

Australian Orthopaedic Association National Joint Replacement Registry

2023 SUPPLEMENTARY REPORT

Demographics and Outcome of Ankle Arthroplasty



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Registry

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Registry**

**Demographics and Outcome of Ankle
Arthroplasty**

2023 Supplementary Report

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The AOANJRR is funded by the Australian Government Department of Health and Aged Care

Cite this report

Smith PN, Lewis PL, Gill DR, McAuliffe MJ, McDougall C, Stoney JD, Vertullo CJ, Wall CJ, Corfield S, Cashman K, Cuthbert AR, Du P, Harries D, Holder C, Lorimer MF, Stavrou P. Demographics and Outcome of Ankle Arthroplasty: Supplementary Report in *Hip, Knee & Shoulder Arthroplasty: 2023 Annual Report*, Australian Orthopaedic Association National Joint Replacement Registry, AOA, Adelaide; 2023. <https://doi.org/10.25310/GMUX5994>

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Acknowledgements

The Registry continues to receive support and invaluable assistance from the Australian Government, state and territory health departments and orthopaedic companies.

The Registry acknowledges the cooperation and support provided by those undertaking the surgery and completing the data forms, in particular, all orthopaedic surgeons, registrars and nursing staff.

The Registry acknowledges the ongoing support of all hospitals, both public and private, that undertake arthroplasty surgery nationally. The support provided by each hospital through their nominated coordinator(s) is appreciated. A complete list of participating hospitals and coordinators is presented at the end of the Hip, Knee and Shoulder Arthroplasty Annual Report.

The Registry greatly appreciates the participation of all joint replacement patients throughout Australia. Their contribution allows ongoing improvements in arthroplasty outcomes to be achieved.

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Introduction

This Ankle Arthroplasty Supplementary Report is based on the analysis of 4,646 ankle procedures with a procedure date from 2006 up to and including 31 December 2022.

This Report is one of 16 supplementary reports to complete the AOANJRR Annual Report for 2023.

Information on the background, purpose, aims, benefits and governance of the Registry can be found in the Introductory chapter of the 2023 Hip, Knee and Shoulder Arthroplasty Annual Report.

The Registry data quality processes including data collection, validation and outcomes assessment, are provided in detail in the Data Quality section of the introductory chapter of the 2023 Hip, Knee and Shoulder Arthroplasty Annual Report:

<https://aoanjrr.sahmri.com/annual-reports-2023>

Ankle Replacement

CATEGORIES OF ANKLE REPLACEMENT

Ankle replacements are grouped into two broad categories: primary total and revision ankle replacement.

A primary total ankle replacement is the initial replacement procedure involving replacing both the tibial and talar articular surfaces of the ankle joint with tibial and talar prostheses and an intervening insert which may or may not be attached to the tibial component.

Revision procedures are subsequent operations of previous ankle replacements where one or more of the prosthetic components are replaced, removed, or another component is added. Revisions include subsequent operations of primary total or previous revision procedures.

Ankle revisions are subcategorised into three classes: major total, major partial and minor revisions. Major total involves replacing both the tibial and talar components. Major partial involves revising either the tibial or talar component, and a minor revision procedure retains the original tibial and talar components and most often involves a revision of the insert only.

There is a third category of ankle replacement procedure data that the AOANJRR collects. This is information on re-operation after ankle replacement but without revision of any of the components. Surgeons have reported a small number of these procedures and the future aim of the AOANJRR is to increase reporting of these operations.

DEMOGRAPHICS OF ANKLE REPLACEMENT

This report is an analysis of 4,646 ankle replacement procedures (3,948 primaries (85%) and 698 revisions (15%). This excludes 2 primary partial resurfacing ankle replacements from 2008.

Ankle replacement is more frequently undertaken in males (61.3%). The overall mean age is 67.2 years and the most common age group for both male and female patients is 65-74 years (Table A1 to Table A3 and Figure A1).

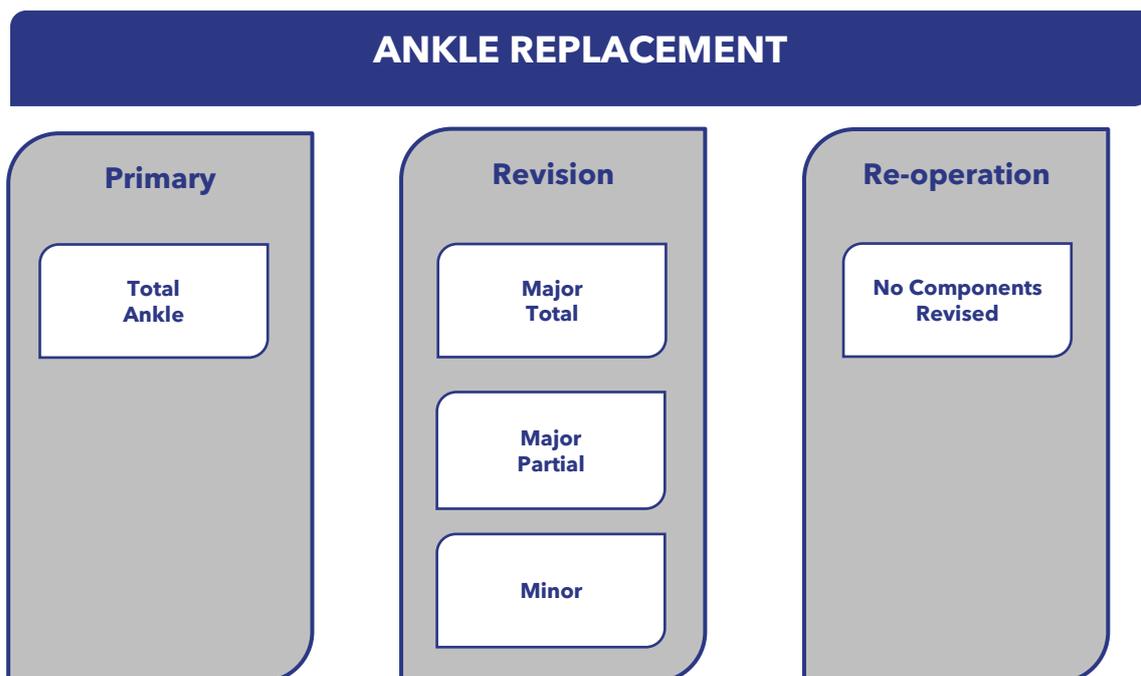


Table A1 Number of Ankle Replacements by Gender

Ankle Replacement	Male		Female		TOTAL	
	N	Row%	N	Row%	N	Row%
Primary Total	2408	61.0	1540	39.0	3948	100.0
Revision	439	62.9	259	37.1	698	100.0
TOTAL	2847	61.3	1799	38.7	4646	100.0

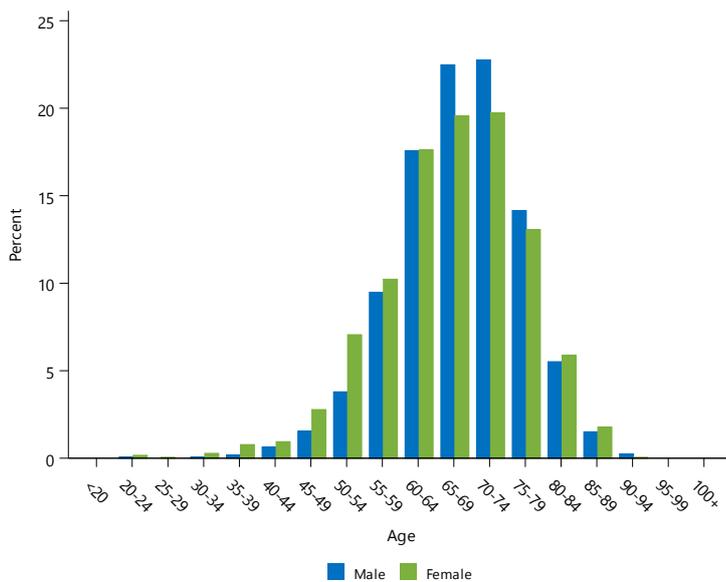
Table A2 Number of Ankle Replacements by Age

Ankle Replacement	<55		55-64		65-74		75-84		≥85		TOTAL	
	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%
Primary Total	330	8.4	1130	28.6	1666	42.2	751	19.0	71	1.8	3948	100.0
Revision	66	9.5	141	20.2	329	47.1	150	21.5	12	1.7	698	100.0
TOTAL	396	8.5	1271	27.4	1995	42.9	901	19.4	83	1.8	4646	100.0

Table A3 Age and Gender of Primary and Revision Ankle Replacement

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	1799	38.7%	20	90	67	66.4	9.9
Male	2847	61.3%	23	94	68	67.8	8.6
TOTAL	4646	100.0%	20	94	68	67.2	9.2

Figure A1 Ankle Replacement by Age and Gender



Primary Total Ankle Replacement

DEMOGRAPHICS

There have been 3,948 primary total ankle replacements reported to the Registry. This is an additional 500 procedures since the last report.

For further information on the **closure of the database** please see the **Glossary** of the **Hip, Knee & Shoulder Arthroplasty Annual Report**:

<https://www.aoanjrr.sahmri.com/annual-reports-2023>

The use of total ankle replacement was highest in 2021 and lowest in 2014. There has been a 210.3% increase in the use of ankle replacement since 2014. In 2022, there was a 3.4% decrease in the number of total ankle replacements compared to 2021 (Figure A2). The principal primary diagnosis is osteoarthritis (93.7%) (Table A4).

Figure A2 Numbers of Ankle Replacement

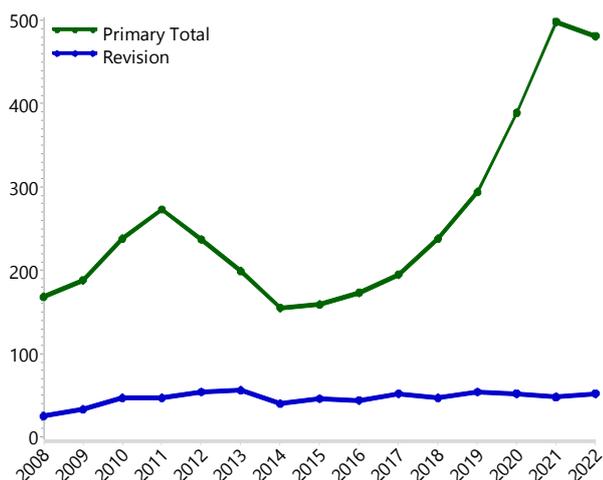


Table A4 Primary Total Ankle Replacement by Primary Diagnosis

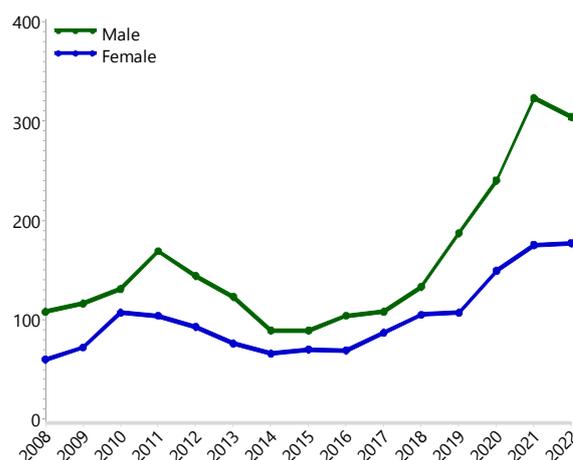
Primary Diagnosis	Number	Percent
Osteoarthritis	3700	93.7
Rheumatoid Arthritis	171	4.3
Other Inflammatory Arthritis	26	0.7
Instability	19	0.5
Fracture/Dislocation	11	0.3
Osteonecrosis	7	0.2
Tumour	2	0.1
Other	12	0.3
TOTAL	3948	100.0

Table A5 Age and Gender of Primary Total Ankle Replacement

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	1540	39.0%	20	90	67	66.3	9.9
Male	2408	61.0%	23	94	68	67.6	8.6
TOTAL	3948	100.0%	20	94	68	67.1	9.1

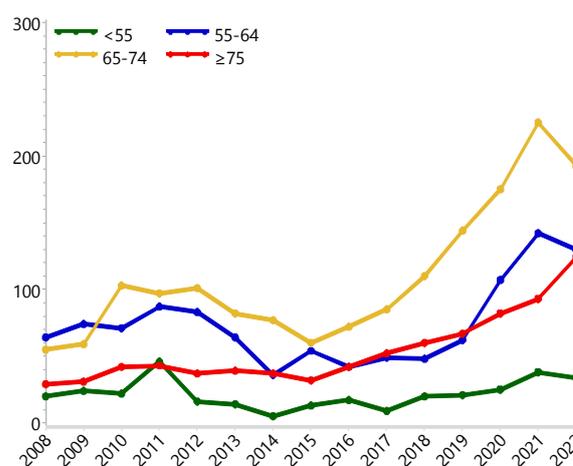
Overall, 61.0% of primary ankle procedures are performed on males. The use of primary ankle replacement in males has increased in recent years (Table A5 and Figure A3).

Figure A3 Number of Primary Total Ankle Replacement by Gender



The median age is 68 years with males and females having a similar median age. The most common age group is 65-74 years. This age group and the 55-64 age group has increased more rapidly than other age groups in the last few years but have had fewer procedures recorded in 2022 (Figure A4).

Figure A4 Number of Primary Total Ankle Replacement by Age



ASA AND BMI

ASA scores are an indication of comorbidity and have been collected since 2012. The Registry has ASA data on 2,666 primary total ankle replacement procedures. Total ankle replacement is most commonly performed in patients with ASA score 2 (Table A6).

BMI data have been collected since 2015. There are BMI data on 2,260 primary total ankle replacement procedures. Total ankle replacement is more common in patients who are pre-obese or Obese Class 1 (Table A7).

BILATERAL PROCEDURES

The Registry has recorded 259 bilateral ankle replacements, 15.0% of which were performed

within 6 months of the initial procedure (Table A8).

PROSTHESIS USE

Information on the changing use of tibial and talar prostheses in recent years compared to 2008, is provided in Table A9 and Table A10.

Table A6 ASA Score for Primary Total Ankle Replacement

ASA Score	Number	Percent
ASA 1	269	10.1
ASA 2	1465	55.0
ASA 3	907	34.0
ASA 4	25	0.9
TOTAL	2666	100.0

Table A7 BMI Category for Primary Total Ankle Replacement

BMI Category	Number	Percent
Underweight	9	0.4
Normal	360	15.9
Pre Obese	907	40.1
Obese Class 1	700	31.0
Obese Class 2	206	9.1
Obese Class 3	78	3.5
TOTAL	2260	100.0

Note: BMI has not been presented for patients aged ≤ 19 years

Table A8 Time between Procedures for Bilateral Primary Ankle Replacement

Bilateral Procedures	Same Day		1 day-6 months		≥ 6 months		TOTAL	
	N	Total%	N	Total%	N	Total%	N	Total%
Both - Total Ankle	4	1.5	35	13.5	220	84.9	259	100.0
TOTAL	4	1.5	35	13.5	220	84.9	259	100.0

Table A9 Most Used Tibial Prostheses in Primary Total Ankle Replacement

2008		2018		2019		2020		2021		2022	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	70	Salto Talaris	137	Infinity	200	Infinity	266	Infinity	287	Infinity
34	Hintermann Series H3	69	Infinity	52	Salto Talaris	81	Trabecular Metal	90	Trabecular Metal	73	Trabecular Metal
18	Buechel-Pappas	30	Hintermann Series H3	41	Trabecular Metal	40	Inbone	47	Salto Talaris	59	Inbone
11	Salto	21	Inbone	26	Inbone	32	Salto Talaris	41	Inbone	27	Salto Talaris
6	BOX	21	Salto	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3	21	Hintermann Series H3
1	Ankle Joint (Eska)	17	Trabecular Metal	13	Hintermann Series H3	15	Vantage	23	Vantage	14	Vantage
		9	Zenith	4	Salto	1	Salto	4	Zenith		
		1	S.T.A.R	4	Zenith			2	Invision		
								1	Salto		
10 Most Used											
168	(6) 100.0%	238	(8) 100.0%	294	(8) 100.0%	389	(7) 100.0%	498	(9) 100.0%	481	(6) 100.0%

Table A10 Most Used Talar Prostheses in Primary Total Ankle Replacement

2008		2018		2019		2020		2021		2022	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	70	Salto Talaris	107	Infinity	129	Infinity	199	Infinity	237	Infinity
34	Hintermann Series H3	58	Infinity	54	Inbone	108	Inbone	108	Inbone	105	Inbone
18	Buechel-Pappas	32	Inbone	52	Salto Talaris	81	Trabecular Metal	90	Trabecular Metal	73	Trabecular Metal
11	Salto	30	Hintermann Series H3	41	Trabecular Metal	32	Salto Talaris	47	Salto Talaris	27	Salto Talaris
6	BOX	21	Salto	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3	21	Hintermann Series H3
1	Ankle Joint (Eska)	17	Trabecular Metal	13	Hintermann Series H3	15	Vantage	23	Vantage	14	Vantage
		9	Zenith	4	Salto	3	Invision	4	Zenith	4	Invision
		1	S.T.A.R	4	Zenith	1	Salto	2	Invision		
				2	Invision			1	Salto		
10 Most Used											
168	(6) 100.0%	238	(8) 100.0%	294	(9) 100.0%	389	(8) 100.0%	498	(9) 100.0%	481	(7) 100.0%

OUTCOME FOR ALL DIAGNOSES

PRIMARY DIAGNOSIS

The cumulative percent revision for osteoarthritis at 10 years is 14.8%. There has only been a small number of procedures for rheumatoid arthritis and, when adjusted for age and gender, there is no difference in the revision rate when compared to osteoarthritis (Table A11 and Figure A5).

REASON FOR REVISION

Loosening is the most common reason for revision of primary total ankle replacement. This accounts for 30.2% of all revisions, followed by infection, lysis, instability, and implant breakage (Table A12). The cumulative incidence of the five most common reasons for revision is presented in Figure A6.

TYPE OF REVISION

The main type of revision is an insert only revision (48.0%) (Table A13).

CHANGE IN OUTCOME OVER TIME

There has been a reduction in the cumulative percent revision rate of primary total ankle replacement procedures undertaken since 2015.

Comparing procedures undertaken prior to 2015 to those undertaken since 2015, the 5 year cumulative percent revision has declined from 10.7% to 5.6% (Table A14 and Figure A7).

RE-OPERATION

There have been 49 procedures where a re-operation without component revision was performed on a primary total ankle replacement. These procedures are not included in the revision analysis.

PROSTHESIS TYPES

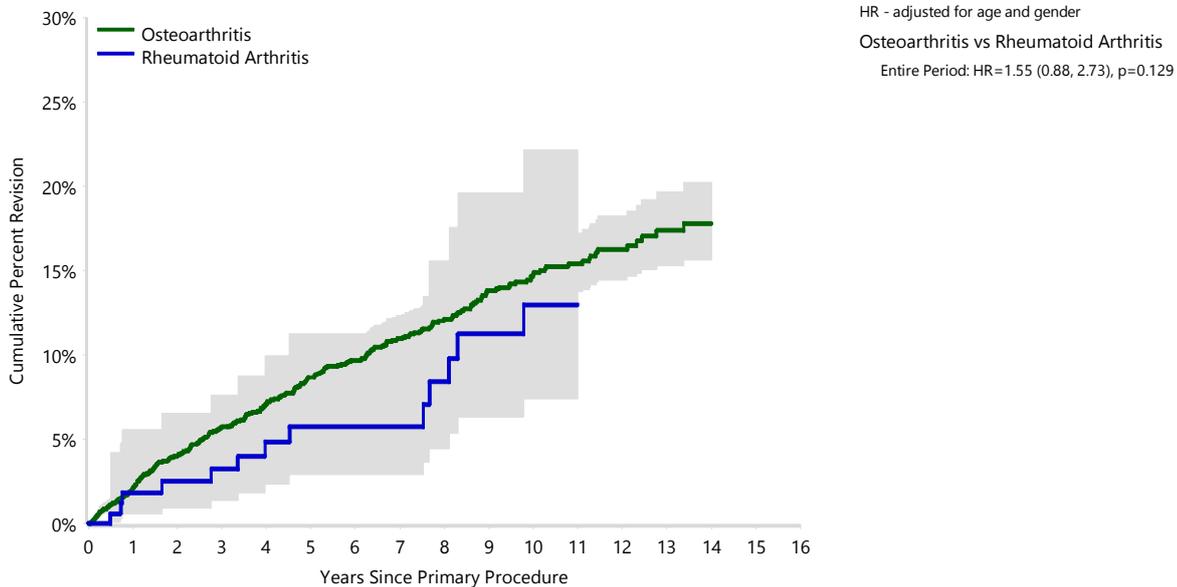
The outcomes of different prosthesis types are listed in Table A15.

Table A11 Cumulative Percent Revision of Primary Total Ankle Replacement by Primary Diagnosis

Primary Diagnosis	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Osteoarthritis	326	3700	2.1 (1.7, 2.7)	5.7 (4.9, 6.6)	8.7 (7.6, 9.8)	11.0 (9.7, 12.3)	14.8 (13.2, 16.5)	17.8 (15.6, 20.3)
Rheumatoid Arthritis	13	171	1.8 (0.6, 5.6)	3.2 (1.4, 7.6)	5.7 (2.9, 11.2)	5.7 (2.9, 11.2)	13.0 (7.4, 22.2)	
Other Inflammatory Arthritis	2	26	0.0 (0.0, 0.0)	9.3 (2.4, 32.4)	9.3 (2.4, 32.4)	9.3 (2.4, 32.4)	9.3 (2.4, 32.4)	
Instability	3	19	5.3 (0.8, 31.9)	5.3 (0.8, 31.9)	5.3 (0.8, 31.9)	18.8 (4.4, 62.1)	35.0 (11.5, 78.1)	
Other	0	12	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
Fracture/Dislocation	0	11	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
Other (2)	0	9	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	
TOTAL	344	3948						

Note: Only primary diagnoses with over 10 procedures have been listed

Figure A5 Cumulative Percent Revision of Primary Total Ankle Replacement by Primary Diagnosis



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Osteoarthritis	3700	3151	2194	1633	1238	738	122
Rheumatoid Arthritis	171	158	129	98	78	50	6

Note: Only primary diagnoses with over 50 procedures have been listed

Table A12 Reason for Revision of Primary Total Ankle Replacement

Revision Diagnosis	Number	Percent
Loosening	104	30.2
Infection	46	13.4
Lysis	33	9.6
Instability	32	9.3
Implant Breakage Ankle Insert	31	9.0
Pain	21	6.1
Impingement	18	5.2
Fracture	16	4.7
Prosthesis Dissociation	8	2.3
Wear Ankle Insert	6	1.7
Arthrofibrosis	6	1.7
Malalignment	6	1.7
Heterotopic Bone	4	1.2
Synovitis	3	0.9
Incorrect Sizing	2	0.6
Implant Breakage Tibial	2	0.6
Metal Related Pathology	1	0.3
Tumour	1	0.3
Osteonecrosis	1	0.3
Other	3	0.9
TOTAL	344	100.0

Table A13 Type of Revision of Primary Total Ankle Replacement

Type of Revision	Number	Percent
Insert Only	165	48.0
Tibial/Talar	52	15.1
Arthrodesis	46	13.4
Tibial Only	35	10.2
Talar Only	20	5.8
Cement Spacer	15	4.4
Minor Components	6	1.7
Removal of Prostheses	5	1.5
TOTAL	344	100.0

Figure A6 Cumulative Incidence Revision Diagnosis of Primary Total Ankle Replacement

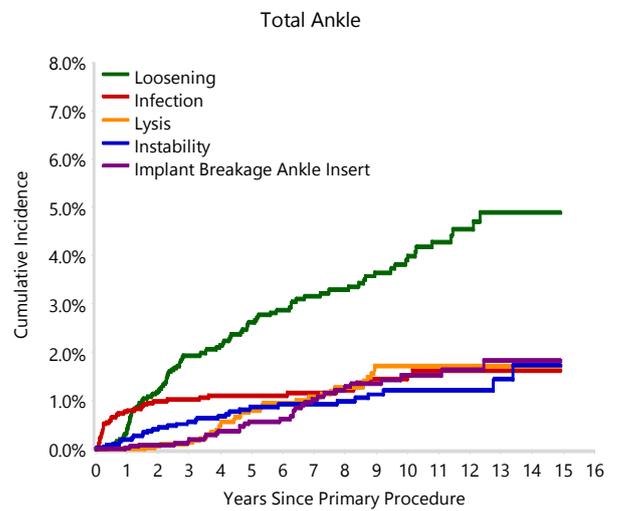
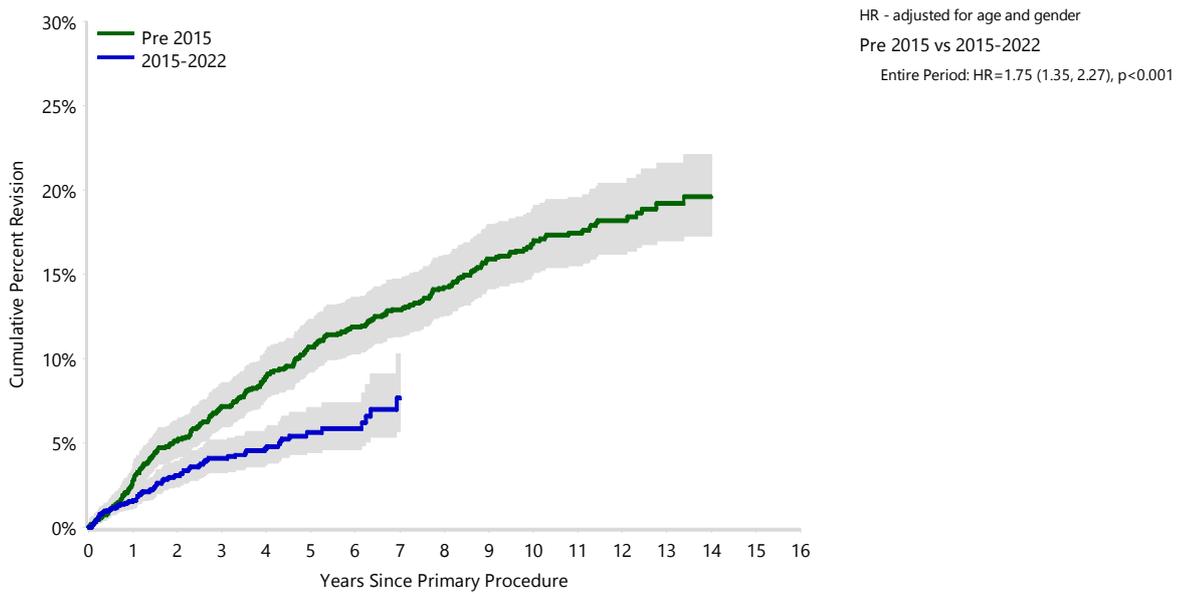


Table A14 Cumulative Percent Revision of Primary Total Ankle Replacement by Period

Period	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
2015-2022	89	2427	1.6 (1.1, 2.2)	4.1 (3.2, 5.2)	5.6 (4.5, 7.1)	7.7 (5.7, 10.3)		
Pre 2015	255	1521	2.8 (2.1, 3.7)	7.2 (6.0, 8.6)	10.7 (9.2, 12.4)	12.9 (11.3, 14.7)	16.9 (15.0, 19.0)	19.6 (17.3, 22.1)
TOTAL	344	3948						

Figure A7 Cumulative Percent Revision of Primary Total Ankle Replacement by Period



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Pre 2015	1521	1467	1376	1289	1208	802	129
2015-2022	2427	1900	989	474	131	0	0

Table A15 Cumulative Percent Revision of Primary Total Ankle Replacement by Prosthesis Combination

Tibia	Talar	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
BOX	BOX*	15	114	1.8 (0.4, 6.8)	5.4 (2.4, 11.6)	10.1 (5.7, 17.5)	10.1 (5.7, 17.5)	14.9 (9.2, 23.7)	
Buechel-Pappas	Buechel-Pappas*	10	63	1.6 (0.2, 10.7)	8.0 (3.4, 18.1)	9.6 (4.4, 20.1)	11.2 (5.5, 22.2)	16.5 (9.2, 28.6)	16.5 (9.2, 28.6)
Hintermann Series H3	Hintermann Series H3	91	538	4.2 (2.8, 6.3)	8.5 (6.4, 11.3)	11.7 (9.2, 14.9)	16.2 (13.1, 19.9)	20.5 (16.8, 24.8)	
Inbone	Inbone	7	196	3.0 (1.3, 7.2)	4.6 (2.2, 9.6)				
Infinity	Inbone	8	232	0.5 (0.1, 3.2)	5.2 (2.3, 11.5)				
	Infinity	14	744	1.4 (0.7, 2.8)	3.0 (1.7, 5.2)				
Mobility	Mobility*	87	568	2.3 (1.3, 3.9)	7.1 (5.2, 9.5)	10.2 (7.9, 13.0)	11.1 (8.8, 14.0)	14.8 (12.0, 18.1)	17.4 (14.1, 21.4)
S.T.A.R	S.T.A.R*	12	49	4.1 (1.0, 15.5)	12.6 (5.8, 25.8)	14.7 (7.3, 28.4)	21.6 (12.2, 36.6)		
Salto	Salto*	58	421	2.2 (1.1, 4.1)	5.5 (3.7, 8.2)	9.1 (6.7, 12.3)	11.9 (9.1, 15.6)	15.1 (11.7, 19.4)	
Salto Talaris	Salto Talaris	22	506	1.2 (0.5, 2.7)	3.8 (2.4, 6.0)	4.7 (3.1, 7.3)	5.1 (3.3, 7.8)		
Trabecular Metal	Trabecular Metal	5	339	1.3 (0.5, 3.4)	1.9 (0.8, 4.8)				
Vantage	Vantage	0	69	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)				
Zenith	Zenith*	13	87	3.4 (1.1, 10.3)	7.0 (3.2, 15.0)	15.2 (8.9, 25.4)	15.2 (8.9, 25.4)		
Other (8)		2	22	0.0 (0.0, 0.0)	11.9 (3.1, 39.8)	11.9 (3.1, 39.8)	11.9 (3.1, 39.8)	11.9 (3.1, 39.8)	
TOTAL		344	3948						

Note: Only prostheses with over 15 procedures have been listed

*denotes prosthesis combinations that have not had any reported use in primary total ankle procedures in 2022

OUTCOME FOR OSTEOARTHRITIS

DEMOGRAPHICS

Age and Gender

Age is a risk factor for revision. Patients aged ≥ 75 years have a lower rate of revision compared to patients aged 65-74 years and 55-64 years after 2.5 years and aged < 55 years for the entire period (Table A16 and Figure A8).

There is no difference in the rate of revision between males and females (Table A17 and Figure A9).

ASA and BMI

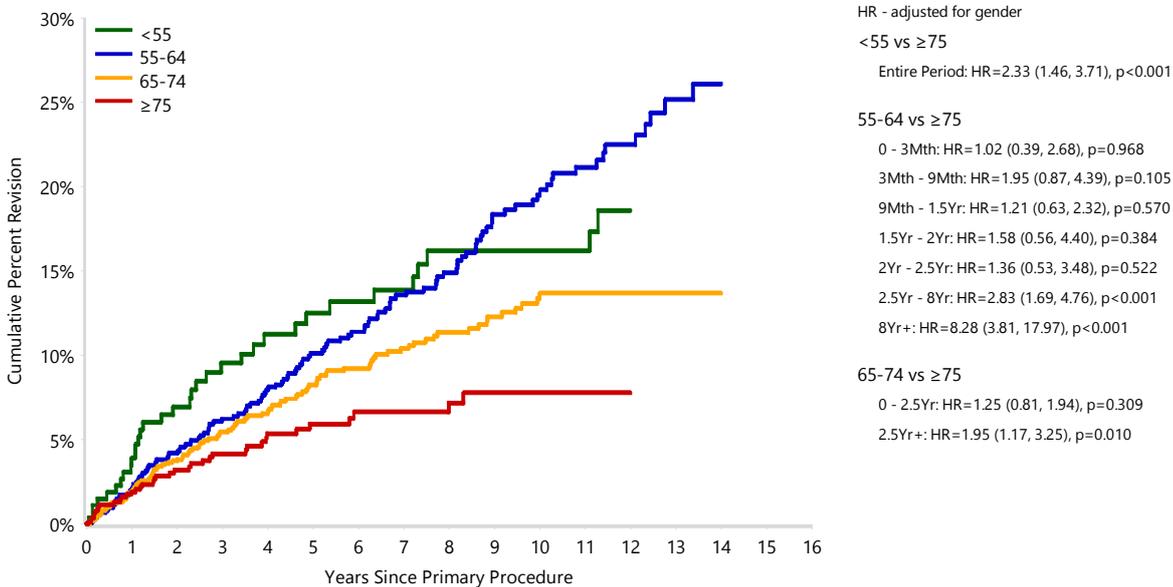
ASA is not a risk factor for revision (Table A18 and Figure A10).

As the number of procedures in each BMI category is relatively small, an analysis of combined BMI $< 30 \text{ kg/m}^2$ (underweight, normal and pre-obese) compared to BMI of $\geq 30 \text{ kg/m}^2$ (obese classes 1-3) was undertaken. There is no difference in the rate of revision comparing obese and non-obese patients (Table A19 and Figure A11).

Table A16 Cumulative Percent Revision of Primary Total Ankle Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
<55	34	274	3.9 (2.1, 7.1)	9.5 (6.4, 14.2)	12.5 (8.7, 17.9)	13.9 (9.8, 19.5)	16.2 (11.6, 22.4)	
55-64	133	1054	2.0 (1.3, 3.1)	6.2 (4.8, 8.1)	10.1 (8.2, 12.5)	13.6 (11.2, 16.4)	19.5 (16.4, 23.1)	26.1 (21.6, 31.3)
65-74	121	1576	2.0 (1.4, 2.8)	5.5 (4.3, 6.9)	8.2 (6.7, 10.1)	10.4 (8.6, 12.6)	13.7 (11.3, 16.5)	13.7 (11.3, 16.5)
≥ 75	38	796	1.9 (1.1, 3.2)	4.2 (2.9, 6.1)	5.9 (4.2, 8.3)	6.6 (4.7, 9.3)	7.8 (5.5, 10.9)	
TOTAL	326	3700						

Figure A8 Cumulative Percent Revision of Primary Total Ankle Replacement by Age (Primary Diagnosis OA)

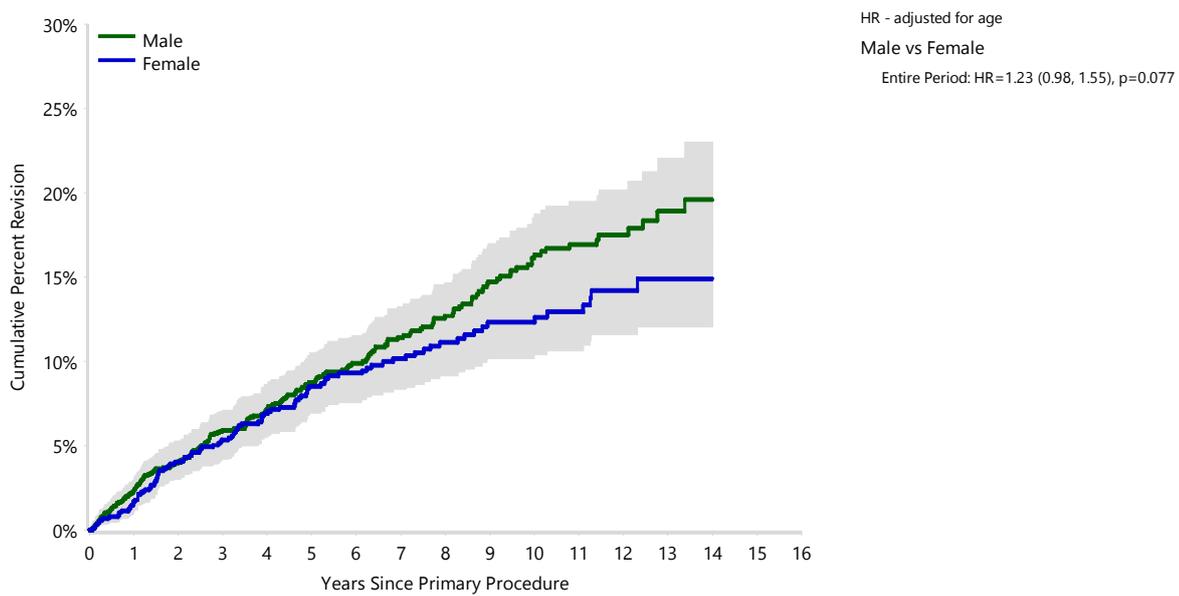


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
<55	274	234	169	133	113	86	17
55-64	1054	912	640	521	421	265	49
65-74	1576	1359	924	665	497	287	43
≥ 75	796	646	461	314	207	100	13

Table A17 Cumulative Percent Revision of Primary Total Ankle Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Male	214	2322	2.4 (1.8, 3.1)	5.9 (5.0, 7.1)	8.7 (7.4, 10.3)	11.4 (9.9, 13.3)	16.3 (14.2, 18.8)	19.6 (16.6, 23.0)
Female	112	1378	1.7 (1.1, 2.6)	5.4 (4.2, 6.9)	8.6 (6.9, 10.5)	10.2 (8.3, 12.4)	12.3 (10.2, 14.9)	14.9 (12.1, 18.4)
TOTAL	326	3700						

Figure A9 Cumulative Percent Revision of Primary Total Ankle Replacement by Gender (Primary Diagnosis OA)

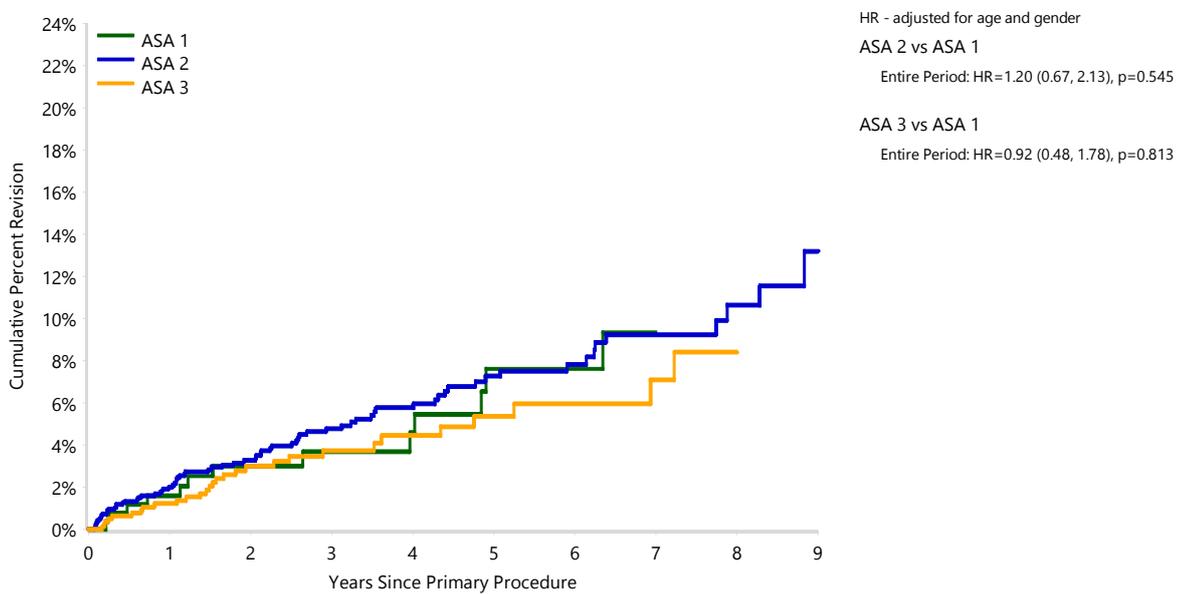


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Male	2322	1962	1346	992	753	445	80
Female	1378	1189	848	641	485	293	42

Table A18 Cumulative Percent Revision of Primary Total Ankle Replacement by ASA Score (Primary Diagnosis OA)

ASA Score	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	5 Yrs	7 Yrs	9 Yrs
ASA 1	14	263	1.6 (0.6, 4.3)	3.0 (1.5, 6.3)	3.7 (1.8, 7.3)	7.6 (4.2, 13.7)	9.3 (5.1, 16.7)	
ASA 2	74	1404	2.0 (1.4, 3.0)	3.3 (2.4, 4.5)	4.8 (3.6, 6.3)	7.3 (5.6, 9.4)	9.2 (7.1, 12.0)	13.2 (9.2, 18.7)
ASA 3	29	821	1.2 (0.6, 2.3)	3.0 (1.9, 4.7)	3.8 (2.5, 5.7)	5.4 (3.5, 8.1)	7.1 (4.4, 11.3)	
ASA 4	0	23	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)		
TOTAL	117	2511						

Figure A10 Cumulative Percent Revision of Primary Total Ankle Replacement by ASA Score (Primary Diagnosis OA)



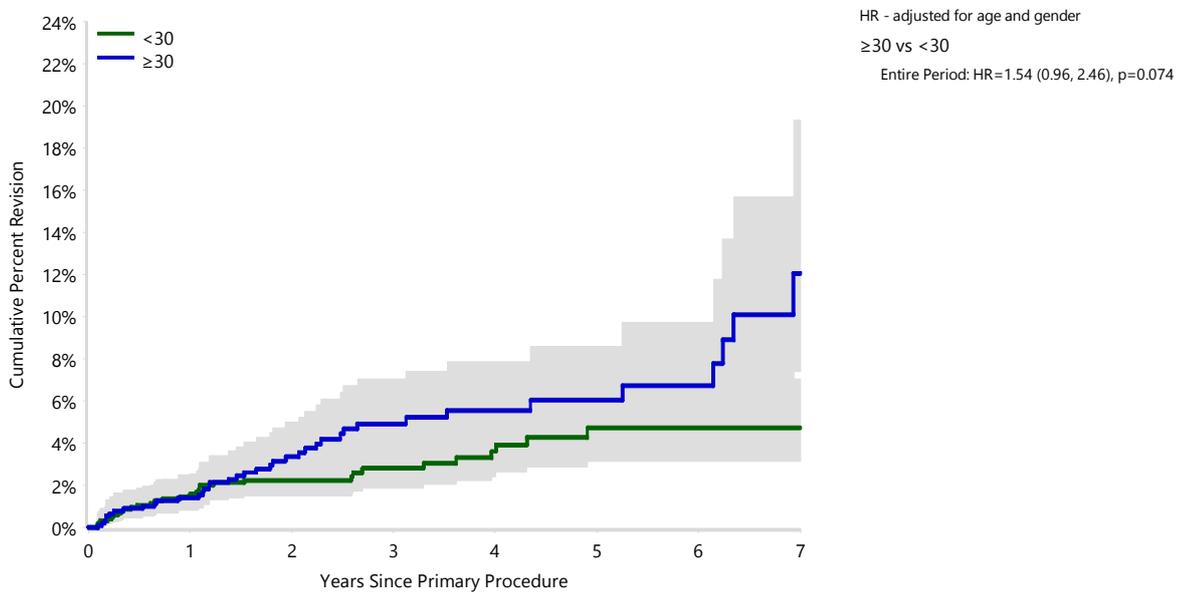
Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	7 Yrs	9 Yrs
ASA 1	263	226	177	136	85	42	17
ASA 2	1404	1115	854	653	374	195	47
ASA 3	821	645	467	332	181	80	19

Table A19 Cumulative Percent Revision of Primary Total Ankle Replacement by BMI Category (Primary Diagnosis OA)

BMI Category	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
Underweight (<18.50)	0	6	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)		
Normal (18.50-24.99)	10	330	1.4 (0.5, 3.6)	2.2 (1.0, 4.8)	3.6 (1.7, 7.3)	4.6 (2.3, 9.1)	5.6 (2.9, 10.9)	
Pre Obese (25.00-29.99)	22	855	1.7 (1.0, 2.9)	2.3 (1.4, 3.7)	2.6 (1.6, 4.1)	3.3 (2.0, 5.3)	4.4 (2.7, 7.3)	4.4 (2.7, 7.3)
Obese Class 1 (30.00-34.99)	27	667	1.4 (0.7, 2.7)	3.2 (2.0, 5.1)	4.7 (3.1, 7.2)	5.1 (3.4, 7.8)	5.1 (3.4, 7.8)	6.0 (3.8, 9.5)
Obese Class 2 (35.00-39.99)	8	201	0.6 (0.1, 4.1)	3.1 (1.2, 8.2)	5.3 (2.4, 11.6)	6.9 (3.2, 14.4)		
Obese Class 3 (≥40.00)	4	68	3.4 (0.9, 12.8)	5.6 (1.8, 16.6)	5.6 (1.8, 16.6)	5.6 (1.8, 16.6)		
TOTAL	71	2127						

Note: BMI has not been presented for patients aged ≤19 years

Figure A11 Cumulative Percent Revision of Primary Total Ankle Replacement by BMI Category (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
<30	1191	928	665	457	315	201	111
≥30	936	713	494	345	233	158	93

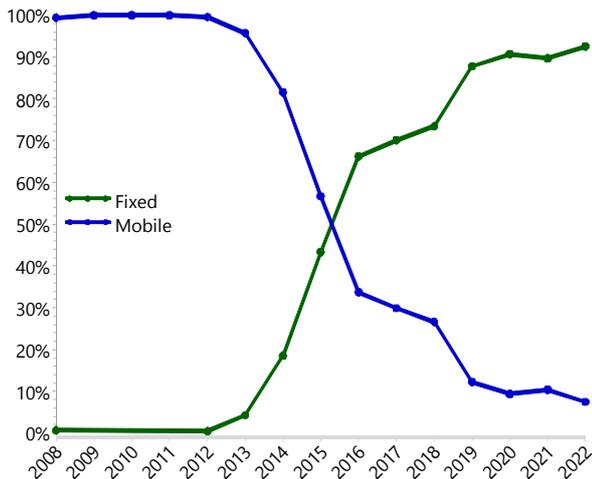
Note: BMI has not been presented for patients aged ≤19 years

PROSTHESIS CHARACTERISTICS

Insert Mobility

Inserts used in primary ankle replacement may be either fixed or mobile. There has been a major change in the type of insert chosen during the last decade. Fixed inserts are now more common for primary total ankle replacements (Figure A12).

Figure A12 Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)



This is the first year in which fixed inserts are used in the majority of primary total ankle replacements (52.0%). Total ankle replacements with fixed inserts have a lower rate of revision compared to mobile inserts (Table A20 and Figure A13).

Fixation

It is not possible to assess the comparative revision rate of cement and cementless fixation as almost all procedures (98%) use cementless fixation for both the tibial and talar components (Table A21).

Approximately 58% of cementless prostheses have an HA coating. Prostheses with an HA coating have a higher rate of revision compared to prostheses without HA (Table A22 and Figure A14). However, there is no difference in revision rate for either fixed or mobile bearing prostheses when those with and without HA coating are compared (Table A23 and Figure A15).

Image Derived Instrumentation (IDI)

IDI has been used in 936 primary total ankle replacement procedures since 2015 (Figure A16). There is no difference in the rate of revision when primary total ankle replacement procedures using IDI are compared to procedures without IDI use (Table A24 and Figure A17). However, the results should be interpreted with caution as IDI is used with a limited number of primary total ankle prostheses.

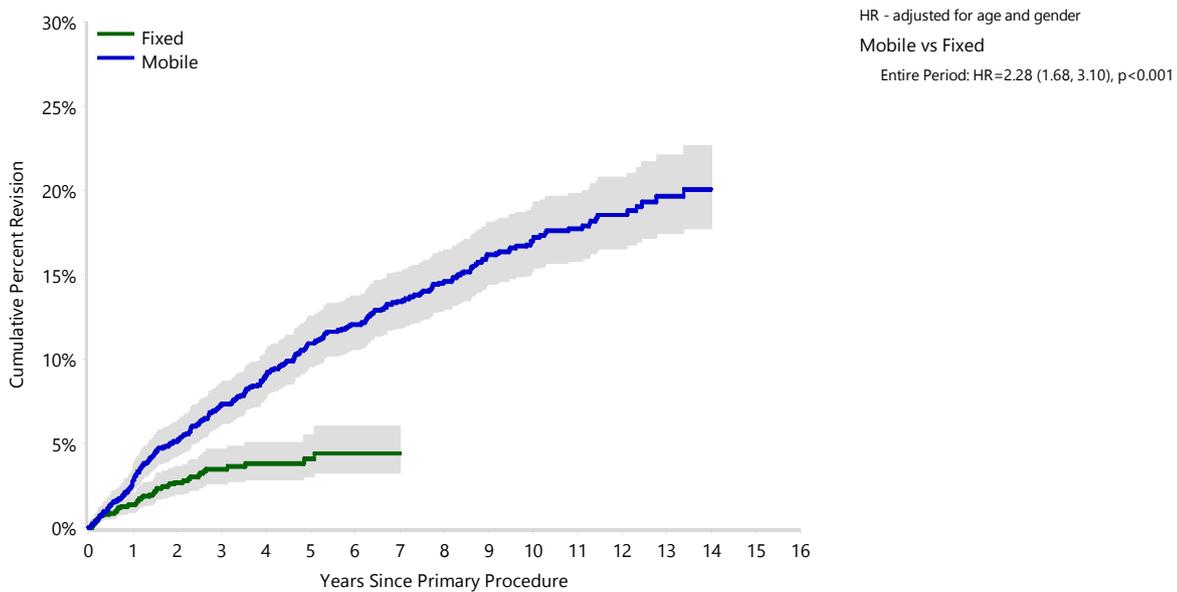
Surgeon Variation

There is some surgeon-related variability in the revision rate of total ankle replacement. The proportions of revisions for surgeons who have undertaken at least 15 ankle procedures since 2015 are shown in Figure A19.

Table A20 Cumulative Percent Revision of Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)

Mobility	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	53	1923	1.4 (0.9, 2.1)	3.5 (2.6, 4.6)	4.1 (3.0, 5.5)	4.4 (3.2, 6.0)		
Mobile	273	1777	2.8 (2.1, 3.7)	7.3 (6.2, 8.7)	10.9 (9.5, 12.6)	13.4 (11.8, 15.2)	17.1 (15.3, 19.2)	20.1 (17.7, 22.7)
TOTAL	326	3700						

Figure A13 Cumulative Percent Revision of Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	1923	1468	694	310	83	2	2
Mobile	1777	1683	1500	1323	1155	736	120

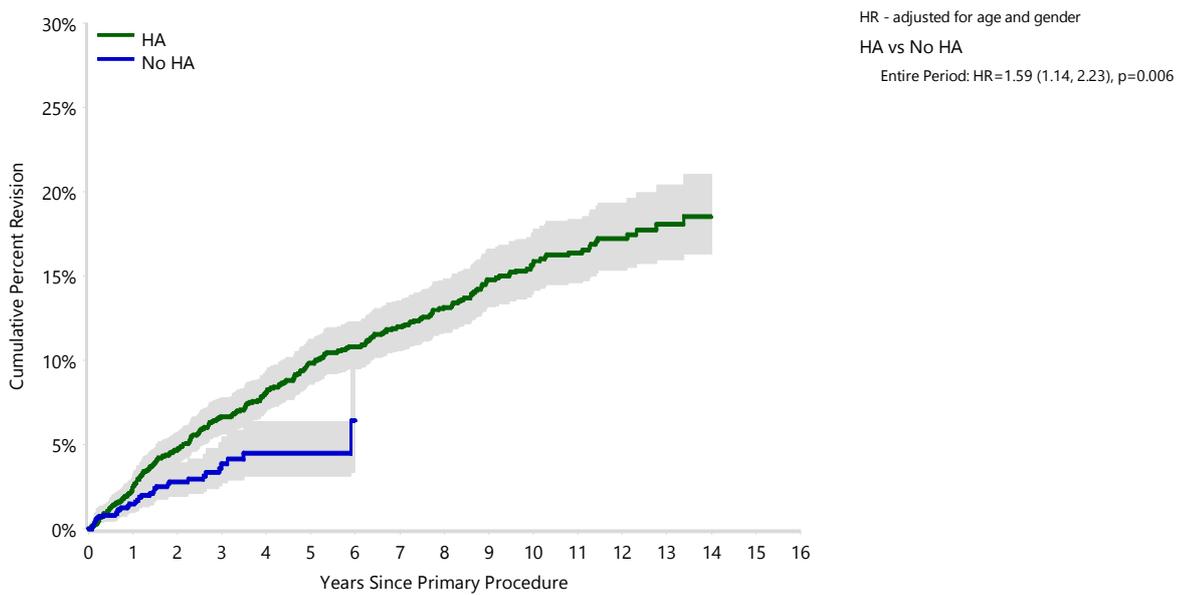
Table A21 Cumulative Percent Revision of Primary Total Ankle Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Cemented	1	25	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	
Cementless	324	3628	2.1 (1.7, 2.7)	5.8 (5.0, 6.7)	8.8 (7.7, 9.9)	11.1 (9.8, 12.5)	14.9 (13.3, 16.7)	18.0 (15.8, 20.4)
Hybrid (Tibial Cemented)	0	19	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
Hybrid (Talus Cemented)	1	28	0.0 (0.0, 0.0)	3.7 (0.5, 23.5)	3.7 (0.5, 23.5)			
TOTAL	326	3700						

Table A22 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Surface Coating (Primary Diagnosis OA)

Coating	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
HA	280	2106	2.5 (1.9, 3.3)	6.6 (5.6, 7.8)	9.8 (8.6, 11.2)	12.0 (10.6, 13.6)	15.8 (14.0, 17.7)	18.5 (16.3, 21.0)
No HA	44	1522	1.5 (1.0, 2.3)	3.9 (2.7, 5.5)	4.5 (3.1, 6.4)			
TOTAL	324	3628						

Figure A14 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Surface Coating (Primary Diagnosis OA)

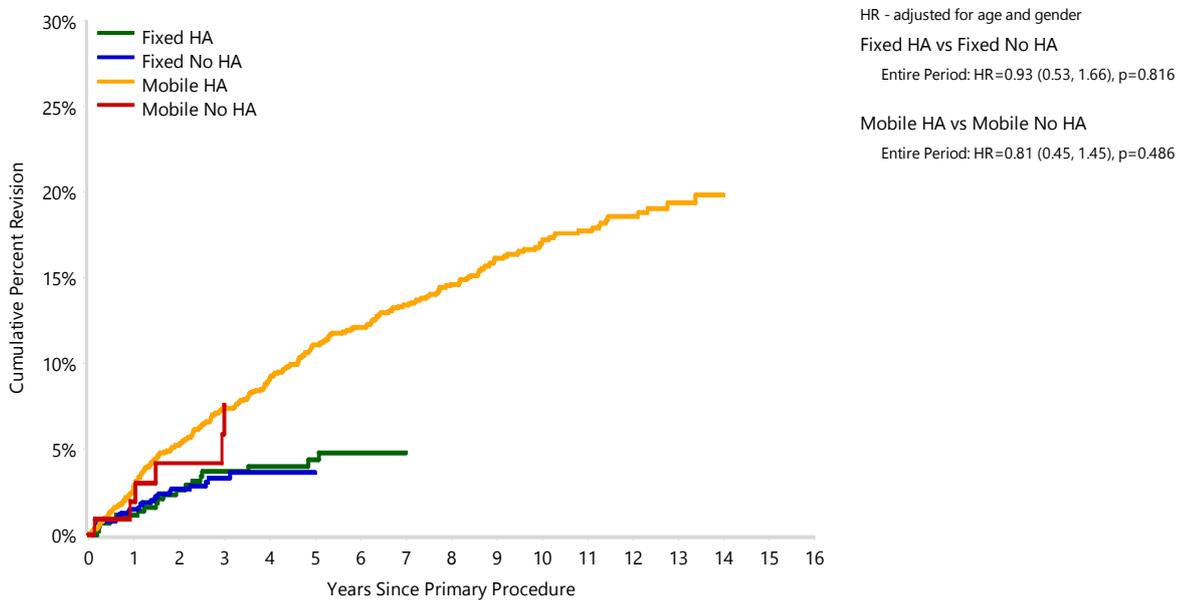


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
HA	2106	1999	1783	1516	1196	728	120
No HA	1522	1087	380	96	30	4	0

Table A23 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Mobility and Surface Coating (Primary Diagnosis OA)

Mobility	Coating	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	HA	19	449	1.1 (0.5, 2.7)	3.7 (2.2, 6.1)	4.4 (2.7, 7.0)	4.8 (3.0, 7.6)		
	No HA	32	1411	1.5 (0.9, 2.3)	3.3 (2.3, 4.8)	3.6 (2.5, 5.3)			
Mobile	HA	261	1657	2.9 (2.2, 3.8)	7.4 (6.2, 8.8)	11.1 (9.6, 12.7)	13.4 (11.8, 15.2)	17.1 (15.2, 19.2)	19.8 (17.5, 22.4)
	No HA	12	111	2.0 (0.5, 7.6)	7.6 (3.4, 16.5)				
TOTAL		324	3628						

Figure A15 Cumulative Percent Revision of Cementless Primary Total Ankle Replacement by Mobility and Surface Coating (Primary Diagnosis OA)



Number at Risk		0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Fixed	HA	449	419	346	238	78	1	1
	No HA	1411	993	326	60	0	0	0
Mobile	HA	1657	1580	1437	1278	1118	727	119
	No HA	111	94	54	36	30	4	0

Figure A16 Primary Total Ankle Replacement by IDI Usage (Primary Diagnosis OA)

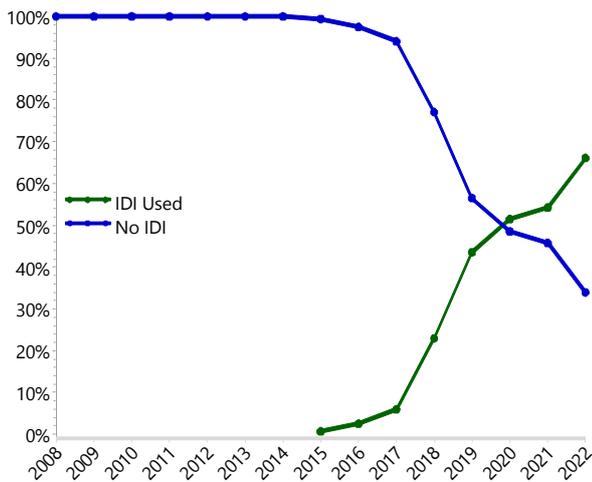
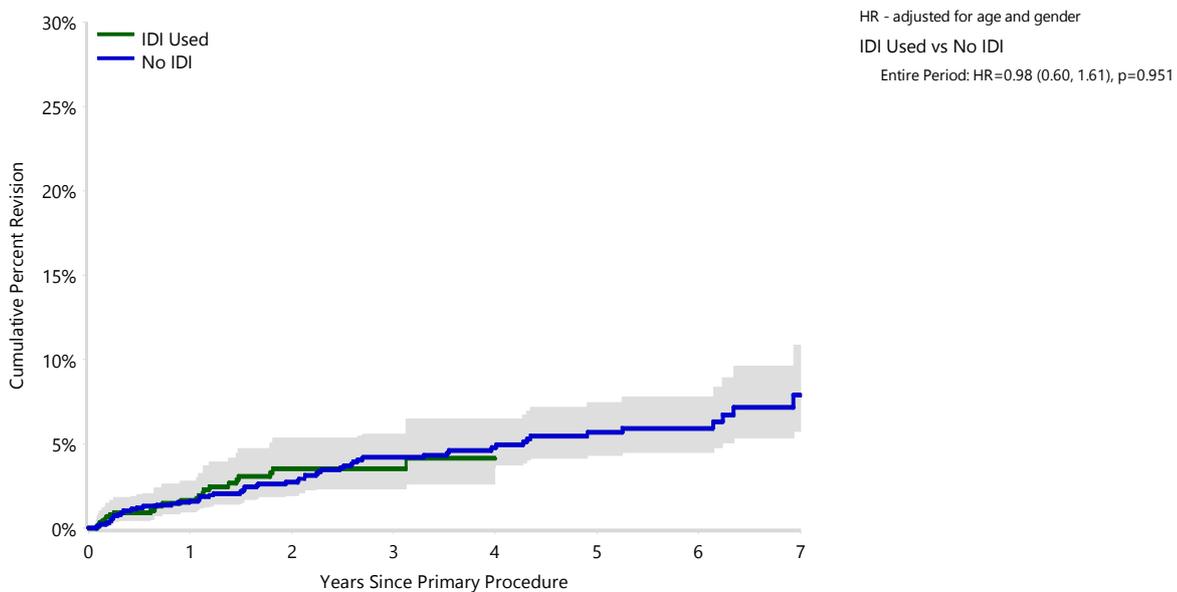


Table A24 Cumulative Percent Revision of Primary Total Ankle Replacement Since 2015 by IDI Usage (Primary Diagnosis OA)

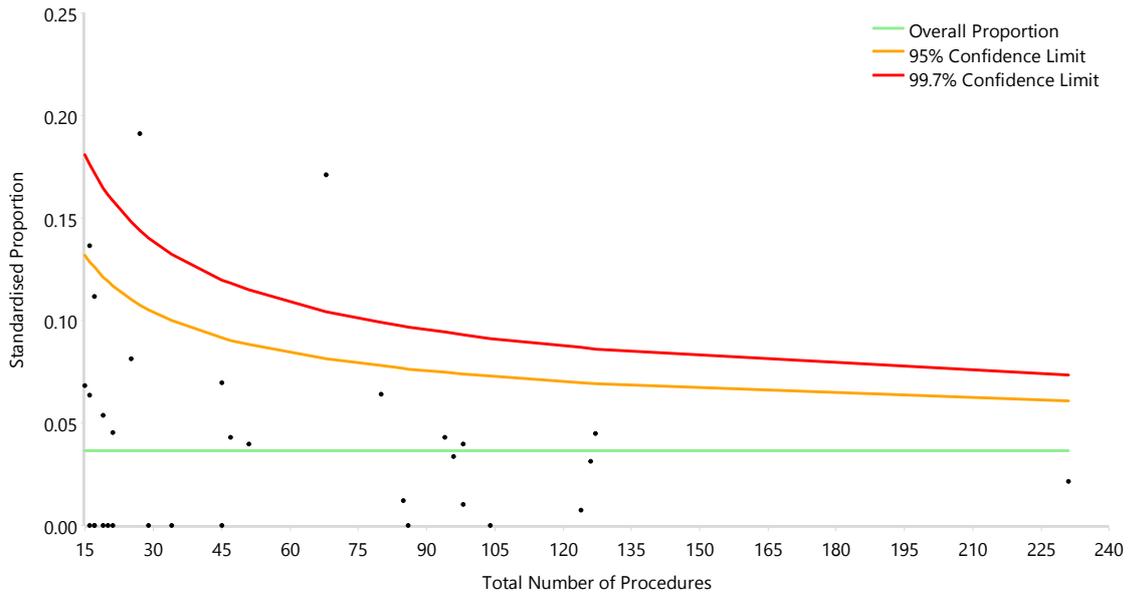
IDI Usage	N Revised	N Total	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
IDI Used	24	936	1.6 (0.9, 2.8)	3.5 (2.3, 5.4)	3.5 (2.3, 5.4)	4.1 (2.6, 6.5)		
No IDI	60	1352	1.6 (1.1, 2.5)	2.7 (1.9, 3.8)	4.2 (3.1, 5.6)	4.8 (3.6, 6.3)	5.7 (4.3, 7.5)	5.9 (4.5, 7.8)
TOTAL	84	2288						

Figure A17 Cumulative Percent Revision of Primary Total Ankle Replacement Since 2015 by IDI Usage (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs
IDI Used	936	618	357	173	63	14	4
No IDI	1352	1171	940	747	588	429	261

Figure A18 Funnel Plot of Revision of Primary Total Ankle Replacement Since 2015 by Surgeon (Primary Diagnosis OA)



DEMOGRAPHICS OF ALL REVISIONS

This report analyses 698 revisions of ankle replacements with a procedure date up to and including 31 December 2022. This is an additional 59 procedures compared to the previous report.

TYPE OF REVISION

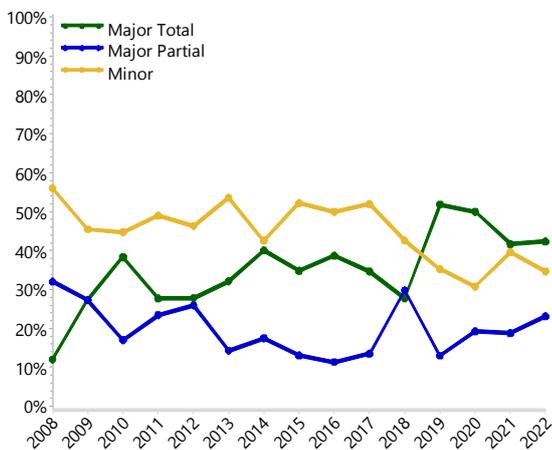
The majority of revisions recorded by the Registry are major revisions (55.4%) (Table A25).

The proportion of revisions that are major total, major partial and minor revisions has changed since 2008. In 2008, 32.0% of ankle revisions performed were major partial revisions, and this has decreased to 23.1%. The proportion of minor revisions has also decreased over this time. The proportion of major total revisions has increased, from 12.0% of revisions performed in 2008 to 42.3% of revisions performed in 2022 (Figure A19).

REASON FOR REVISION

Overall, the most common reasons for revision are loosening (32.5%), infection (12.6%), implant breakage of the ankle insert (11.2%), and lysis (9.0%) (Table A26).

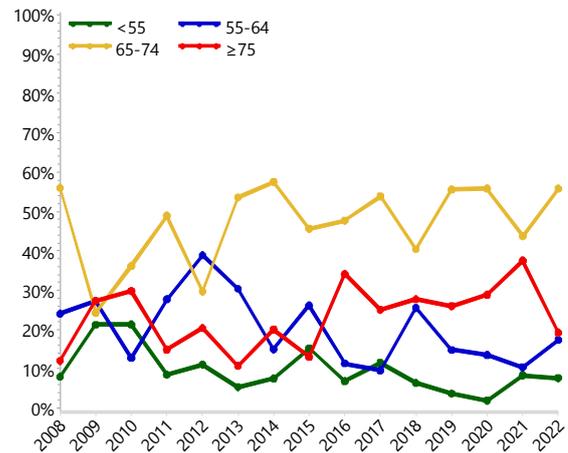
Figure A19 Revision Ankle Replacement by Class



AGE AND GENDER

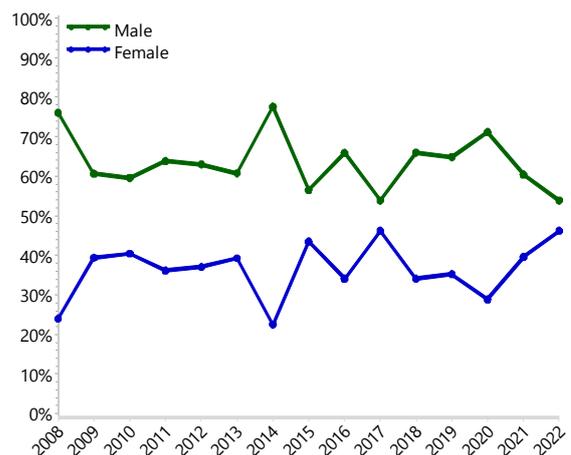
Compared to 2008, there has been an increase in the proportion of revision procedures in patients aged ≥ 75 years and a decrease in the proportion of procedures in patients aged 55-64 years (Figure A20).

Figure A20 Revision Ankle Replacement by Age



Revision ankle replacement is more common in males (62.9%). There has been a decrease in the proportion of males undergoing revisions since 2008 (Figure A21).

Figure A21 Revision Ankle Replacement by Gender

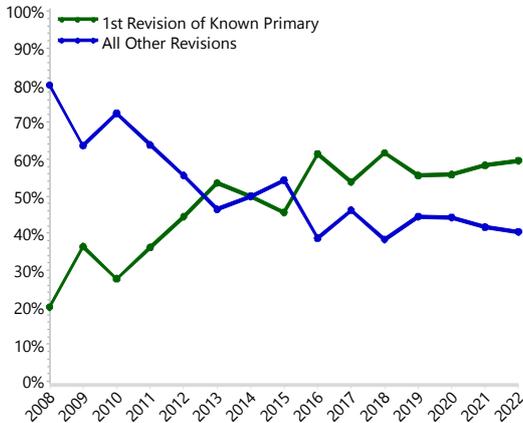


DEMOGRAPHICS OF 1ST REVISIONS OF KNOWN PRIMARY PROCEDURES

There have been 344 1st revision procedures where the primary procedure has been recorded by the Registry. This includes revisions of all primary total ankle replacements (Figure A22).

There are a higher proportion of minor revisions in the 1st revisions of known primary procedures group (49.7%) compared to the all revisions group (44.6%) (Table A25).

Figure A22 Ankle Replacement by Revision



REASON FOR REVISION

There are differences in the reasons for revision between the 1st revisions of known primary procedures group and the all revisions group. Loosening is the most common reason for revision in both groups, but the proportion is lower in the 1st revisions of known primary procedures group (30.2% compared to 32.5%). There is a smaller proportion of implant breakage ankle insert in the 1st revisions group (9.0%) compared to the all revisions group (11.2%). Other diagnoses such as infection, lysis, instability and pain are slightly higher in the 1st revisions of known primary procedures group (Table A26).

TYPE OF REVISION

The '1st revisions of known primary procedures' group and the 'all revisions' group differ in the types of revisions recorded.

The 1st revisions of known primary procedures group has a slightly smaller proportion of major revisions (50.3%) compared to the all revisions group (55.4%). There are less arthrodesis, tibial/talar and talar only replacements, but more tibial only revisions (Table A25).

Table A25 Revision Ankle Replacement by Type of Revision

Type of Revision	1st Revision of Known Primary		All Revisions	
	Number	Percent	Number	Percent
Tibial/Talar	52	15.1	125	17.9
Arthrodesis	46	13.4	127	18.2
Tibial Only	35	10.2	45	6.4
Talar Only	20	5.8	43	6.2
Cement Spacer	15	4.4	32	4.6
Removal of Prostheses	5	1.5	15	2.1
N Major	173	50.3	387	55.4
Insert Only	165	48.0	303	43.4
Minor Components	6	1.7	8	1.1
N Minor	171	49.7	311	44.6
TOTAL	344	100.0	698	100.0

Table A26 Revision Ankle Replacement by Reason for Revision

Reason for Revision	1st Revision of Known Primary		All Revisions	
	Number	Percent	Number	Percent
Loosening	104	30.2	227	32.5
Infection	46	13.4	88	12.6
Lysis	33	9.6	63	9.0
Instability	32	9.3	57	8.2
Implant Breakage Ankle Insert	31	9.0	78	11.2
Pain	21	6.1	37	5.3
Impingement	18	5.2	40	5.7
Fracture	16	4.7	22	3.2
Prosthesis Dissociation	8	2.3	17	2.4
Arthrofibrosis	6	1.7	11	1.6
Malalignment	6	1.7	10	1.4
Wear Ankle Insert	6	1.7	11	1.6
Heterotopic Bone	4	1.2	6	0.9
Synovitis	3	0.9	3	0.4
Implant Breakage Tibial	2	0.6	2	0.3
Incorrect Sizing	2	0.6	2	0.3
Metal Related Pathology	1	0.3	1	0.1
Osteonecrosis	1	0.3	3	0.4
Tumour	1	0.3	2	0.3
Avascular Talus			1	0.1
Cysts			1	0.1
Fusion/Arthrodesis			1	0.1
Malposition			1	0.1
Prosthesis Dislocation			1	0.1
Valgus Deformity			1	0.1
Other	3	0.9	12	1.7
TOTAL	344	100.0	698	100.0

OUTCOME OF 1ST REVISION OF KNOWN PRIMARY ANKLE REPLACEMENT

This analysis reports the outcome of the 1st revision of a known primary total ankle replacement.

There is no difference in the rate of 2nd revision when the classes of 1st revision are compared (Table A27 and Figure A23).

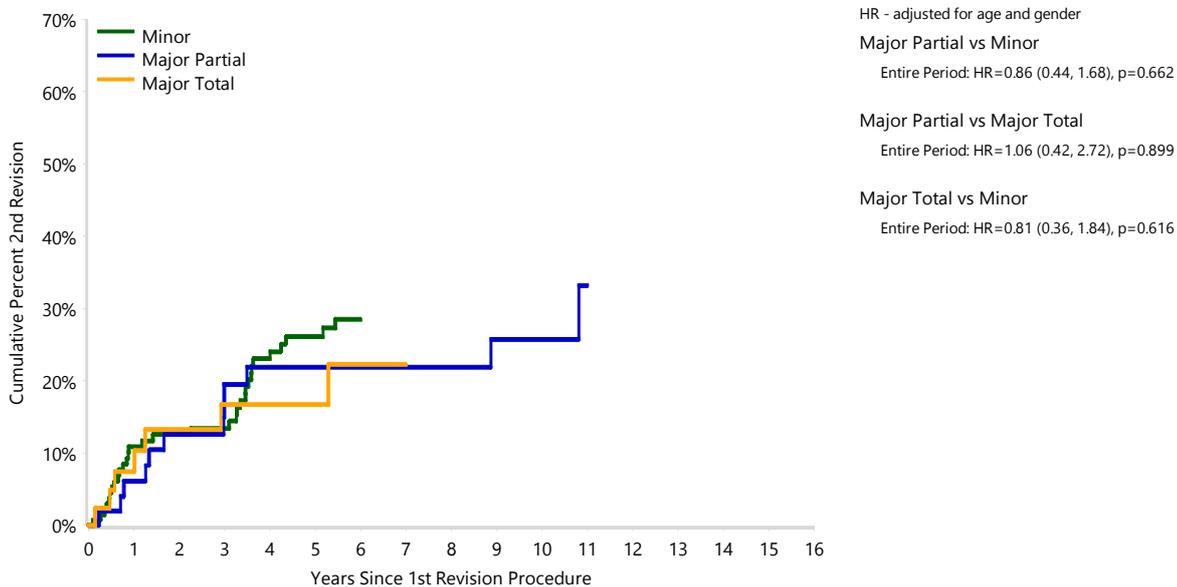
There are 228 1st revisions of primary total ankle replacements undertaken for osteoarthritis, excluding all procedures with a 1st revision for infection or where no tibial or talar components have been inserted.

Table A27 Cumulative Percent 2nd Revision of Known Primary Total Ankle Replacement by Class of 1st Revision (Primary Diagnosis OA, Excluding 1st Revision for Infection)

Class of 1st Revision	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Minor	32	133	10.9 (6.6, 17.8)	13.5 (8.6, 20.8)	26.1 (18.9, 35.3)			
Major Partial	12	51	6.2 (2.0, 18.0)	19.5 (10.6, 34.2)	21.9 (12.4, 37.0)	21.9 (12.4, 37.0)	25.8 (14.9, 42.5)	
Major Total	7	44	7.5 (2.5, 21.4)	16.7 (7.8, 33.8)	16.7 (7.8, 33.8)	22.3 (10.7, 42.8)		
TOTAL	51	228						

Note: Excluding revisions where no minor or major tibial/talar components have been inserted

Figure A23 Cumulative Percent 2nd Revision of Known Primary Total Ankle Replacement by Class of 1st Revision (Primary Diagnosis OA, Excluding 1st Revision for Infection)



Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	14 Yrs
Minor	133	110	91	64	39	12	1
Major Partial	51	44	35	26	22	15	0
Major Total	44	32	24	15	7	2	0

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The AOANJRR is funded by the Australian Government Department of Health and Aged Care