

Why Revision Total Hip Arthroplasty Fails

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Abstract Current outcomes data on revision total hip arthroplasty focuses on specific implants and techniques rather than more general outcomes. We therefore examined a large consecutive series of failed THAs undergoing revision to determine if survivorship and modes of failure differ in comparison to the current data. We retrospectively reviewed the medical records of 1100 revision THAs. The minimum followup was 2 years (mean, 6 years; range, 0–20.4 years). Eighty-seven percent of revision total hips required no further surgery; however, 141 hips (13%) underwent a second revision at a mean of 3.7 years (range, 0.025–15.9 years). Seventy percent (98 hips) had a second revision for a diagnosis different from that of their index revision, while 30% (43 hips) had a second revision for the same diagnosis. The most common reasons for failure were instability (49 of 141 hips, 35%), aseptic loosening (42 of 141 hips, 30%), osteolysis and/or wear (17 of 141 hips, 12%), infection (17 of 141 hips, 12%), miscellaneous (13 of 141 hips, 9%), and periprosthetic fracture (three of 141 hips, 2%). Survivorship for revision total hip arthroplasty using second revision as endpoint was 82% at 10 years.

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Each author certifies that his or her Institutional Review Board has approved the reporting of this data, and that all investigations were conducted in conformity with ethical principles of research.

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Aseptic loosening and instability accounted for 65% of these failures.

Level of Evidence: Level IV, therapeutic (retrospective) study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

The success of primary total hip arthroplasty is well-documented in the literature with survival rates over 90% at 15-year followup [7–9, 17, 34, 39]. As our population ages, the number of total hip arthroplasties performed is increasing dramatically. Unfortunately, some are not successful and have eventual revision. Recent projections indicate the burden of revision total hip arthroplasty is expected to increase by 137% over the next 25 years [29]. In addition, the cost and resource utilization of revision procedures are substantially higher than those of primary procedures [4]. While a majority of patients are subjectively satisfied with their revision hip arthroplasty, many have unrealistic expectations regarding the longevity of their revision procedure [3, 11, 31, 44, 45].

The current body of literature on revision total hip arthroplasty focuses mainly on the success of certain types of implants [23, 26, 32, 33, 50, 52], treating specific defects [12, 38, 41], or evaluating specific techniques [6, 47–49]. Survival rates in the literature on revision total hip arthroplasty range from 35% at 10 years for cemented revisions [43] to 100% at 10 years for femoral revision with impaction grafting [46]. Most of the literature on revision THA focuses on specific techniques or implants, rather than outcomes from a variety of approaches and it is unclear whether specific data applies generally.

Therefore, considering patients undergoing revision for a variety of failures and approaches, we raised the following questions: (1) What is the survival probability of index revision hip surgery? (2) What are the most common reasons for the failure of index revision? (3) Have the reasons for failure changed over the time period of the study? Finally, we sought to determine if failures were different in comparison to the current literature on specific techniques and implants in revision total hip arthroplasty and identify areas where improvement is needed.

Materials and Methods

We retrospectively reviewed all 1036 patients (1100 hips) who had revision hip arthroplasties for a variety of indications (Table 1) performed between 1986 and August 2005. There were 594 women and 442 men. The average age was 63.7 years (range, 22–96 years). We identified failed revision hips that had a second revision based on a query of prospectively collected registry data. Periodic audits and comparisons between the institutions practice management data and registry data are performed to ensure completeness of data. The minimum followup was 2 years (mean, 6 years; range, 0–20.4 years).

Revision surgery was defined as any surgery that involved an open procedure to address a mode of failure of the primary hip arthroplasty. It included revision of any major component (acetabular or femoral) as well as exchange of modular parts (femoral head and acetabular liner) and irrigation and débridement to treat deep periprosthetic infection. Closed reductions were not categorized as revision procedures. If patients had not been evaluated within 6 months, we conducted phone surveys to confirm the patient had not undergone revision of the implant for any reason. Lost to followup was defined using a 24-month endpoint. Exhaustive methods were used to locate all patients. One-hundred and eleven patients (114 hips) were categorized as lost-to-followup for the following reasons: five patients were infirmed; 28 patients were contacted but refused followup; and 78 patients had inaccurate contact information.

Table 1. Indicators for initial revision (N = 1100) from 1985 to 2005

Initial diagnosis	N (%)
Aseptic loosening	498 (45%)
Instability	172 (16%)
Osteolysis/wear	172 (16%)
Deep periprosthetic infection	118 (11%)
Periprosthetic fracture	63 (6%)
Miscellaneous	77 (7%)

Time to failure was defined as the period from index revision surgery to repeat revision surgery. Index revision diagnosis was determined based on information entered into the database by the operating surgeon determined at the time of revision and cross-referenced with ICD-9 codes. The failure rate was determined using the ratio of the number having repeat surgery to the total number. Time to failure and failure rate were calculated for the entire cohort as well as by each diagnosis. The dates of index revision were stratified into three equivalent time periods. Time periods were defined based on three equal periods during which the study took place. Time period 1 was index revision performed from January 1986 through July 15, 1992; time period 2 from July 1, 1992 through February 28, 1999; and time period 3 from February 29, 1999 through August 2005.

We calculated standard descriptive statistics including mean, range, frequency, and proportions for diagnosis and time to failure. Survivorship analysis was conducted using the Kaplan-Meier method using second revision for any reason as the endpoint; survival probability was estimated with 95% confidence intervals [15]. All patients were included regardless of lost-to-followup status. Cases were censored at their last followup evaluation or date of death. Survivorship was calculated for the entire cohort as well as each failure mechanism. Statistical differences in failure rate over time were determined using a 3×2 chi square analysis at an a priori significance level of 0.05.

Results

Overall survivorship at 10 years was 82% (95% CI \pm 4%) and 72.6% at 15 years (95% CI \pm 6%) (Fig. 1).

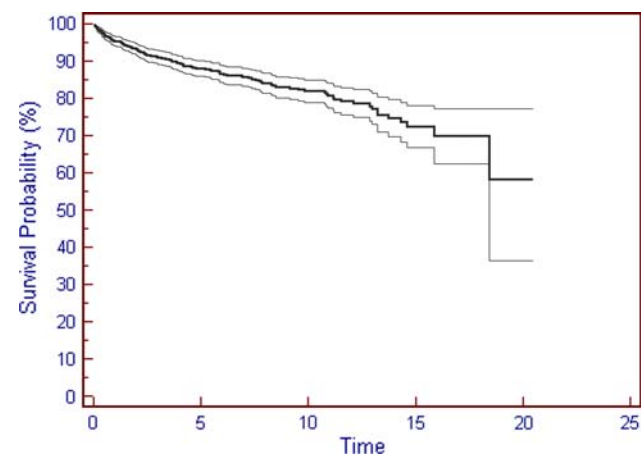


Fig. 1 The Kaplan-Meier survivorship for 1100 hips undergoing index revision total hip arthroplasty from 1985 to 2005 used second revision for any reason as an endpoint. Survivorship at 10 years was 82% and at 15 years was 72.6%.

Survivorship was also determined based on diagnosis at time of index revision (Fig. 2A–D). Survivorship for those patients initially revised for aseptic loosening using second revision for any reason was 81% (95% CI \pm 4%) at 10 years and 70% at 15 years (95% CI \pm 8%). For those patients initially revised for a diagnosis of instability using second revision for any reason, survivorship was 86% (95% CI \pm 10%) at 8 years. For those patients initially revised for a diagnosis of osteolysis/wear using second revision for any reason, survivorship was 90% at 5 years (95% CI \pm 4%) and 87% at 10 years (95% CI \pm 6%). For those patients initially revised for a diagnosis of infection using second revision for any reason, survivorship was 87% at 6 years (95% CI \pm 6%) and 81% at 11 years (95% CI \pm 10%). One hundred and forty-one (13%) revision total hip arthroplasties in 139 patients failed and underwent

a second revision (Table 2). The average time to failure from the index revision was 44 months (range, 0.3–190.3 months). The average age of these 65 men and 74 women was 57.9 years (range, 22–86 years). Of the 911 patients (959 hips) that did not require a second revision, there were 526 women and 385 men at an average age of 64.2 (range, 22.3–96.2 years).

Of the 1100 index revision procedures, 43 hips (30%) had a second revision for the same diagnosis as their index revision, while 98 hips (70%) underwent a second revision for a different diagnosis than their index revision. Over the 236-month time period examined by this study, the major reasons for failure of revision total hip arthroplasty were instability and aseptic loosening (Fig. 3).

The percentages of failure changed ($p < 0.001$) over the time of the study, although aseptic loosening and instability

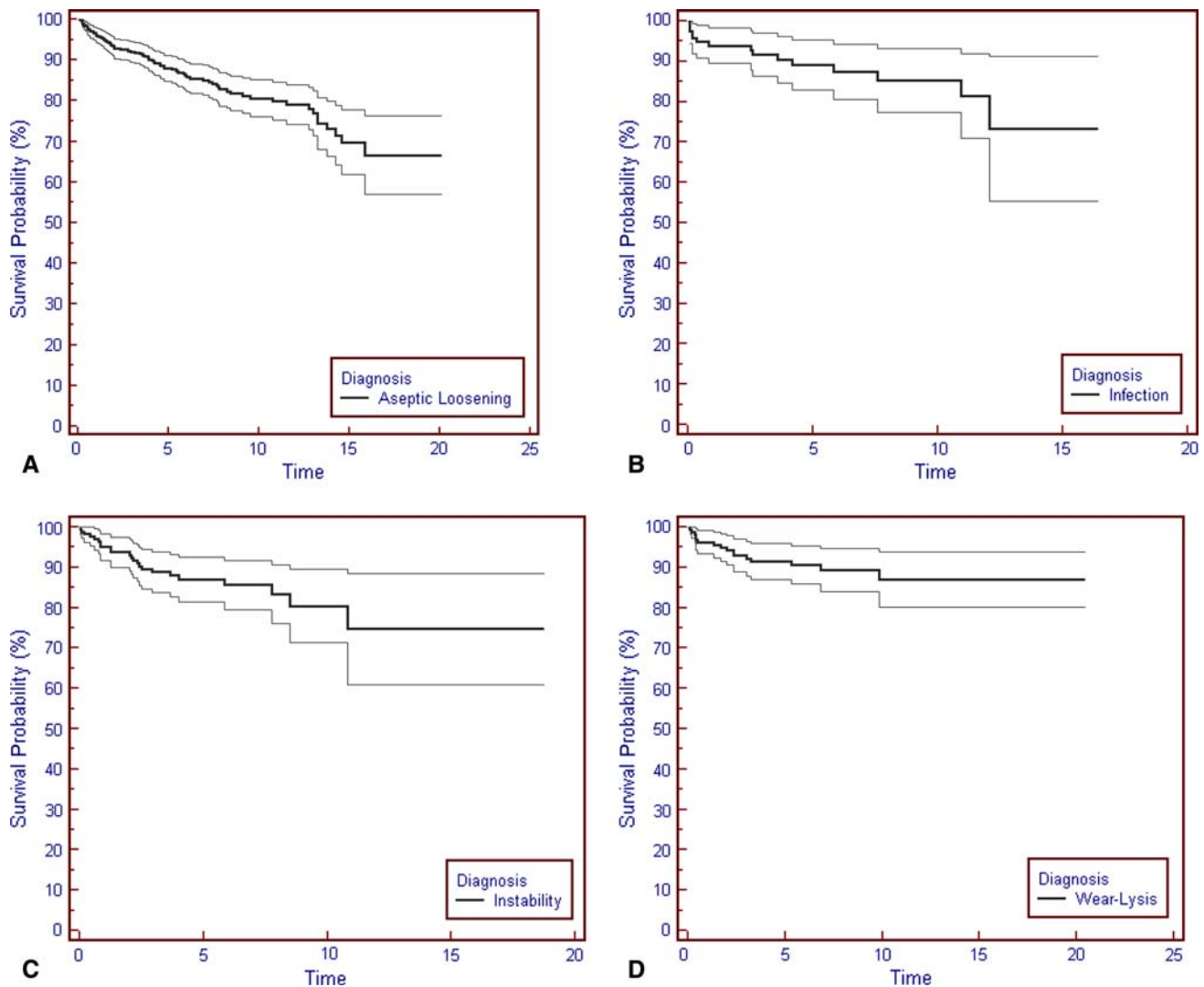


Fig. 2A–D The Kaplan-Meier survivorship for index revision total hip arthroplasty based on initial index revision diagnosis is shown. Results presented are based on (A) a diagnosis of aseptic loosening;

(B) a diagnosis of infection; (C) a diagnosis of instability; and (D) a diagnosis of wear-lysis.

Table 2. Reasons for failure requiring second revision (N = 141)

Initial diagnosis	N (%)
Instability	49 (35%)
Aseptic loosening	42 (30%)
Osteolysis/wear	17 (12%)
Deep periprosthetic infection	17 (12%)
Miscellaneous	13 (9%)
Periprosthetic fracture	3 (2%)

were the primary modes of failure throughout. For revisions performed during time period 1, the most common reasons for failure were aseptic loosening (38%) and wear/osteolysis (25%). For revisions performed during time period 2, the most common reasons for failure were instability (48%), aseptic loosening (21%), and infection (17%). For revisions performed during time period 3, the most common reasons for failure were instability (43%) and aseptic loosening (34%).

Discussion

There is little doubt modern primary total hip arthroplasty has achieved excellent and predictable long-term clinical success [7–9, 17, 34, 39]. Not all primary total hip replacements are successful however. Most outcome studies of revision arthroplasty consider specific mechanisms of failure, techniques, or implants. We therefore raised the following questions considering all revisions in general: (1)

What is the survival probability of index revision hip surgery? (2) What are the most common reasons for the failure of index revision? (3) Have the reasons for failure changed over the time period of the study?

There are some limitations with this current study. We chose to use re-revision surgery as our endpoint for failure. Although this is a firm, objective endpoint, patients with radiographic failure, those who have yet to come to second revision, and those with instability treated by closed means were not included as failures. Paprosky et al. [37] reported a 4% radiographic failure rate using extensively porous-coated stems for femoral revision at a mean followup of 13.2 years. Only one patient was awaiting revision surgery. In the study by Haydon [21], survivorship of the cemented femoral component in revision total hip arthroplasty using revision for any reason was 87% at 10 years but decreased to 71% when including radiographic failures. Thus, our ultimate failure rate will likely be higher than reported here with further time since the index revision.

The overall survivorship of revision total hip arthroplasty in our study using re-revision as an endpoint was 82% at 10 years and 72.6% at 15 years (Fig. 1). The results of survivorship in revision total hip arthroplasty for a variety of techniques were evaluated (Table 3). In 1989, Retpen et al. [43] reported overall survival of 35% for revision total hip arthroplasty at an average of 120 months. Englebrecht et al. [16], reviewing the results of mainly cemented revisions, reported an 8.8% failure rate at an average followup of 7.4 years in 138 revisions. An additional 43 stems and 53 cups however had

Fig. 3 The most common modes of failure for revision total hip arthroplasty for three equivalent time periods during the study were determined. Instability and infection remained common modes of failure throughout the study, while aseptic loosening and wear/osteolysis were more common modes of failure for those patients revised early in the study.

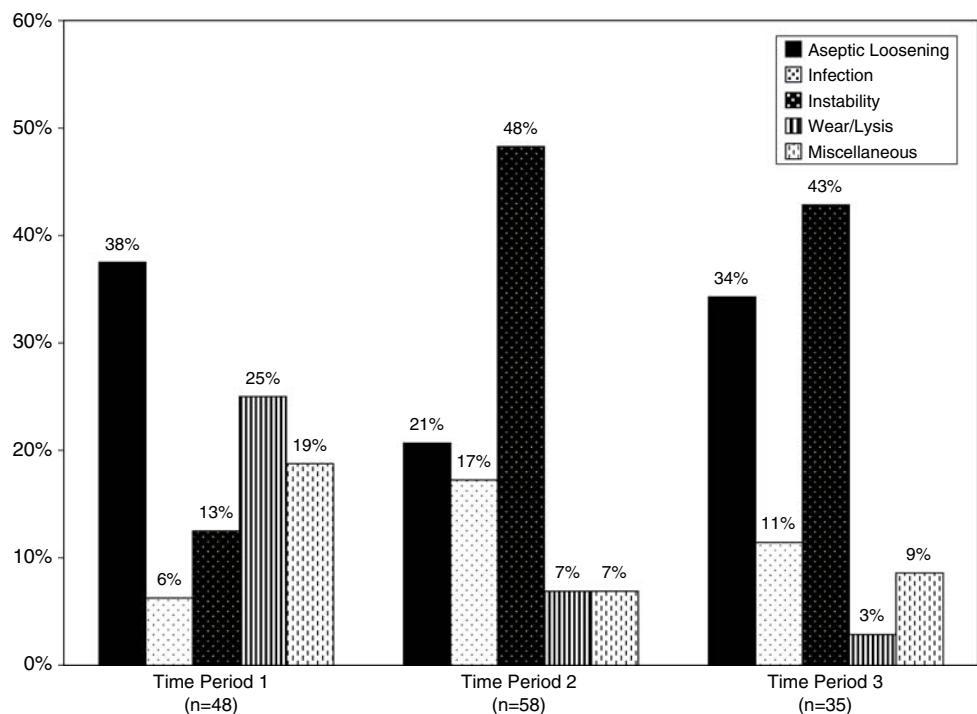


Table 3. Failure by diagnosis

Initial revision diagnosis	N (%)	Second revision diagnosis	N (%)	Time to failure in months (range)
Aseptic loosening	74 (15%)	Aseptic loosening	31 (43%)	54.1 (1.7–190.3)
		Instability	20 (27%)	
		Osteolysis/wear	12 (16%)	
		Miscellaneous	6 (7%)	
		Infection	4 (5%)	
		Periprosthetic fracture	1 (1%)	
Instability	21 (12%)	Instability	12 (57%)	34.5 (1–129.6)
		Aseptic loosening	3 (14%)	
		Infection	2 (10%)	
		Osteolysis/wear	2 (10%)	
		Implant fracture	2 (10%)	
Osteolysis/wear	16 (9%)	Instability	7 (44%)	29.9 (0.7–117.6)
		Implant fracture	2 (12.5%)	
		Infection	2 (12.5%)	
		Osteolysis/wear	2 (12.5%)	
		Aseptic loosening	1 (6%)	
		Failed bipolar	1 (6%)	
		Periprosthetic fracture	1 (6%)	
Deep periprosthetic infection	13 (11%)	Infection	6 (38%)	37.7 (0.5–145.1)
		Instability	5 (36%)	
		Aseptic loosening	1 (8%)	
		Periprosthetic fracture	1 (8%)	
Periprosthetic fracture	9 (14%)	Aseptic loosening	3 (33.3%)	13.2 (0.3–49.4)
		Infection	3 (33.3%)	
		Instability	3 (33.3%)	

radiographic evidence of loosening. More recently, McCarthy et al. [33] reported on the results of cementless modular revision total hip arthroplasty. The survivorship at 14 years was 60%. Aseptic loosening in patients with compromised femoral bone accounted for the majority of failures.

Our data and that in the literature suggest aseptic loosening and instability continue to be the primary modes of failure for both primary and revision total hip arthroplasty (Table 4) [5, 14, 25, 33, 40, 42]. We found aseptic loosening and instability accounted for 61% of the index revision surgeries. Sixty-five percent of second revisions also were performed for either aseptic loosening (30%) or instability (35%). The majority of failures for aseptic loosening that occurred on the femoral side were associated with proximally coated femoral stems. The majority of femoral stems used at our institution were fully porous-

coated stems and failure due to aseptic loosening was rare. This data coincides with the literature on low rates of failure for fully porous-coated stems and high failure rate with proximally porous-coated revision stems [5, 18, 36, 37, 40, 51].

Recent reports on cementless hemispherical acetabular fixation in revision surgery have shown promising result with a reported survivorship of 97% at 15-year followup for cementless hemispherical acetabular revisions [13, 14]. Recently, newer 3-D ingrowth materials have been introduced by several manufactures. These implants have highly porous surfaces (eg, trabecular metal) with biological substrates that allow for high bony ingrowth rates. In addition, a high coefficient of friction improves initial stability at the time of implantation. Early to mid-term results even in patients with severe acetabular bone stock deficiency have been promising [50].

Table 4. Literature review of revision total hip survivorship

Author	Year	Number of patients	Followup	Type of revision	Survivorship of revision THA	Most common modes of failure
Repten et al. [43]	1989	306	120 months	Cemented revisions (both components)	35% @ 120 months	Aseptic loosening
Kershaw et al. [27]	1991	191	75 months	Cemented revisions (both components)	77% @ 10 years	Aseptic loosening
Stromberg & Herberts [49]	1994	59	10 years	Cemented revisions pt < 55 years of age (both components)	48% @ 10 years	Aseptic loosening
Berry et al. [5]	1995	375	4.7 years	Proximally coated femoral revisions	58% @ 8 years	Aseptic loosening
Iorio et al. [25]	1995	89	7.7 years	Cemented revisions (both components)	76% @ 10 years	Aseptic loosening
Peters et al. [40]	1995	49	65 months	Proximally coated femoral revisions	37% @ 72 months	Aseptic loosening
Raut et al. [42]	1995	387	5.5 years	Cemented acetabular revisions	85% @ 10 years	Aseptic loosening and instability
Paprosky et al. [37]	1999	170	13.2 years	Fully porous-coated femoral revisions	95% @ 13 years	Aseptic loosening
Gramkow et al. [20]	2001	84	11.4 years	Cemented femoral revisions	77.9% @ 10 years	Aseptic loosening
Whaley et al. [53]	2001	89	7.2 years	Acetabular revision with cementless jumbo cups	93% @ 10 years	Aseptic loosening
Head et al. [22]	2001	1179	6.2 years	Cementless calcar femoral revisions	93.6% @ 13 years	Aseptic loosening
Engl et al. [18]	2002	34	13.3 years	Fully porous stems for severe bone loss	89% @ 10 years	Aseptic loosening
Gerber et al. [19]	2003	61	min 5 years	Acetabular revision with reinforcement ring	81% @ 10 years	Aseptic loosening
Kwong et al. [30]	2003	143	40 months	Modular cementless femoral component revisions	97.2% @ 5 years	Infection
Haydon et al. [21]	2004	129	min 5 years	Cemented femoral revisions	71% @ 10 years	Aseptic loosening
Hungerford et al. [24]	2006	30	8.2 years	Cemented and cementless femoral component revisions	90% @ 5 years	Aseptic loosening
Della Valle [14]	2005	138	15 years	Cementless acetabular revisions	55% @ 10 years	
Schreurs et al. [46]	2006	33	10.4 years	Femoral revision with impaction grafting	27% @ 20 years	Instability
McCarthy & Lee [33]	2007	62	14 years	Modular cementless femoral component revisions	100% @ 10 years	No failures
Springer et al.	2008	1036	min 2 years	All revisions	60% @ 14 years	Aseptic loosening
					82% @ 10 years	Instability and aseptic loosening

Instability is the leading cause of failure in revision total hip arthroplasty and results in the literature range from 2% to 16% [1, 35]. The cause of dislocation after revision total hip arthroplasty is related to multiple etiologies, including patient factors, component design and position, and status of the surrounding soft tissue and muscles. Alberton et al. [1] reported a 7.4% failure rate due to instability after revision total hip arthroplasty. Trochanteric nonunion and small head sizes (22 mm) were associated with higher rates of dislocation. Only 57% of hips were stable at latest followup. We similarly found instability as the leading cause of failure leading to repeat revision. The lack of readily available large-head technology and constrained component options during the span of this 20-year study could have contributed to this finding. All failures having repeat revision for instability in our series were performed prior to 2000. All patients were treated with 28-mm heads with either extended neck length or offset/elevated liners. Larger head sizes and posterior capsular repair may have reduced the incidence of this complication recently. However, little published data exists as to their role in preventing this complication in the revision setting [2, 10, 28, 54].

We evaluated the modes of failure in revision hip arthroplasty and to identify areas where improvement is needed. Overall survivorship of revision total hip arthroplasty at 10 years was 82%. Instability and aseptic loosening accounted for 65% of these failures. Additional focus on these two areas should be made by the revision surgeon to diminish the need for re-revision.

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