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ORIGINAL PAPER

Hip fusion takedown to a total hip arthroplasty—is it worth it? A systematic review

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Abstract
Introduction Patients with surgically or spontaneously fused hips are often dissatisfied with their overall function and the debilitating effect on adjacent joints. Therefore, in properly selected patients, hip fusion-takedown and conversion to total hip arthroplasty (THA) can result in improved function and decreased pain. We aimed to (1) evaluate the indications for conversion, (2) evaluate the clinical outcomes, (3) analyze the overall complications, and (4) identify the overall satisfaction following the procedure.
Methods A systematic and comprehensive literature search was performed to analyze studies evaluating conversion of hip fusion to THA. After reviewing 3,882 studies, 27 total studies (1,104 hips) met our inclusion/exclusion criteria and were included in our final analysis. A weighted mean of rates was determined for each complication, including infection, instability, loosening, nerve-related, abductor-related, venous thrombotic event, and revision.
Results The study population consisted of 53.2% male and 46.8% female subjects. The mean age at time of conversion was 52 years (range 36–65 years), the mean time until follow-up was 9.2 years (range 2.5–17.3), and the mean duration of arthrodesis was 27.7 years (range 11–40.2). As measured by Harris Hip Score, overall clinical outcomes improved from 58.1 points (range 42.4–70 points) pre-operatively to 80.0 (range 62–93.5) post-operatively. The specific complication rates were 5.3% (range 0–43.6%) for infection, 2.6% (range 0–15.4%) for instability, 6.2% (range 0–17.2%) for loosening, 4.7% (range 0–13%) for nerve-related complications, 13.1% (range 0–87%) for abductor-related complications, and 1.2% (range 0–13%) for venous thrombotic events. The revision rate was 12.0% (range 0–43.6%).
Conclusion Takedown of a fused-hip can be a challenging procedure. Although patients can benefit functionally, both patients and surgeons need to be aware of the complications and increased risk of further revision procedures, which should be an important part of the pre-operative discussion.

Keywords Hip fusion · Hip arthrodesis · Takedown · Girdlestone · Total hip arthroplasty · Total hip replacement

Introduction

A spontaneously or surgically fused hip joint can lead to a durable, painless, and stable hip [1]. However, in the long term, a fused hip can be a significant source of pain and lead to degenerative changes in the lower back, contralateral hip, and ipsilateral knee, especially when the hip is in suboptimal functional position [2–4]. Additionally, patients can also experience gait disturbances, instability, and leg-length discrepancy [2]. Therefore, patients with fused hips may desire a conversion procedure to a total hip arthroplasty (THA). Adjacent joint disease, restricted mobility, difficulty in negotiating small spaces, functionally debilitating pain, and patient dissatisfaction are some other indications for conversion to total hip arthroplasty [4].

Conversion to a THA has been shown to restore range of motion, relieve pain, and decrease stress in adjacent joints [5].

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Furthermore, THA can enhance quality of life (QOL), improve function, and restore the ability to perform activities of daily living (ADL) [4]. However, the conversion procedure is challenging due to the effects of the previous disease, past surgical procedures (including the presence of hardware), altered bone and soft tissue anatomy, stability, and physiology of the joint [2, 3, 6]. Although some studies have reported on conversion THA, the limited number of studies and patients make it difficult to draw consistently, meaningful conclusions on such a procedure.

Therefore, the purpose of this study was to (1) evaluate the primary indications for takedown, (2) evaluate the clinical outcomes, (3) analyze detailed complications associated with a THA for patients who underwent a takedown of a fused hip, and (4) identify overall satisfaction statements with the procedure.

Methods

A comprehensive literature search was performed to include and assess all studies in the literature until August 2015. We used the databases from the United States National Library of Medicine (National Institutes of Health), Embase, and Ovid, and followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. The specific terms that were searched in this study were "Hip Arthrodesis", "Hip Arthrodesed", "Hip Fusion", "Hip Conversion", "Hip Ankylosis", "Hip Ankylosed", and "Girdlestone", which yielded a total of 3,882 studies. Then, we excluded any studies that were written in languages other than English, resulting in 2,564 studies. After reviewing these studies, there was a selection process of these abstracts based upon specific inclusion and exclusion criteria; we included studies performed in patients who were adult that underwent conversion to total hip arthroplasty from a fused (surgical or spontaneous) hip. We excluded single case reports, case series with less than five fusions, mean follow-up of less than two years and review articles. Additionally, cross-referencing was performed to include additional relevant articles. Our study criteria led to a total of 27 articles that qualified for our final review as shown in the flow chart of Fig. 1.

The entire search process was performed by one of the authors (JKK) and then independently repeated by another (JJJ) author to ensure inclusion of all relevant studies. We evaluated the mean age, duration and cause of arthrodesis, indications for conversion, length of follow-up, surgical techniques and approaches, complications, clinical outcome scores, and satisfaction statements.

We assessed the primary indication for fusion, either spontaneous or surgical arthrodesis and subclassified it as traumatic, infectious, autoimmune, osteoarthritis/degenerative joint disease (DJD), childhood related disorders, failed arthroplasty,

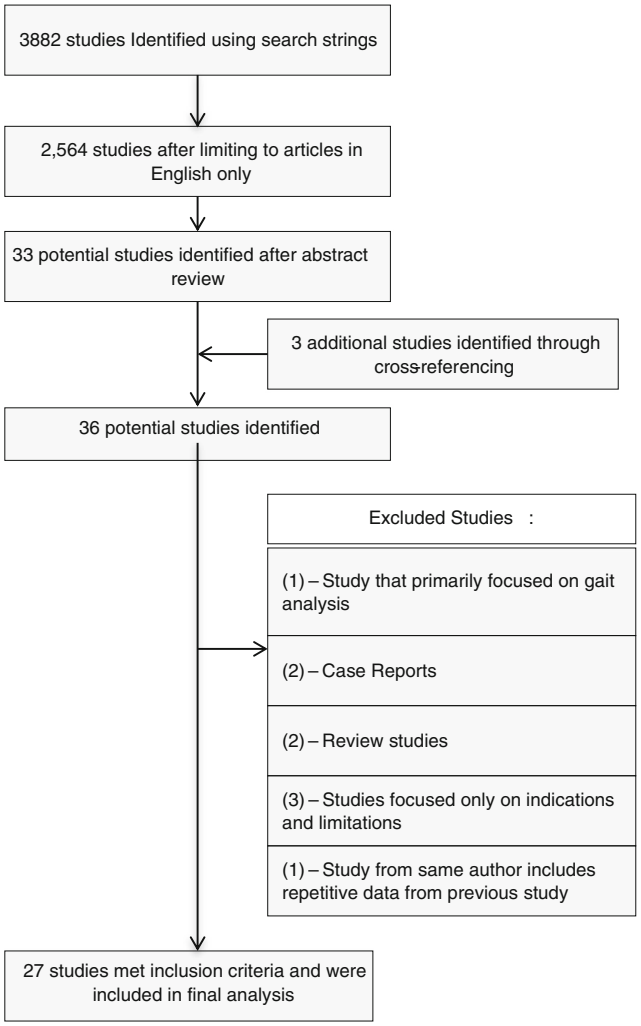

Fig. 1 Search methodology flowchart

and other (which also included unknown or non-reported). Traumatic causes of fusion were due to post traumatic chondrolysis and fusion, heterotopic ossification, hip fracture, or dislocation. Both tuberculosis and non-tuberculosis infections were classified as infectious causes. The specifics of childhood related causes of arthrodesis were due to developmental hip dysplasia, congenital hip dislocation, Legg-Calve-Perthes disease, infections, and other unspecified childhood causes. Autoimmune disorders included rheumatoid arthritis, ankylosing spondylitis, and systemic lupus erythematosus (SLE), and others with less than three hips or unknown classified as others. Of the evaluated complications, we specifically focused on deep infection, dislocation, aseptic loosening, neural injury, vascular injury, abductor-related complications, and venous thrombo-embolic events. Additionally, the revision arthroplasty rate was also evaluated in these patients and was defined as return to operative room (OR) for revision of either the acetabular, femoral, or both components (the studies did not describe if patients had to return to the OR for exchange of the polyethylene liner). A meta-analysis was

attempted; however, due to the heterogeneity of the data, a systemic review was performed and completed instead. This systematic review focused on clinical studies involving conversion of fused hips to total hip arthroplasty (see Table 1 for Level of Evidence).

The data for each study was compiled into an electronic spreadsheet (Microsoft Excel, Microsoft Office, Redmond, Washington). Then, with the aid of statistical software (MedCalc Version 15.2, MedCalc Software bvba, Ostend, Belgium), we calculated the weighted mean of complication rates. Additional descriptive statistics were performed with every other outcome measure. This study was performed without any external funding.

Results

Twenty-seven studies evaluating a total of 1,104 hips (mean of 41 hips per study) were included in our final analysis. Of the studies, 53.2% of the patients were males and 46.8% were females, with a mean age of 52.5 years. These studies had follow-up range of means of 2.5–17.3 years after conversion THA. The hips within these studies were arthrodesed for a mean of 27.7 years (range of means of 11–40.2 years) before conversion to THA (see Table 1). After stratifying these hips into surgically fused (n = 590 hips) or spontaneously fused (n = 351 hips), the three most common diagnoses for initial arthrodesis described in the evaluated studies were infectious (n = 442 hips), traumatic (n = 152 hips), and degenerative osteoarthritis (n = 123 hips; see Table 2). The discrepancy between the number of surgically and spontaneously fused hips and the total number of hips is due to the lack of differentiation in some of the studies.

Complications of the procedure were analyzed using weighted complication rates and ranges. Specifically, the weighted mean of infection rates was 5.3% (range 0–43.6%), for instability it was 2.6% (range of 0 to 15.4%), loosening of hip components 6.2% (range 0–17.2%), nerve-related complication 4.7% (range 0–13%), abductor-related complication 13.1% (range 0–87%), and thromboembolic events had a weighted mean rate of 1.2% (range 0–13%). Femoral artery injury was reported in one patient. Revision rate was 12.0% (range 0–43.6%) and the literature did not report any mortality at latest follow-up. The numbers of patients that sustained complications and their corresponding confidence intervals are detailed in Table 3.

Pre-operative Harris Hip Scores (HSS) were only reported in eight studies, and 11 studies provided information regarding their post-operative HSS. The HSS in these patients improved from a weighted pre-operative mean of 58.1 points (range of means of 42.4 to 70 points) to a weighted post-operative mean of 80.0 points (range of means of 72 to 93.5 points) at the latest follow-up. Although due to the lack of detail in the evaluated studies we were unable to analyze the improvement in HHS, all of the studies described that the improvement was significant ($p < 0.05$).

Although a formal patient satisfaction rate could not be calculated, the majority of the included studies suggested a high satisfaction rate associated with hip fusion takedown and conversion to THA. Any available satisfaction statement described in each study is recorded in Appendix 2.

Four studies reported survivorship at ten years following the conversion procedure (Table 4).

Discussion

Although patients with fused hips may have adequate stability and durability, they have limited function and quality of life. In addition, the limited range of motion puts additional stress in the lower back, knees, and contralateral hip, which can cause severe pain and functional impairments in the patient [19, 21]. These factors strongly motivate these patients to seek help with potential fusion takedown and conversion to THA, especially when the contemporary results of primary THA are satisfying. This challenging procedure often provides significant improvement in the quality of life [4]. Although current literature reports many associated risks and complications with THA takedown and conversion, the actual rates of these complications have not been adequately described and analyzed [2, 3]. Therefore, it is of paramount importance to perform a systemic review to comprehensively assess the current state of art and performance of conversion THA.

The limitations of this study include heterogeneity of the data and results. In addition, our study is limited by the available data included in each of the studies. Some of the studies did not provide information for all variables aimed to be investigated, such as clinical outcomes or patient satisfaction. Furthermore, it is possible that not all complications reported in the analyzed studies were reported, which may underestimate the complication rates evaluated in this paper. We also had to exclude heterotopic ossification as a complication due to the lack of consistency and variability in rates. This study is further limited because most of the studies reported in the literature are retrospective without a high level of evidence. Additionally, due to the paucity of studies describing this procedure, we did not stratify our results according to whether the arthrodesis was spontaneous or surgical; hence, certain complications might be over or underreported in the other cohort. Furthermore, functional outcomes could be diminished due to the presence of coexisting knee or spine problems. Finally, the operative approaches, techniques, and implant choices vary in each of the analyzed studies (see Appendix 1). Despite these limitations, this study has extensively and thoroughly analyzed the largest cohort of patients undergoing this procedure. Our analysis focused on the complications associated with

Table 1 Detailed descriptions regarding number of patients, gender distribution, mean age, mean years with fused hip, and mean follow up after conversion THA reported in each study and level of evidence

Author, Year	Surgically fused hips	Non-surgically (spontaneous) fused hips	Male/ Female	Mean age at conversion in years	Mean follow-up in years [range]	Mean duration of arthrodesis in years [range]	Level of evidence
Aderinto et al., 2012 [7]	14	4	5/13	53	5 [2–15]	33 [11–60]	3
Brewster et al., 1975 [8]	33	0	19/14	-	[1–3.5]	-	2
Callaghan et al., 1985 [9]	6		-	58	6 [1–6,12,19,21,31,32]	40.2 [20–50]	4
Cameron and Jung, 1987 [10]	13		7/6	49	[1–9]	19 [5–40]	4
Cameron, 2005 [11]	18	4	-	50.5	8.6 [2–17]	-	4
Fernandez-Fairen et al., 2010 [12]	30	18	34/14	52	17 [10–29]	26 [3–47]	3
Hamadouche et al., 2001 [13]	20	25	19/26	55.8	8.5	35.7 [3–65]	4
Hardinge et al., 1986 [14]	73	39	-	-	8.15 [2–19]	-	4
Howard et al., 2002 [15]	3	2	4/1	46	-	25 [8–50]	4
Joshi et al., 2002 [16]	160	48	86/101	51	9.2 [2–26]	27 [10–69]	3
Kilgus et al., 1990 [17]	13	28	20/18	53	7 [2–16.5]	-	4
Kim et al., 2003 [18]	38	49	48/38	47.89	10.47 [8–18]	28.3 [10–49]	4
Kim et al., 2007 [19]	24		12/0	36	11 [3–17]	11 [1–20]	4
Kreder et al., 1999 [20]	40		24/16	58.5	2.5 [1–4]	-	3
Lubahn et al., 1980 [21]	14	4	13/4	59	-	21 [5–60]	4
Morsi, 2007 [22]	8	11	11/7	51	7.1 [5.4–9.6]	21.2 [5–41]	2
Park et al., 2015 [23]	7	18	11/12	-	5.4 [2.8–9.1]	-	4
Peterson et al., 2009 [3]	25	5	12/18	52.5	10.4 [2–20.5]	32.6 [1–42]	4
Rajaratnam et. Al, 2009 [24]	10	6	9/6	52	11 [5–19.5]	36 [3.5–65]	4
Reikerås et al., 1995 [25]	46	0	9/37	58	8 [5–13]	17 [7–28]	4
Richards and Duncan, 2011 [4]	26		20/6	49	9 [2–21]	-	3
Rittmeister et al., 2005 [26]	39		-	65	7.8 [1–17.3]	1.3 [0.08–16]	4
Rutz et al., 2009 [27]	10	12	15/7	53.7	13.2 [2–19]	32.5 [2–61]	4
Schäfer et al., 2000 [28]	15		8/7	-	5.4 [2–13.3]	30.9 [2–61]	4
Sirikonda et al., 2008 [29]	35	10	20/24	48.7	17.29 [2–25]	32 [12–54]	3
Strathy and Fitzgerald, 1988 [30]	20	60	-	49.8	10.4 [9–15]	18.1 [1–50]	4
Villanueva et al., 2013 [6]	13	8	7/13	58	8 [3–14]	39 [2–65]	4

Table 2 Detailed descriptions of primary causes of hip fusion reported in each study

Author, year	Traumatic[a]	Infectious[b]	Autoimmune[c]	Osteoarthritis/ DJD	Childhood[d]	Post-THA	Failed arthroplasty	Other/ Unknown
Aderinto et al., 2012 [7]	8	7	0	0	3	0	0	0
Brewster et al., 1975 [8]	12	4	0	2	4	0	0	11
Callaghan et al., 1985 [9]	0	4	0	0	1		0	1
Cameron and Jung, 1987 [10]	2	5	0	2	2	0	2	0
Cameron, 2005 [11]	3	8	1	3	5	0	0	2
Fernandez-Fairen et al., 2010 [12]	8	27	0	0	11	0	0	2
Hamadouche et al., 2001 [13]	0	31	0	3	10	0	0	1
Hardinge et al., 1986 [14]	15	40	0	25	16	0	0	8
Howard et al., 2002 [15]	3	1	0	0	0	0	0	1
Joshi et al., 2002 [16]	16	87	48	34	16	0	0	7
Kilgus et al., 1990 [17]	8	23	7	0	2	0	0	1
Kim et al., 2003 [18]	4	79	4	0	0	0	0	0
Kim et al., 2007 [19]	2	10	12	0	0	0	0	0
Kreder et al., 1999 [20]	0	0	0	21	0	0	0	19
Lubahn et al., 1980 [21]	5	3	2	6	1	0	0	1
Morsi, 2007 [22]	6	10	2	0	0	0	0	1
Park et al., 2015 [23]	5	16	4	0	0	0	0	0
Peterson et al., 2009 [3]	8	15	0	0	3	2	2	0
Rajaratnam et al., 2009 [24]	4	4	2	0	6	0	0	0
Reikerås et al., 1995 [25]	1	0	2	16	25	0	0	2
Richards and Duncan, 2011 [4]	0	0	0	0	0	0	0	26
Rittmeister et al., 2005 [26]	0	0	0	0	0	0	0	39
Rutz et al., 2009 [27]	8	0	8	2	4	0	0	0
Schäfer et al., 2000 [28]	4	0	6	2	3	0	0	0
Sirikonda et al., 2008 [29]	11	26	0	1	5	0	0	2
Strathy and Fitzgerald, 1988 [30]	19	29	10	6	15	0	0	1
Villanueva et al., 2013 [6]	0	13	0	0	3	0	0	5

[a] Degenerative changes, HO, hip fracture, dislocation

[b] Tuberculosis, non-tuberculosis

[c] Rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythematosis (SLE)

[d] Developmental hip dysplasia, congenital hip dislocation, Legg-Calve-Perthes disease, other unspecified childhood causes

conversion of hip arthrodesis to THA and provided an extensive analysis.

The major indications for conversion THA identified in our systematic review are disabling low back pain, ipsilateral knee pain, and contralateral hip pain. The fusion of the hip joint leads to an immobile and sometimes malpositioned hip, which causes tremendous stress to neighboring joints. With the conversion THA, relief of pain, increased in functionality, and improved QOL have been seen in many of these previously symptomatic patients.

Our study was also able to identify major complication rates and compare them to the rates found in primary or revision THA. A prior study by Fernandez-Fairen demonstrated complication and failure rates, patient satisfaction, and improvement in hip function that were similar between

Table 3 Number of patients and complications rates with 95% confidence interval

Complication type	Number of patients	Weighted rate	Range of rates
Infection	59	5.3%	3.0–8.1%
Instability	29	2.6%	1.7–4.2%
Loosening of hip components	68	6.2%	3.2–8.3%
Nerve-related complications	52 (25 sciatic, 27 unspecified)	4.7%	2.6–6.0%
Venous thrombotic events	13 (3 pulmonary embolism, 10 deep vein thrombosis)	1.2%	0.6–1.9%
Abductor-related	145	13.1%	5.4–22.8%
Revision	133	12.0%	7.2–15.5%

Table 4 Ten-year survivorship of hip implant following hip takedown and conversion

Author, Year	Ten-year survivorship (percentage)
Fernandez-Fairen et al., 2010 [12]	93%
Joshi et al., 2002 [16]	96.1%
Kilgus et al., 1990 [17]	96%[a]
Richards and Duncan, 2011 [4]	74.2%

[a] Reported value for 13-year survivorship

conversion from a fused hip to THA and primary THA [12]. Another study by Richards and Duncan found conversion THA to have significantly worse clinical outcome scores and patient satisfaction as well as higher complication rates and poor survivorship in comparison to both revision and primary THA [4]. Our study demonstrated that conversion THA has a 5.3% infection rate, which is higher than the infection rate following primary or revision THA. In a recent meta-analysis by Yoon et al., an overall infection rate after THA of less than 1% was demonstrated [31]. Similarly, Blom et al. showed that infection rate is as low as 1.08% for primary THA and 2.1% for revised THA [32]. Instability had a 2.6% rate in takedown patients with up to 15.4 % of these patients dislocating; this is higher than primary THA (1–1.5%) as reported by a meta-analysis by Weegen et al. [33]. However, these rates may be lower than those described in the revision setting with rates that go up to 9% [34, 35]. In addition, our study showed that loosening of hip components could be as high as 6.2 %. Importantly, our data suggests that conversion THA has higher neurological complications (4.7 %) than primary THA (ranges from 0.1 to 3.7%), but may be equivalent to those of revision THA (ranges from 0.1 to 7.6%) [16, 36]. In terms of thromboembolic events, conversion THA had slightly higher VTE rate (1.2 %) compared to 0.5% in primary THA [37]. Moreover, data revealed that at ten-year follow up, nearly 12.0 % of these hips undergo revision procedures. In contrast, current primary THA literature may consider this rate unacceptable [38, 39]. In addition to higher complication rates, recent literature reported that patients undergoing conversion THA have higher costs and worse outcomes compared to primary THA [4]. However, results of conversion THA are reported to be similar to revision total hip arthroplasty [3].

Improvement in pain of the converted hip and adjacent joints is one of the desired goals following a hip fusion takedown and conversion to THA. Hamadouche et al. reported no pain in the converted hip in 43 of 45 patients after conversion [13]. Reikeras et al. demonstrated a reduction in lower back pain (scale of 0 to 10) from a mean of 5.6 pre-operatively to 3.3 post-operatively [25]. Brewster et al. demonstrated complete pain relief, including knee and back pain in 31 of 33 patients with two patients requiring subsequent TKA for pain relief [8]. Rittmeister et al. reported relief of back pain in eight of ten cases, but relief of knee pain in only two of nine cases [26]. Fernandez-Fairen et al. also reported 86% relief of back pain and knee pain with five patients going on to require ipsilateral TKA [12]. Morsi et al. reported the need for analgesia to help with residual pain in patients following conversion [22]. Kim et al. reported in the patients with conversion of the bilateral arthrodesis to THA, relief of knee pain is more expected and persistent back pain is common. However, relief of both back and knee pain are expected in the unilateral cases [19]. Studies by Richards and Duncan4], Reikeras et al.25], and Peterson et al. [3] demonstrated that only about one third of the converted cases achieved complete relief of pain and the remainder had partial relief. Therefore, relief of pain in both the converted hip and adjacent joints is an inconsistent result of the conversion procedure.

An overall analysis of satisfaction statements (see Appendix 2) revealed mostly positive feedback. The majority of patients were satisfied with the procedure and had increased range of motion and increased functionality in daily activity. There were inconsistent findings with regards to relief of joint pain in the studies.

There are multiple patient and surgeon factors that must be considered prior to surgery [1, 40]. Time of fusion and length of arthrodesis have both been shown to be factors that can influence the outcome of a takedown procedure [16]. For patients with surgical instrumented arthrodesis, adjustment of surgical approach is a consideration. Surgeons, for example, can consider a two-stage procedure with removal of previous hardware as a first intervention and conversion in a second stage. Commonly used approaches include the standard posterior, direct lateral, antero-lateral, or transtrochanteric. The approach should be chosen based on surgeon ability as well as patient factors. In patients with atrophied weak abductors, the trans-trochanteric approach is preferred to limit muscle injury as well as to allow trochanteric advancement to increase stability. Adductor tenotomy can be performed to obtain adequate abduction of 30 degrees. If insufficient, the psoas tendon can be divided to allow for better range of motion [16]. Finally, conversion is complicated by distorted hip anatomy, loss of bone stock and surgical landmarks, which will significantly increase the difficulty of the case [14]. This will lead to the need for a more extensive dissection, which can contribute significantly to operative complications [13]. Imaging such as CT and Judet view radiographs can be helpful in determining bone stock, location of prior hardware, as well as viewing anterior and posterior columns to determine if bone grafting is needed. In addition, doctors should discuss the ramifications of this procedure and alternative treatment options with their patients. However, due to the multiple coexisting debilitating conditions in the adjacent joints, this procedure may be the

only alternative. Ipsilateral knee, contralateral hip, and back pain are primary indications for hip fusion takedown [3, 16]. For these patients, conversion THA remains an effective treatment modality that provides relief of these symptoms after conversion to THA [21]. In this systematic review, studies with available data showed that patients could have significant improvements in clinical outcomes (HHS) after conversion procedure.

Conclusion

Takedown of a fused hip can be a challenging procedure. Although patients may benefit functionally with improved satisfaction, both the patients and their surgeons need to be aware of the complications and increased risk of further revision procedures. Patients should be counseled about the chance of resolution of pain. This data shows that conversion THA has an overall rate of complications in comparison to primary and revision THA. Physicians should also discuss alternatives with patients prior to choosing this treatment option.

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