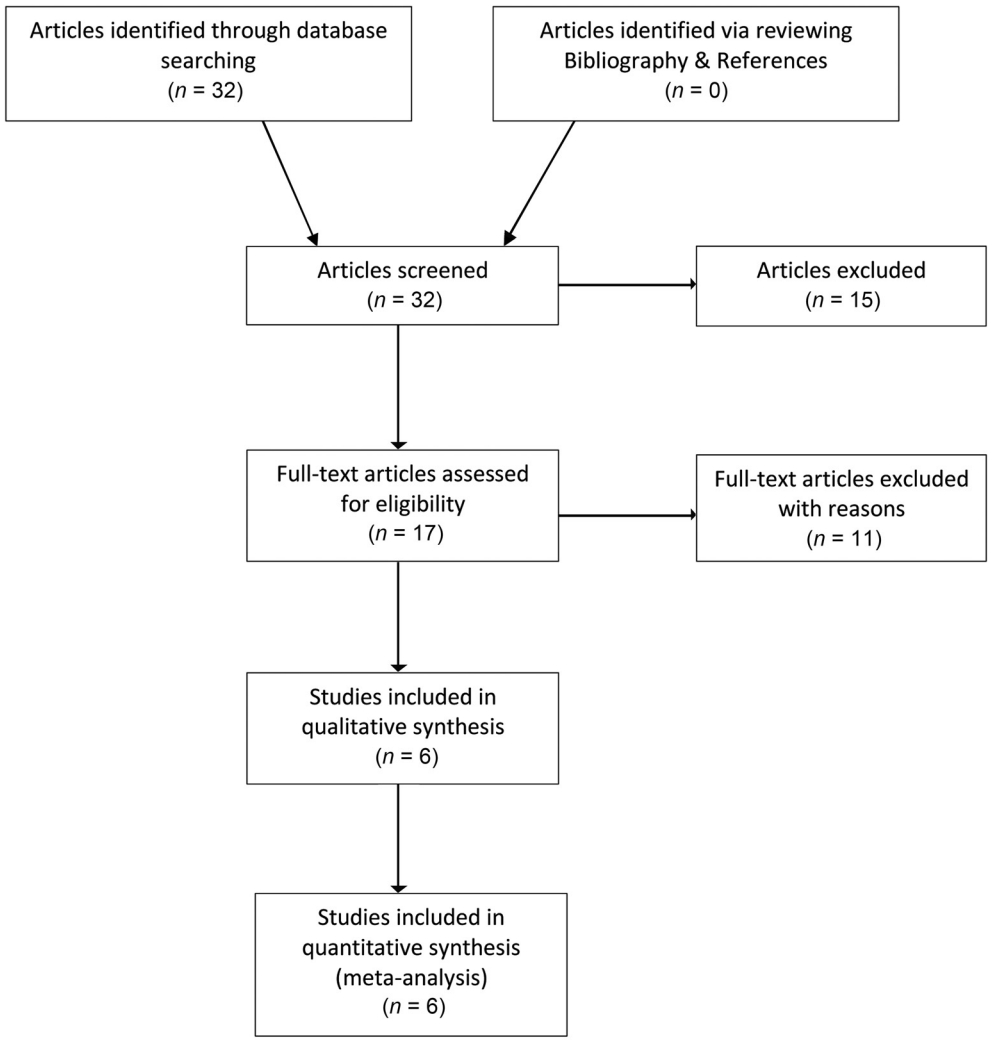

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart—demonstrating application of inclusion and exclusion criteria.

to go into sufficient detail of the surgical intervention in their method so that an external group could repeat their study.[10] One study was responsible for data dredging by performing an unplanned subgroup analysis.[19]

Study Characteristics

The six studies are all retrospective case series. In total, 106 hips in 97 patients were operated on. These patients had a mean age of 54.7 years, 52 were male and 45 female. BMI was recorded in four studies, with a mean value of 26. The affected limb was operated on 65 times, compared with 41 for the unaffected limb. Five of the studies utilized the Harris Hip Score[23] (HHS) as their primary measure of hip function,[4,7–10] with a preoperative scores average of 57.05 (±11.38 standard deviation [SD]). Two studies calculated the preoperative HHS combining both unaffected and affected limbs,[10,20] the remaining three kept that data separate where applicable. One study[22] used the Japanese Orthopaedic Association (JOA)[24] hip score instead, with the patient's average preoperative score being 42.8. These findings are summarized in ►**Table 3**.

Intraoperatively, 62 procedures were performed via a lateral THA approach, while the other 44 utilized a posterior approach. Seventy-nine of the arthroplasties were uncemented, with 27 cemented. Standard unconstrained implants were utilized in 103 hips and 3 utilized a face-changing acetabular liner. No dual mobility or constrained implants were used in any study. These findings are summarized in ►**Table 4**.

Patients were followed up for an average of 78.27 months. The postoperative HHS average was 85.79 (± SD 4.32), with the postoperative JOA score measuring 78.8. A variety of postoperative radiological parameters were used by the articles including limb length discrepancy,[17,20,22] anteversion,[10,20,22] and acetabular inclination.[10,17,20,22] Buttaro et al did not report any significant postop radiological findings. Complications were most reported by DeDeugd et al, with three posterior dislocations and two fractures recorded; other complications reported include local infections and nerve palsies. These findings are summarized in ►**Table 5**.

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Table 1 Details of articles included in this systematic review

Primary author	Title of publication	Year of publication	Type of study	Numbers of hips	Level of evidence
CM DeDeugd et al	Total hip arthroplasty in patients affected by poliomyelitis	2018	Case series	59	IV
Cho et al	Outcome after cementless total hip arthroplasty for arthritic hip in patients with residual poliomyelitis: a case series	2016	Case series	11	IV
Buttaro et al	Long-term outcome of unconstrained primary total hip arthroplasty in ipsilateral residual poliomyelitis	2017	Case series	6	IV
Sonekatsu et al	Total hip arthroplasty for patients with residual poliomyelitis at a mean eight years of follow-up	2018	Case series	6	IV
Yoon et al	Total hip arthroplasty performed in patients with residual poliomyelitis: does it work?	2014	Case series	10	IV
Faldini et al	Outcomes of total hip replacement in limbs affected by poliomyelitis	2017	Case series	14	IV

Discussion

The aim of this systematic review was to assess the outcomes of THA in post-polio patients. This review identified six retrospective case series covering 106 hips which largely demonstrates that THA is beneficial in polio survivors. Five of the studies that utilized the HHS[23] showed an average increase of 28.7 points postoperatively. Sonekatsu et al[22] utilized the JOA as its primary outcome measure with an average postoperative improvement of 46 points.

The overwhelming majority of hips had unconstrained implants (103 out of 106 hips). The other three had face-changing acetabulum implants with no patient receiving a dual mobility implants.[25] There were 6 dislocations reported from the 106 hips; 4 in the affected limb (as reported by DeDeugd et al and Buttaro et al), and the other 2 in the unaffected limb (Cho et al and Yoon et al). This equates to a dislocation rate among the polio population of 5.7%. This is more than double the risk of post-THA dislocation in non-polio patients of 2%.[26]

DeDeugd et al reported three dislocations when the affected side was operated on, all of whom underwent a posterior approach. They did not specify which implants were used for these three hips which limits analyzing trends with respect to implants (e.g., cemented or uncemented, constrained or unconstrained, femoral head sizes) and dislocation risk. DeDeugd et al attributed the dislocation incidence to the neuromuscular changes of flaccid paralysis and the resulting muscular imbalance between the hip abductors and hip adductors.[10,19] The other dislocation of an affected limb was reported by Buttaro et al after cemented implantation of the acetabular and femoral component. It was not specified which surgical approach was utilized. Two dislocations were reported following THA in the nonparalytic limb. In both cases, uncemented unconstrained implants were inserted via a posterior approach. It is believed that these unconstrained hip implants reduce dislocations as they improve range of motion before impingement occurs.[17]

There were five reports of postoperative radiographic osteolysis identified during follow-up imaging, three following THA of the affected hip and two in the nonaffected hip. These patients were reported by DeDeugd et al, but due to the lack of detail we are unable to exactly deduce the implants used or the approach. Nonetheless, the frequency of osteolysis was deemed to be consistent with non-polio patients 2 years postop.

DeDeugd et al being the largest study (59 hips) in the review was able to demonstrate 59 THAs in 51 patients, thus at least 9 patients had bilateral THAs with 9 on the non-affected limb. This is unique in comparison to the other studies in the review where only affected limb THAs were analyzed. There is no comparable published literature detailing the same patient with THAs on the affected and nonaffected limbs. This allowed comparative conclusions to be made within their study; 3 hips dislocated following surgery on the affected side, none from the nonaffected side. This was determined to be clinically but not statistically significant.

There has been no reported literature on the use of dual mobility in THAs for polio patients. Recent reports have demonstrated statistically significant reductions in dislocations rates in non-polio patients.[25] This is a potential area of research considering the reported stability benefits for a patient group with increased rates of dislocation and instability.

This review has several limitations; the data are derived from a mere six retrospective case studies. No inferable statistical analysis was possible. The widespread variability in the data available (e.g., different approaches, use of implants, length of follow-up) limited the analysis of the data to descriptive statistics.

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Journal of Hip Surgery Vol. 7 No. 3/2023 © 2023. Thieme. All rights reserved.

Table 2 Downs and Black criteria analysis

Author	Objective described	Outcome described	Exclusion criteria described	Intervention described	Main findings reported	Random variability	Adverse events	Probability values	Representative sample invited to participate	Representative sample included	Lack of data dredging	Use of appropriate statistic	Accurate outcome measure	Confounders accounted for	Power calculation	Number of criteria met
Yoon et al, 2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	14
Cho et al, 2016	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	13
Buttaro et al, 2017	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	13
Faldini et al, 2017	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	N	Y	Y	N	11
Sonekatsu et al, 2018	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	13
DeDeugd et al, 2018	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	N	12

Table 3 Preoperative findings

Author	Affected limb	Unaffected limb	Male	Female	Average age (y)	BMI	HHS	JOA
Yoon et al, 2014	4	6	7	3	48	NR	70	NR
Cho et al, 2016	7	4	9	2	57	NR	52.5	NR
Buttaro et al, 2017	6	0	2	4	51.3	25.8	67.58	NR
Faldini et al, 2017	14	0	6	8	51	23.3	52	NR
Sonekatsu et al, 2018	2	4	1	4	54.7	24.8	NR	42.8
DeDeugd et al, 2018	32	27	27	24	66	30	50	NR

Abbreviations: BMI, body mass index; HHS, Harris Hip Score; JOA, Japanese Orthopaedic Association outcome score; NR, not reported.

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Table 4 Intraoperative decisions

Author	Lateral approach	Posterior approach	Uncemented femur	Cemented femur	Uncemented acetabulum	Cemented acetabulum	Unconstrained acetabulum	Face-changing acetabular liner (unconstrained)
Yoon et al, 2014	4	6	10	0	10	0	10	0
Cho et al, 2016	11	0	11	0	11	0	11	0
Buttaro et al, 2017	0	6	1	5	4	2	6	0
Faldini et al, 2017	14	0	13	1	14	0	14	0
Sonekatsu et al, 2018	0	6	6	0	6	0	6	0
DeDeugd et al, 2018	36	23	38	21	58	1	56	3

Table 5 Postoperative outcomes

Author	Follow-up (mo)	HHS	JOA	LLD (mm)	Anteversion (degrees)	Inclination (degrees)	Postop dislocations	Other postop complications
Yoon et al, 2014	56	92	NR	1.7	29	43	1 - U	NR
Cho et al, 2016	79.9	85.8	NR	18.4	20.3	43.1	1 - U	Rotational osteotomy of ipsilateral femur—2 years post-THA for valgus instability
Buttaro et al, 2017	119.5	87.33	NR	NR	NR	NR	1 - A	Instability
Faldini et al, 2017	92	83.3	NR	21	NR	41.9	0	Sciatic nerve palsy (transient)
Sonekatsu et al, 2018	100.8	NR	78.8	–0.3	13.37	41.87	0	0
DeDeugd et al, 2018	72	79	NR	NR	NR	NR	3 - A	2 periprosthetic fractures (surgical fixation) Superficial wound infection (resolved with oral antibiotics) Partial common peroneal nerve palsy (resolved within 1 year)

Abbreviations: A, affected limb; HHS, Harris Hip Score; JOA, Japanese Orthopaedic Association outcome score; LLD, leg length discrepancy; NR, not recorded; THA, total hip arthroplasty; U, unaffected limb.

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The findings in this review suggest that THAs in post-polio patients are successful and beneficial operations. To take these findings further, further research would be needed, ideally prospective randomized control trials. Due to the success of vaccine programs worldwide, polio has largely been eradicated. There are only two countries where polio is known to be prevalent: Pakistan and Afghanistan.[27] As there is an ever-decreasing patient population available for consideration, it seems unlikely high-quality trials would be feasible.

Conclusion

This review demonstrates that polio survivors who undergo THA have beneficial outcomes as determined by improvements in patient-reported outcome measures. The dislocation rate was approximately three times the reported average in non-polio patients. While there are limitations to this review, it may be difficult to perform more robust research due to the success of global vaccination programs and dwindling numbers of patients presenting with degenerative hips following previous polio infection.

Conflict of Interest
None declared.

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