Mechanism of Primary Knee Arthroplasty Failure: Difference of a Decade

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Demand for knee arthroplasty continues to increase, and with it the need for knee revision surgery. Determining the etiology of knee failure can improve surgical technique, implant design, and clinical results. In 2002, Sharkey et al. reported cause of total knee failure in a series of 212 patients from 1997-2000. Their award-winning paper concluded that most TKAs fail early (mean, 3.7 years; range, 9 days–28 years); more than 50% of failures occurred within the first 2 years, and polyethylene wear was the most common failure mechanism. The conclusions from this paper continue to be cited today, but are they still true a decade later?

This retrospective multicenter study sought to determine causes of primary knee arthroplasty failure for revision knees performed over the past 2 years.

Why are Knees Failing Today?		
All Patients	**Knees**	**%**
Aseptic Loosening	263	28.0
Instability	158	16.8
Infection	137	14.6
Polyethylene Wear	84	9.0
Arthrofibrosis	59	6.3
Malalignment	56	6.0
UKA – separate analysis below	94	10.0
Other	87	9.3

Why are UKAs Failing Today?		
All Patients	**Knees**	**%**
Aseptic Loosening	57	60.6
Pain	10	10.6
Instability	7	7.4
Arthritis Progression	4	4.3
Polyethylene Wear	4	4.3
Malalignment	3	3.2
Periprosthetic Fracture	3	3.2
Other	3	3.2
Arthrofibrosis	2	2.1
Infection	1	1.1

Study

Data for 938 revision knees performed by surgeons at six high-volume joint replacement centers from January 1, 2010 to December 31, 2011 were tabulated to determine mechanism of primary knee failure and time to failure. Mechanism of failure (MOF) was determined by the treating surgeon from operative reports, office notes, radiographic data, and laboratory results if necessary, and compiled in a spreadsheet for comparison. Polyethylene exchange for possible infection was not included to avoid counting a failure multiple times. Failed knees were classified as initially successful or never successful.

What is the difference in a decade?

Comparison with previous reports indicates that knee failures continue to occur early.

- Fehring et al. — 440 knee failures over a 14-year period (1986-1999); 63% failed within 5 years of the index procedure.
- Sharkey et al. — 212 knee failures over a 3-year period (1997-2000), 56% failed within 2 years of the index procedure with a mean time to failure of 3.7 years (8 days–28 years).
- This study reports 844 total knee failures over a 2-year period (2010-2011) with a mean time to failure of 5.9 years (10 days–31 years). More than a third of all revisions occurred <2 years from the index arthroplasty, 60.2% failed within 5 years.

Comparison by MOF Over Time

Time to failure is different for each failure mechanism. Analysis of how each MOF occurs over time may clarify the etiology of failure.

Polyethylene Wear

In this study, polyethylene wear was the fourth leading TKA MOF. Less than 2% of all failures in the first 5 years were due to polyethylene wear. In contrast to the study by Sharkey et al, polyethylene wear was the leading MOF only after 15 years. Polyethylene manufactured in the past 10 years rarely fails early.

Time to Failure: All Knees				
	<2 years	2-5 years	5-15 years	>15 years
All Patients	298 (35.3%)	210 (24.9%)	249 (29.5%)	87 (10.3%)
Aseptic Loosening	56 (18.6%)	82 (38.9%)	99 (39.6%)	26 (29.9%)
Instability	75 (24.9%)	39 (18.5%)	40 (16.0%)	4 (4.6%)
Infection	68 (22.8%)	35 (16.7%)	29 (11.6%)	5 (5.7%)
Polyethylene Wear	3 (1.0%)	1 (0.5%)	38 (15.2%)	42 (48.3%)
Arthrofibrosis	38 (12.6%)	15 (7.1%)	5 (2.0%)	1 (1.1%)
Malalignment	24 (8.0%)	16 (7.6%)	15 (6.0%)	1 (1.1%)
Other	34 (11.3%)	22 (10.5%)	23 (9.2%)	8 (9.0%)
Unicompartmental	35 (37.3%)	33 (35.1%)	24 (25.5%)	2 (2.1%)

Infection

Similar to previous studies, this study found that infections occur early: 50% occurred in the first 2 years, 75% in the first 5 years. Early onset of infection may occur from host or surgical factors. Surgeons can directly influence the infection rate through patient selection, education, and medical optimization.

Instability

Instability is the leading cause of revision for knees less than 2 years after primary TKA. Primary instability occurs when the knee is not balanced properly during surgery. Secondary instability occurs when collateral ligaments loosen over time. In this study, 67% of knees revised for instability were never satisfied with their initial TKA surgery. This suggests that primary instability occurred in 67% of knees while secondary instability occurred in 33% of knees revised for instability. Similar to other failure mechanisms, early failure suggests poor surgical performance. Late failure appears to be patient-related.

Arthrofibrosis

Knee revisions due to arthrofibrosis and stiffness occur early; 90% in the first 5 years. A disproportionate early failure rate suggests the cause may be under the surgeon's control. In this study, 86.4% of patients revised for arthrofibrosis never had an initially successful TKA. Only 13.6% of knees were thought to be initially successful. This suggests that an initially well-functioning knee that develops stiffness late has an alternative underlying diagnosis.

Malalignment

This MOF represented less than 7% of all total knee revisions. Recent studies conflict regarding whether implant malalignment causes higher failure rates.

Aseptic Loosening

Aseptic loosening was the leading MOF in this study, the only one that occurred evenly over time, and represents a "catch-all" for multiple mechanisms of failure. Failure occurred in 32.9% of knees classified as never successful, suggesting failure of initial fixation. Failure occurred in 67.1% of knees classified as initially successful implants that loosened over time.

Unicompartmental

In this study, UKAs were revised earlier than TKAs ($p = 0.005$); mean time to revision for 94 UKAs was 4.3 years and for 844 TKAs was 5.9 years. UKA is more likely to be revised for pain alone (10.6%).

Conclusions

Knees continue to fail early. The mean time to TKA revision was 5.9 years, and the mean time to UKA revision was 4.3 years. In contrast to previous reports from 1999-2002, polyethylene wear was not a leading MOF from 2010-2011, representing 10% of all failures and rarely occurring before 15 years postoperatively.

Implant performance is no longer a predominant factor of knee failure.

Aseptic loosening was the predominant MOF in this study. However, it is poorly defined and the least understood, and should be classified by failure of fixation (implants that were never secured well) or aseptic loosening (secure implants that loosen over time).

Mechanisms of failure that are primarily surgeon-dependent occur early. TKA failed in the first 5 years for 75% of infected knees, 72% of unstable knees, 90% of arthrofibrotic knees, and 71% of malaligned knees. Improving surgeon performance through training on instrumentation and surgical technique may reduce the cause of early revision.