Australian Orthopaedic Association National Joint Replacement Registry

2022 Demographics and Outcome of Ankle Arthroplasty Supplementary Report

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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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Contents

Introduction

This Ankle Arthroplasty Supplementary Report is based on the analysis of 4,087 ankle procedures recorded by the Registry with a procedure date from 2006 up to and including 31 December 2021.

This Report is one of 15 supplementary reports to complete the AOANJRR Annual Report for 2022.

Information on the background, purpose, aims, benefits and governance of the Registry can be found in the Introductory chapter of the 2022 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 chapter of the 2022 Hip, Knee and Shoulder Arthroplasty Annual Report: https://aoanjrr.sahmri.com/annual-reports-2022

Ankle Replacement

CATEGORIES OF ANKLE REPLACEMENT

The Registry groups ankle replacement into two broad categories: primary total and revision ankle replacement.

A primary total ankle replacement is the initial replacement procedure undertaken and involves 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 as well as the insert. 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 would like to collect. 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 4,087 ankle replacement procedures (3,448 primaries (84.4%) and 639 revisions (15.6%). This excludes 2 primary partial resurfacing ankle replacements from 2008.

Ankle replacement is more frequently undertaken in males (61.0%). The overall mean age is 67.1 years and the most common age groups for male and female patients are 65-69 years and 70-74 years, respectively (Table A1 to Table A3, and Figure A1).

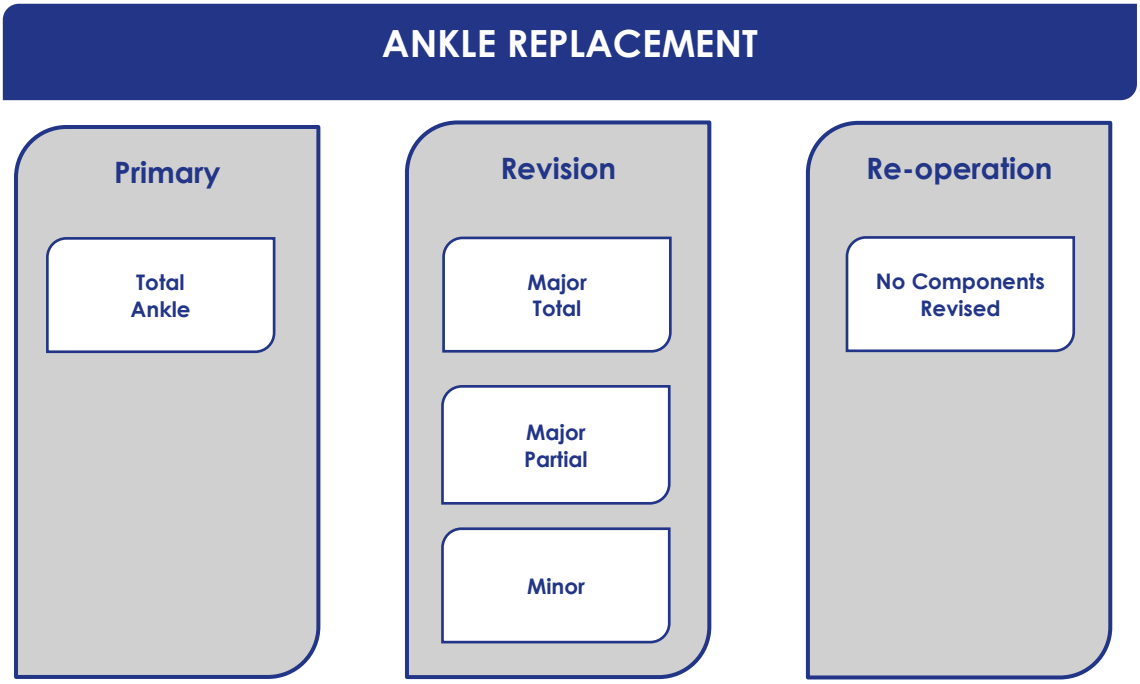


Table A1 Number of Ankle Replacements by Gender

	Male		Female		TOTAL	
Ankle Replacement	N	Row%	N	Row%	N	Row%
Primary Total	2088	60.6	1360	39.4	3448	100.0
Revision	404	63.2	235	36.8	639	100.0
TOTAL	**2492**	**61.0**	**1595**	**39.0**	**4087**	**100.0**

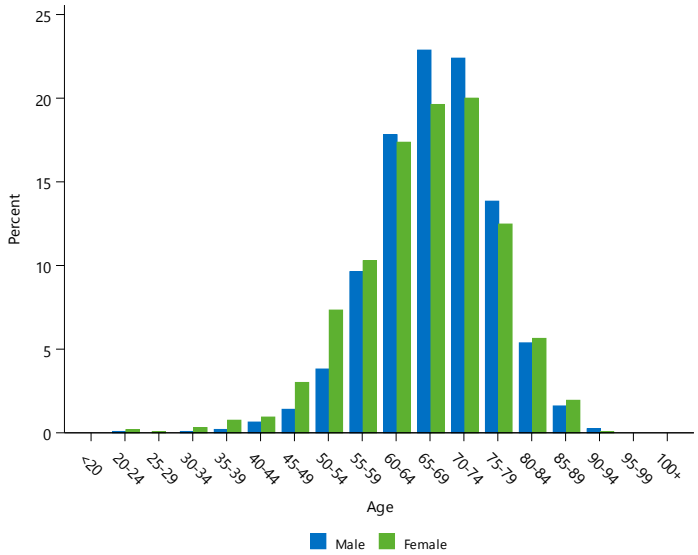
Table A2 Number of Ankle Replacements by Age

	<55		55-64		65-74		75-84		≥85		TOTAL	
Ankle Replacement	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%	N	Row%
Primary Total	295	8.6	993	28.8	1466	42.5	628	18.2	66	1.9	3448	100.0
Revision	61	9.5	132	20.7	294	46.0	140	21.9	12	1.9	639	100.0
TOTAL	**356**	**8.7**	**1125**	**27.5**	**1760**	**43.1**	**768**	**18.8**	**78**	**1.9**	**4087**	**100.0**

Table A3 Age and Gender of Ankle Replacement

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	1595	39.0%	20	90	67	66.2	10.0
Male	2492	61.0%	23	94	68	67.7	8.6
TOTAL	**4087**	**100.0%**	**20**	**94**	**68**	**67.1**	**9.2**

Figure A1 Ankle Replacement by Age and Gender



Primary Total Ankle Replacement

DEMOGRAPHICS

There have been 3,448 primary total ankle replacements reported to the Registry. This is an additional 499 procedures since the last report. The use of total ankle replacement was highest in 2021 and lowest in 2014. There has been a 211.0% increase in the use of ankle replacement since 2014. In 2021, there was a 24.9% increase in the number of total ankle replacements compared to 2020 (Figure A2). The principal primary diagnosis is osteoarthritis (93.7%) (Table A4).

Figure A2 Number of Primary Total Ankle Replacement

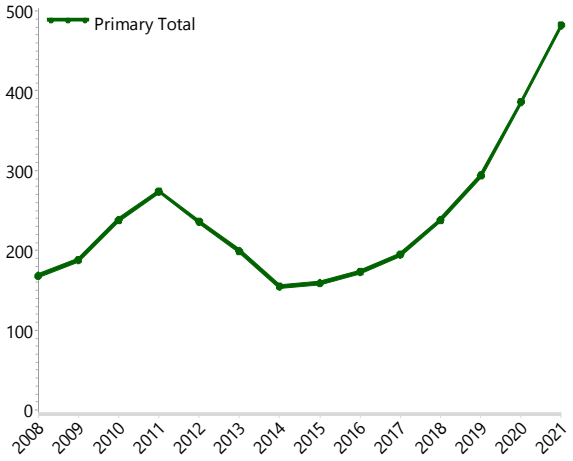
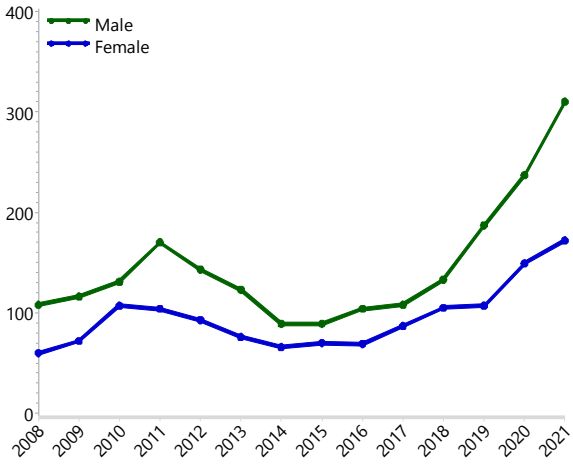


Table A4 Primary Total Ankle Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	3230	93.7
Rheumatoid Arthritis	162	4.7
Other Inflammatory Arthritis	23	0.7
Instability	11	0.3
Fracture/Dislocation	6	0.2
Osteonecrosis	5	0.1
Tumour	2	0.1
Other	9	0.3
TOTAL	**3448**	**100.0**

Overall, 60.6% 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 Primary Total Ankle Replacement by Gender



The median age is 67 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 (Figure A4).

Figure A4 Primary Total Ankle Replacement by Age

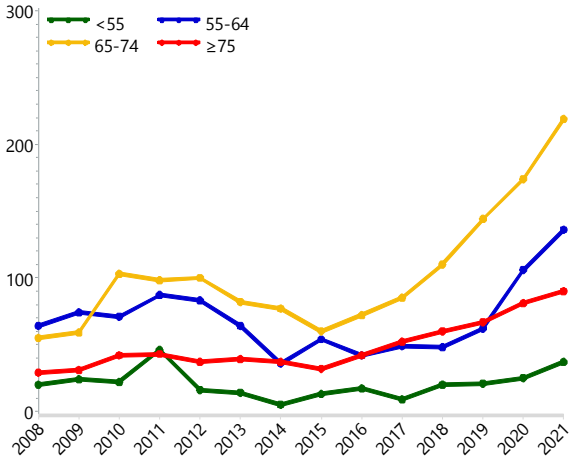


Table A5 Age and Gender of Primary Total Ankle Replacement

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	1360	39.4%	20	90	67	66.1	10.0
Male	2088	60.6%	23	94	68	67.5	8.6
TOTAL	**3448**	**100.0%**	**20**	**94**	**67**	**67.0**	**9.2**

ASA AND BMI

ASA scores are an indication of comorbidity and have been collected since 2012. The Registry has ASA data on 2,169 primary total ankle replacement procedures (Table A6).

BMI data have been collected since 2015. There are BMI data on 1,770 primary total ankle replacement procedures (Table A7).

BILATERAL PROCEDURES

The Registry has recorded 218 bilateral ankle replacements, 13.3% 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	233	10.7
ASA 2	1185	54.6
ASA 3	728	33.6
ASA 4	23	1.1
TOTAL	**2169**	**100.0**

Table A7 BMI Category for Primary Total Ankle Replacement

BMI Category	Number	Percent
Underweight	7	0.4
Normal	277	15.6
Pre Obese	729	41.2
Obese Class 1	539	30.5
Obese Class 2	155	8.8
Obese Class 3	63	3.6
TOTAL	**1770**	**100.0**

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	1.8	29	13.3	185	84.9	218	100.0
TOTAL	**4**	**1.8**	**29**	**13.3**	**185**	**84.9**	**218**	**100.0**

Table A9 Most Used Tibial Prostheses in Primary Total Ankle Replacement

2008		2017		2018		2019		2020		2021	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	86	Salto Talaris	70	Salto Talaris	137	Infinity	199	Infinity	257	Infinity
34	Hintermann Series H3	25	Hintermann Series H3	69	Infinity	52	Salto Talaris	80	Trabecular Metal	87	Trabecular Metal
18	Buechel-Pappas	22	Trabecular Metal	30	Hintermann Series H3	41	Trabecular Metal	40	Inbone	47	Salto Talaris
11	Salto	21	Salto	21	Inbone	26	Inbone	31	Salto Talaris	39	Inbone
6	BOX	14	Infinity	21	Salto	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3
1	Ankle Joint (Eska)	14	Zenith	17	Trabecular Metal	13	Hintermann Series H3	15	Vantage	22	Vantage
		13	Inbone	9	Zenith	4	Salto	1	Salto	4	Zenith
				1	S.T.A.R	4	Zenith			1	Invision
										1	Salto
10 Most Used											
168	(6) 100.0%	195	(7) 100.0%	238	(8) 100.0%	294	(8) 100.0%	386	(7) 100.0%	482	(9) 100.0%
Remainder											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%
TOTAL											
168	(6) 100.0%	195	(7) 100.0%	238	(8) 100.0%	294	(8) 100.0%	386	(7) 100.0%	482	(9) 100.0%

Table A10 Most Used Talar Prostheses in Primary Total Ankle Replacement

2008		2017		2018		2019		2020		2021	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
98	Mobility	86	Salto Talaris	70	Salto Talaris	107	Infinity	128	Infinity	192	Infinity
34	Hintermann Series H3	25	Hintermann Series H3	58	Infinity	54	Inbone	108	Inbone	103	Inbone
18	Buechel-Pappas	22	Trabecular Metal	32	Inbone	52	Salto Talaris	80	Trabecular Metal	87	Trabecular Metal
11	Salto	21	Salto	30	Hintermann Series H3	41	Trabecular Metal	31	Salto Talaris	47	Salto Talaris
6	BOX	16	Inbone	21	Salto	17	Vantage	20	Hintermann Series H3	24	Hintermann Series H3
1	Ankle Joint (Eska)	14	Zenith	17	Trabecular Metal	13	Hintermann Series H3	15	Vantage	22	Vantage
		11	Infinity	9	Zenith	4	Salto	3	Invision	4	Zenith
				1	S.T.A.R	4	Zenith	1	Salto	2	Invision
						2	Invision			1	Salto
10 Most Used											
168	(6) 100.0%	195	(7) 100.0%	238	(8) 100.0%	294	(9) 100.0%	386	(8) 100.0%	482	(9) 100.0%
Remainder											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%
TOTAL											
168	(6) 100.0%	195	(7) 100.0%	238	(8) 100.0%	294	(9) 100.0%	386	(8) 100.0%	482	(9) 100.0%

OUTCOME FOR ALL DIAGNOSES

PRIMARY DIAGNOSIS

The cumulative percent revision for osteoarthritis at 10 years is 15.5%. 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 27.8% 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 (49.2%) (Table A13).

CHANGE IN OUTCOME OVER TIME

There has been a large 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

The Registry has recorded 48 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

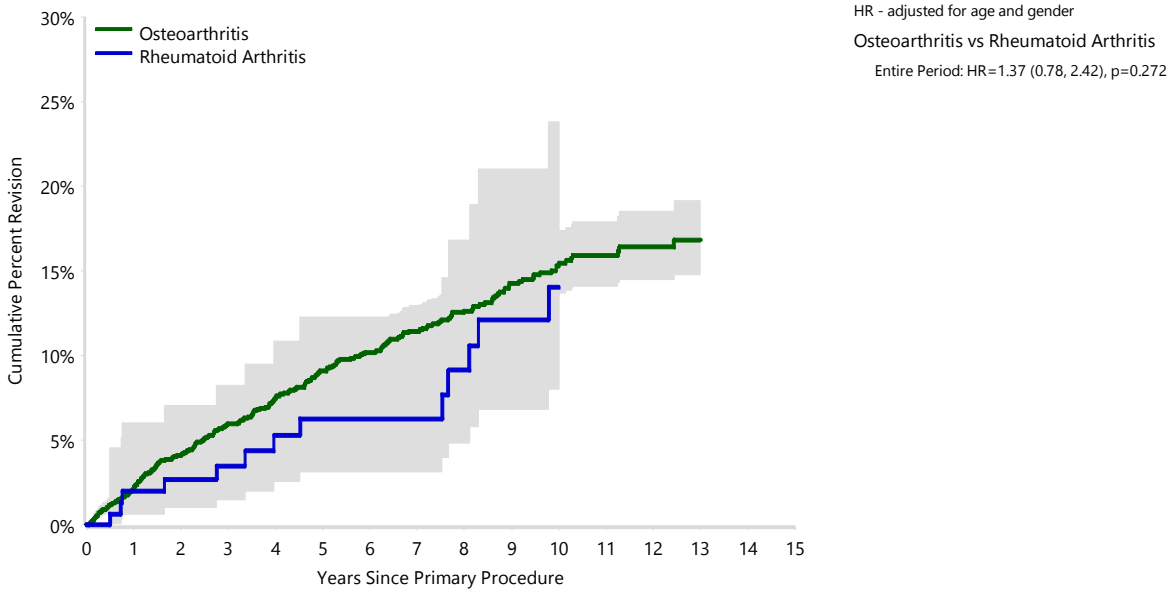
The outcomes of different prosthesis types are listed in Table A15.

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	13 Yrs
Osteoarthritis	292	3230	2.2 (1.7, 2.8)	6.0 (5.1, 7.0)	9.1 (8.0, 10.4)	11.4 (10.1, 12.9)	15.5 (13.7, 17.4)	16.8 (14.8, 19.1)
Rheumatoid Arthritis	13	162	2.0 (0.6, 6.0)	3.5 (1.5, 8.2)	6.3 (3.2, 12.3)	6.3 (3.2, 12.3)	14.0 (8.0, 23.8)	
Other Inflammatory Arthritis	1	23	0.0 (0.0, 0.0)	5.0 (0.7, 30.5)	5.0 (0.7, 30.5)	5.0 (0.7, 30.5)	5.0 (0.7, 30.5)	
Instability	3	11	9.1 (1.3, 49.2)	9.1 (1.3, 49.2)	9.1 (1.3, 49.2)	22.1 (5.8, 64.6)		
Other (4)	0	22	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	**309**	**3448**						

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	13 Yrs
Osteoarthritis	3230	2684	1936	1462	1116	588	126
Rheumatoid Arthritis	162	142	118	89	70	40	9

Note: Only primary diagnoses with over 25 procedures have been listed

Table A12 Reason for Revision of Primary Total Ankle Replacement

Revision Diagnosis	Number	Percent
Loosening	86	27.8
Infection	38	12.3
Lysis	32	10.4
Instability	31	10.0
Implant Breakage Ankle Insert	27	8.7
Pain	21	6.8
Impingement	17	5.5
Fracture	15	4.9
Prosthesis Dissociation	8	2.6
Malalignment	6	1.9
Wear Ankle Insert	6	1.9
Arthrofibrosis	5	1.6
Heterotopic Bone	4	1.3
Synovitis	3	1.0
Implant Breakage Tibial	2	0.6
Incorrect Sizing	2	0.6
Metal Related Pathology	1	0.3
Tumour	1	0.3
Osteonecrosis	1	0.3
Other	3	1.0
TOTAL	**309**	**100.0**

Table A13 Type of Revision of Primary Total Ankle Replacement

Type of Revision	Number	Percent
Insert Only	152	49.2
Arthrodesis	44	14.2
Tibial/Talar	39	12.6
Tibial Only	33	10.7
Talar Only	18	5.8
Cement Spacer	14	4.5
Minor Components	5	1.6
Removal of Prostheses	4	1.3
TOTAL	**309**	**100.0**

Figure A6 Cumulative Incidence Revision Diagnosis of Primary Total Ankle Replacement

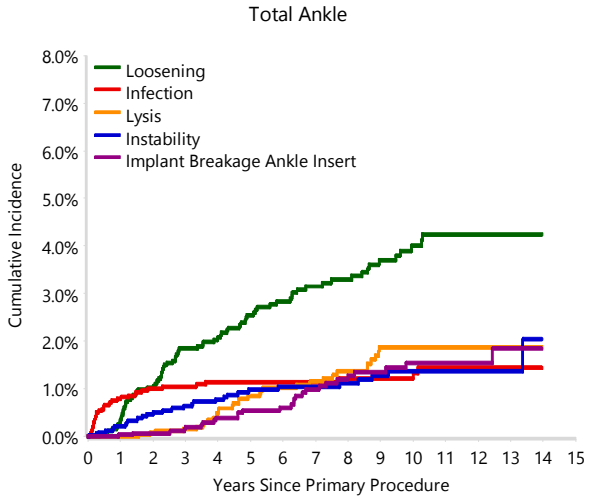
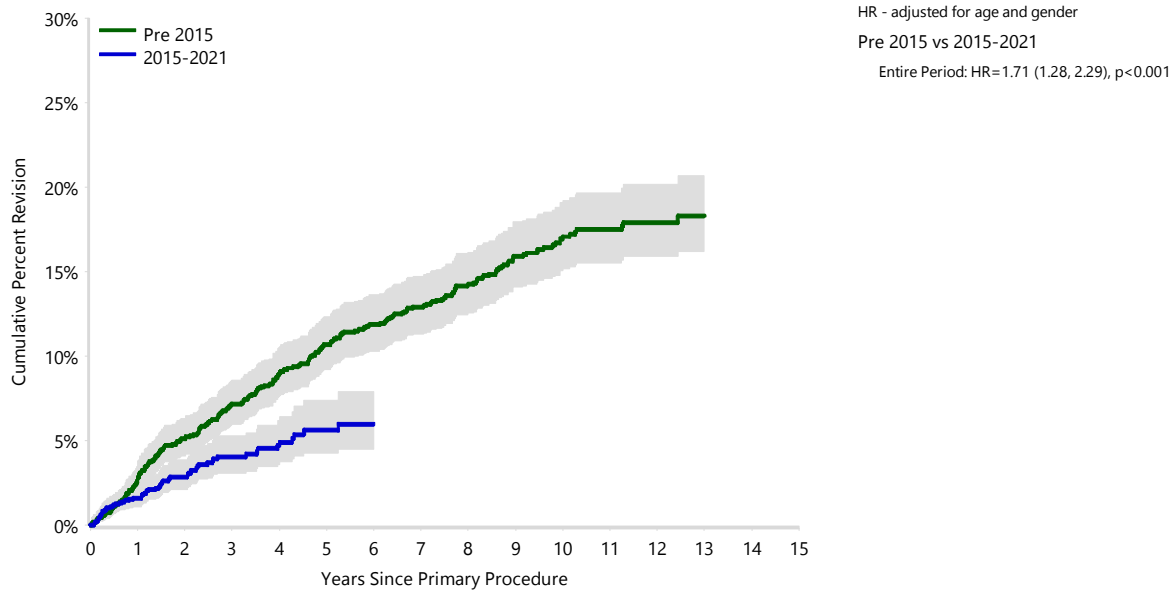


Table A14 Cumulative Percent Revision of Primary Total Ankle Replacement by Period

Period	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
Pre 2015	243	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)	17.1 (15.2, 19.2)	18.3 (16.2, 20.7)
2015-2021	66	1927	1.6 (1.1, 2.3)	4.1 (3.1, 5.3)	5.6 (4.3, 7.4)			
TOTAL	**309**	**3448**						

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	13 Yrs
Pre 2015	1521	1467	1376	1289	1208	639	136
2015-2021	1927	1407	715	294	0	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	13 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)	15.5 (9.5, 24.7)	
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	85	517	4.3 (2.9, 6.5)	8.6 (6.5, 11.5)	12.0 (9.4, 15.4)	16.2 (13.0, 20.0)	21.2 (17.3, 25.8)	
Inbone	Inbone	5	139	2.5 (0.8, 7.7)					
Infinity	Inbone	3	180	0.6 (0.1, 4.1)					
	Infinity	10	499	1.4 (0.6, 3.1)	3.6 (1.8, 7.2)				
Mobility	Mobility*	85	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)	15.0 (12.2, 18.4)	16.4 (13.4, 20.0)
S.T.A.R	S.T.A.R*	11	49	4.1 (1.0, 15.5)	12.6 (5.8, 25.8)	14.7 (7.3, 28.4)	22.3 (12.6, 37.8)		
Salto	Salto	52	421	2.2 (1.1, 4.1)	5.5 (3.7, 8.2)	9.0 (6.6, 12.3)	12.1 (9.2, 15.8)	15.1 (11.6, 19.7)	
Salto Talaris	Salto Talaris	17	478	1.3 (0.6, 2.9)	3.1 (1.8, 5.3)	4.4 (2.6, 7.2)			
Trabecular Metal	Trabecular Metal	4	262	1.3 (0.4, 4.1)	2.5 (0.8, 7.3)				
Vantage	Vantage	0	54	0.0 (0.0, 0.0)					
Zenith	Zenith	11	87	2.4 (0.6, 9.2)	6.1 (2.6, 14.0)	13.7 (7.6, 24.1)	13.7 (7.6, 24.1)		
Other (7)		1	17	0.0 (0.0, 0.0)	7.7 (1.1, 43.4)	7.7 (1.1, 43.4)	7.7 (1.1, 43.4)	7.7 (1.1, 43.4)	7.7 (1.1, 43.4)
TOTAL		**309**	**3448**						

Note: Only prostheses with over 40 procedures have been listed

*denotes prosthesis combinations that have not had any reported use in primary total ankle procedures in 2021

OUTCOME FOR OSTEOARTHRITIS

AGE AND GENDER

Age at the time of surgery is a risk factor for revision. Patients aged ≥75 years have a lower rate of revision compared to patients aged <55 years and 55-64 years (Table A16 and Figure A9).

There is no difference in the rate of revision between males and females (Table A17 and Figure A10).

ASA AND BMI

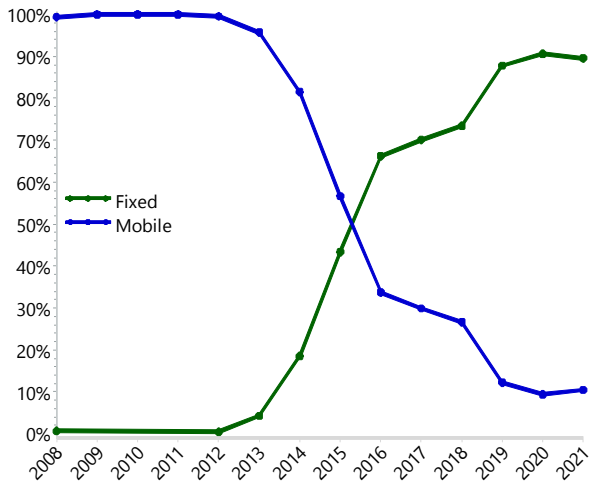
ASA is not a risk factor for revision (Table A18 and Figure A11).

As the number of procedures in each BMI category is relatively small, an analysis of combined BMI categories (underweight-pre-obese vs obese categories 1-3) was undertaken. BMI does not appear to be a risk factor for revision (Table A19 and Figure A12).

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 the insert of choice for most primary total ankle replacements (Figure A8).

Figure A8 Primary Total Ankle Replacement by Mobility (Primary Diagnosis OA)



Although there has been an increase in the use of fixed inserts, the majority of primary total ankle replacements reported to the Registry have used a mobile insert (53.9%). As the increased use of fixed inserts is more recent, the follow-up of this group is shorter. Fixed inserts have a lower rate of revision compared to mobile inserts for the first 5 years (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 are undertaken using cementless fixation of both the tibial and talar components (Table A21).

Approximately 65% of cementless prostheses have a HA coating. There is no difference in the rate of revision when prostheses with HA and non-HA coatings are compared (Table A22 and Figure A14). There is also no difference in outcome when HA and non-HA prostheses in either the fixed or mobile class are compared (Table A23 and Figure A15).

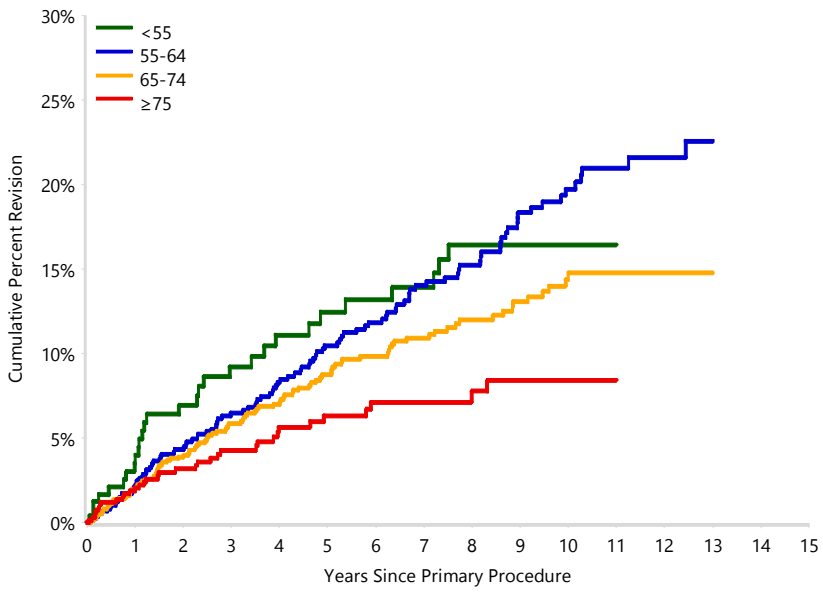
SURGEON VARIATION

As the outcome of ankle replacement procedures undertaken since 2015 are better than pre-2015, surgeon variation data has been presented from 2015 to 2021. Deidentified outcomes of surgeons who have undertaken at least 15 ankle procedures since 2015 have been compared (Figure A16).

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	13 Yrs
<55	30	244	4.0 (2.1, 7.5)	9.2 (6.0, 14.1)	12.5 (8.5, 18.1)	13.9 (9.6, 20.0)	16.4 (11.6, 23.0)	
55-64	115	928	2.1 (1.3, 3.3)	6.5 (4.9, 8.5)	10.5 (8.4, 13.1)	14.0 (11.5, 17.1)	19.7 (16.4, 23.6)	22.6 (18.6, 27.3)
65-74	112	1387	2.0 (1.4, 3.0)	5.9 (4.6, 7.5)	8.7 (7.1, 10.8)	10.9 (9.0, 13.3)	14.8 (12.1, 17.9)	14.8 (12.1, 17.9)
≥75	35	671	2.1 (1.2, 3.5)	4.3 (2.9, 6.4)	6.3 (4.4, 9.0)	7.1 (5.0, 10.1)	8.4 (5.9, 12.1)	
TOTAL	**292**	**3230**						

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



HR - adjusted for gender

<55 vs ≥75

Entire Period: HR=2.12 (1.30, 3.47), p=0.002

55-64 vs ≥75

0 - 1.5Yr: HR=1.45 (0.87, 2.44), p=0.156

1.5Yr - 2.5Yr: HR=1.69 (0.80, 3.59), p=0.170

2.5Yr - 8Yr: HR=2.23 (1.40, 3.55), p<0.001

8Yr+: HR=5.10 (2.30, 11.32), p<0.001

65-74 vs ≥75

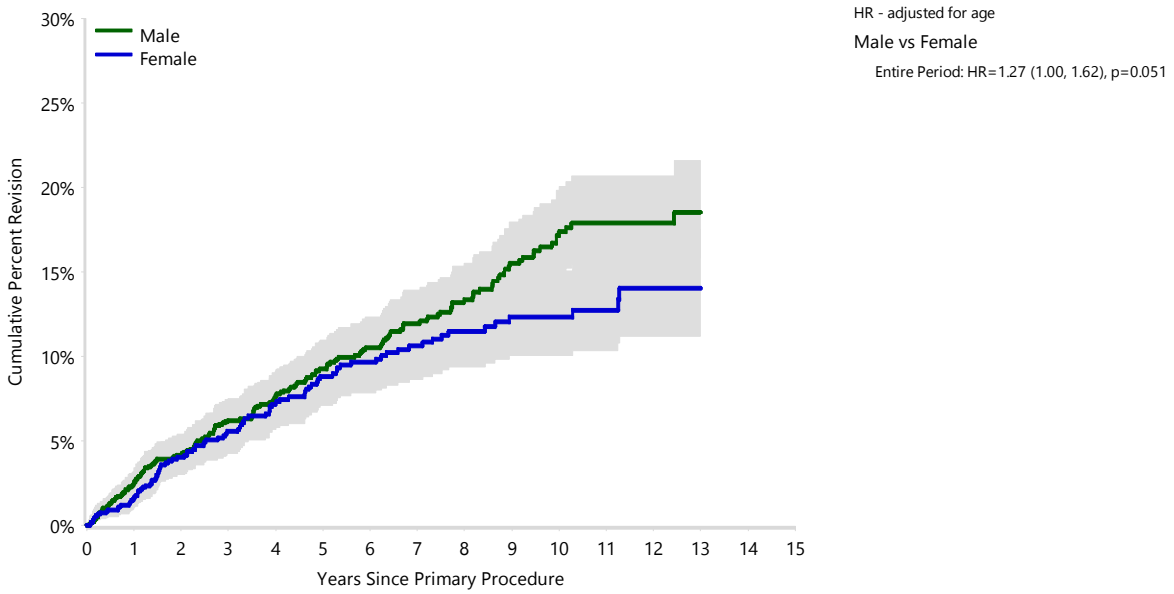
Entire Period: HR=1.51 (1.03, 2.21), p=0.032

Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
<55	244	203	153	127	105	78	17
55-64	928	778	585	477	375	205	52
65-74	1387	1145	796	590	451	225	44
≥75	671	558	402	268	185	80	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	13 Yrs
Male	194	2015	2.5 (1.9, 3.4)	6.2 (5.1, 7.5)	9.2 (7.8, 10.9)	12.0 (10.2, 13.9)	17.4 (15.0, 20.1)	18.5 (15.8, 21.6)
Female	98	1215	1.7 (1.1, 2.6)	5.6 (4.3, 7.2)	8.8 (7.1, 11.0)	10.6 (8.7, 13.0)	12.3 (10.1, 15.0)	14.0 (11.2, 17.5)
TOTAL	**292**	**3230**						

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

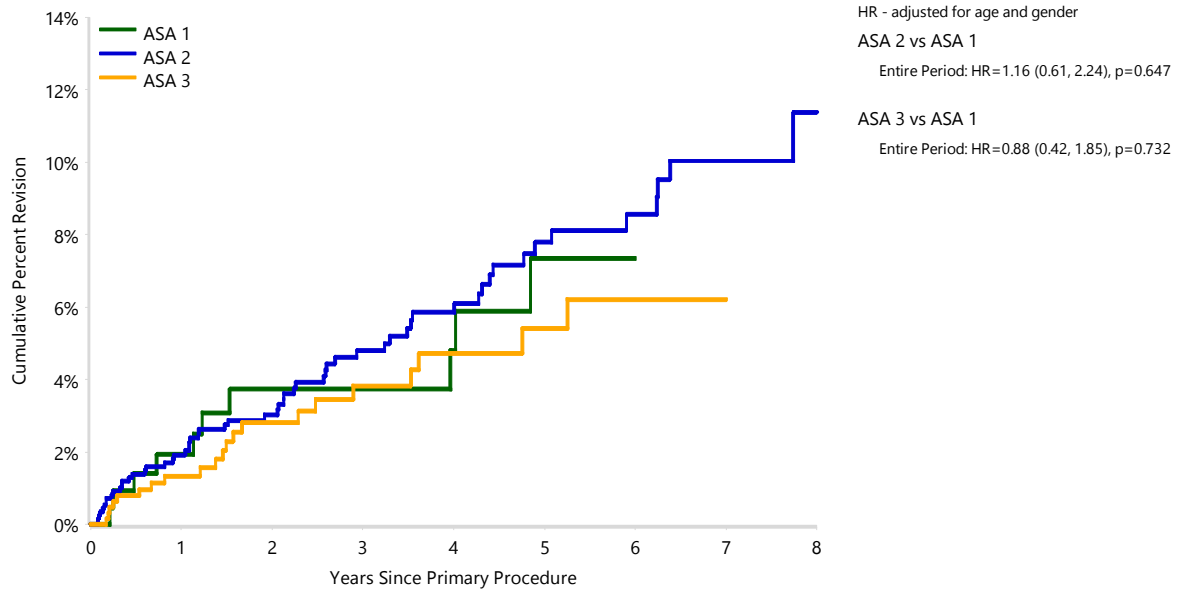


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
Male	2015	1654	1177	895	684	358	83
Female	1215	1030	759	567	432	230	43

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	8 Yrs
ASA 1	11	229	1.9 (0.7, 5.1)	3.7 (1.8, 7.7)	3.7 (1.8, 7.7)	7.3 (3.8, 14.0)		
ASA 2	58	1135	1.9 (1.2, 3.0)	3.0 (2.1, 4.3)	4.8 (3.5, 6.6)	7.8 (5.8, 10.3)	10.0 (7.5, 13.4)	11.4 (8.1, 16.0)
ASA 3	22	659	1.3 (0.7, 2.7)	2.8 (1.7, 4.8)	3.8 (2.3, 6.2)	5.4 (3.3, 8.7)	6.2 (3.8, 10.0)	
ASA 4	0	21	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	**91**	**2044**						

Figure A11 Cumulative Percent Revision of Primary Total Ankle Replacement by ASA Score (Primary Diagnosis OA)



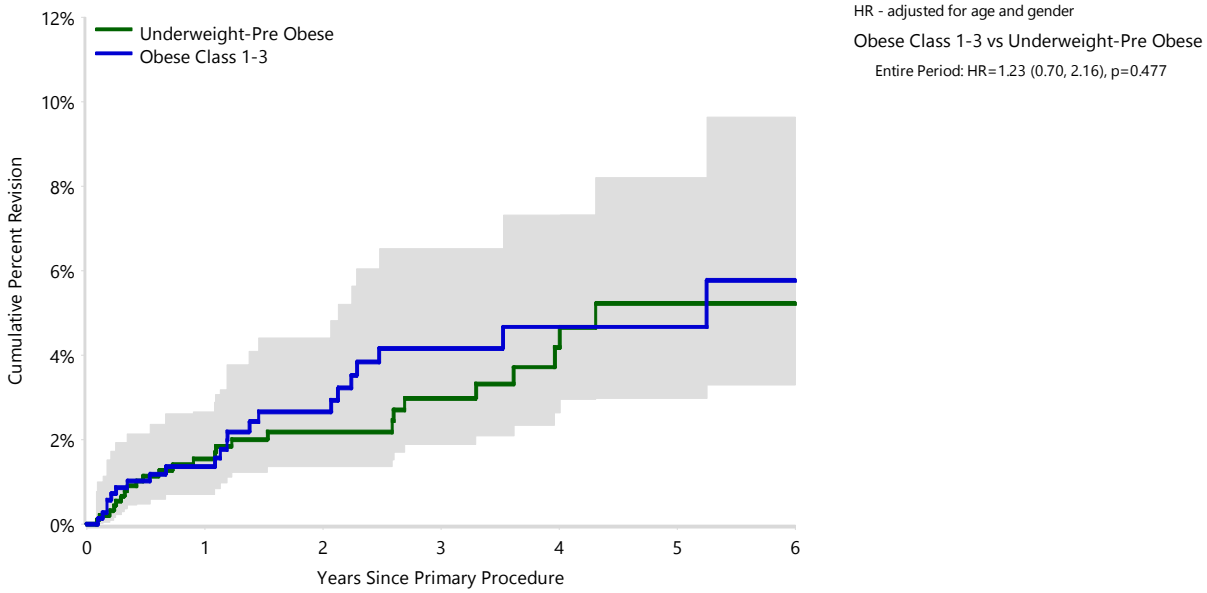
Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	7 Yrs	8 Yrs
ASA 1	229	180	137	108	62	25	18
ASA 2	1135	868	668	508	286	123	49
ASA 3	659	480	341	253	126	52	20

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
Underweight	0	4	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)		
Normal	7	251	0.9 (0.2, 3.4)	1.4 (0.5, 4.3)	3.4 (1.3, 8.3)	4.8 (2.0, 11.3)	
Pre Obese	18	690	1.8 (1.0, 3.2)	2.5 (1.5, 4.2)	2.8 (1.7, 4.8)	4.0 (2.3, 6.8)	4.7 (2.7, 8.1)
Obese Class 1	17	515	1.7 (0.8, 3.3)	2.8 (1.6, 5.0)	4.1 (2.4, 6.8)	4.1 (2.4, 6.8)	4.1 (2.4, 6.8)
Obese Class 2	6	151	0.8 (0.1, 5.4)	1.8 (0.4, 7.0)	4.7 (1.7, 12.6)		
Obese Class 3	1	56	0.0 (0.0, 0.0)	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	4.0 (0.6, 25.2)	
TOTAL	**49**	**1667**					

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

Figure A12 Cumulative Percent Revision of Primary Total Ankle Replacement by BMI Category (Primary Diagnosis OA)



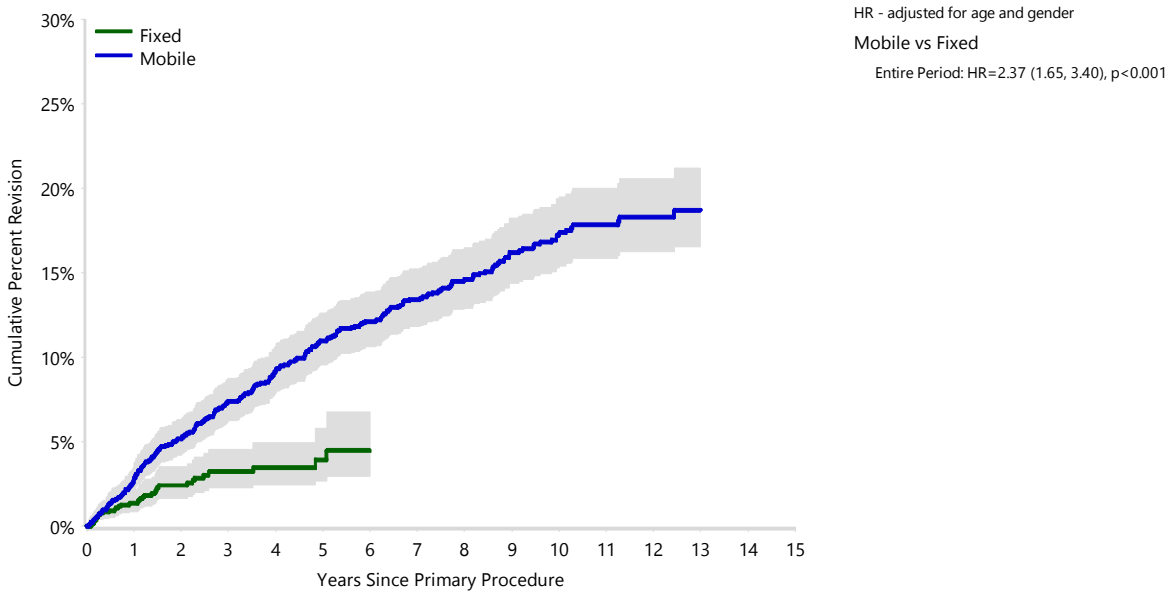
Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs
Underweight-Pre Obese	941	673	463	318	203	112
Obese Class 1-3	722	507	354	236	164	98

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

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	13 Yrs
Fixed	36	1488	1.4 (0.9, 2.1)	3.2 (2.3, 4.6)	4.0 (2.7, 5.8)			
Mobile	256	1742	2.8 (2.1, 3.7)	7.4 (6.2, 8.8)	11.0 (9.6, 12.6)	13.4 (11.8, 15.2)	17.4 (15.4, 19.5)	18.7 (16.5, 21.2)
TOTAL	**292**	**3230**						

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	13 Yrs
Fixed	1488	1049	469	187	31	2	2
Mobile	1742	1635	1467	1275	1085	586	124

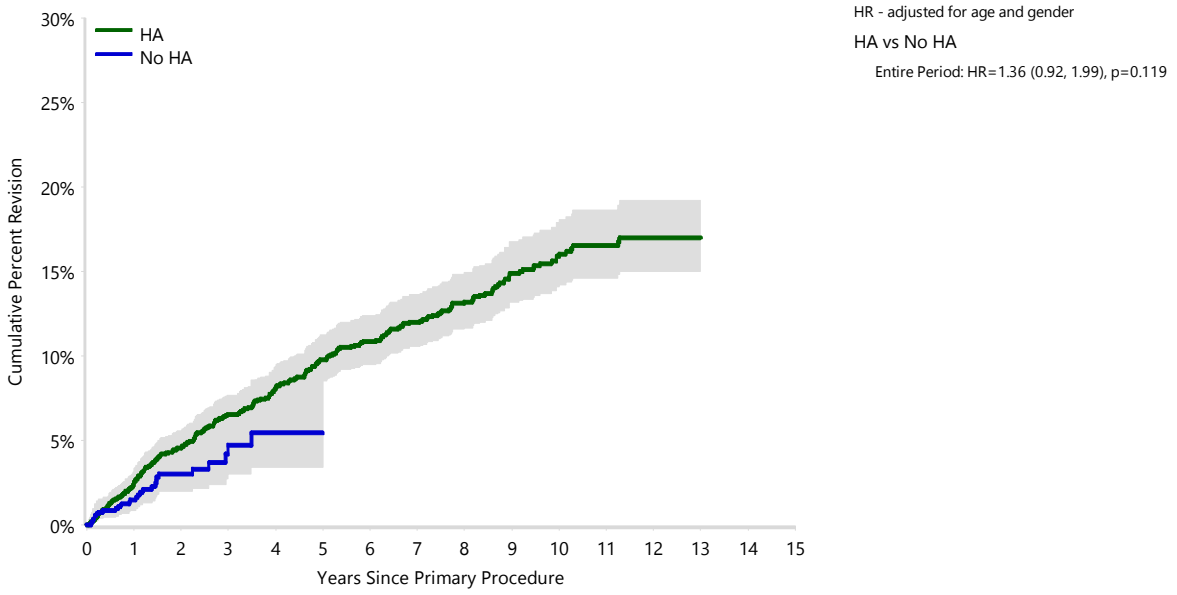
Table A21 Cumulative Percent Revision of Primary Total Ankle Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
Cemented	1	24	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	
Cementless	291	3164	2.2 (1.7, 2.8)	6.0 (5.2, 7.0)	9.2 (8.1, 10.5)	11.6 (10.2, 13.1)	15.6 (13.9, 17.6)	17.0 (14.9, 19.3)
Hybrid (Tibial Cemented)	0	15	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
Hybrid (Talus Cemented)	0	27	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)			
TOTAL	**292**	**3230**						

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	13 Yrs
HA	259	2065	2.5 (1.9, 3.3)	6.5 (5.5, 7.7)	9.8 (8.5, 11.2)	12.0 (10.6, 13.6)	16.1 (14.2, 18.1)	17.0 (15.0, 19.2)
No HA	32	1099	1.5 (0.9, 2.5)	4.7 (3.0, 7.3)	5.4 (3.4, 8.6)			
TOTAL	**291**	**3164**						

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

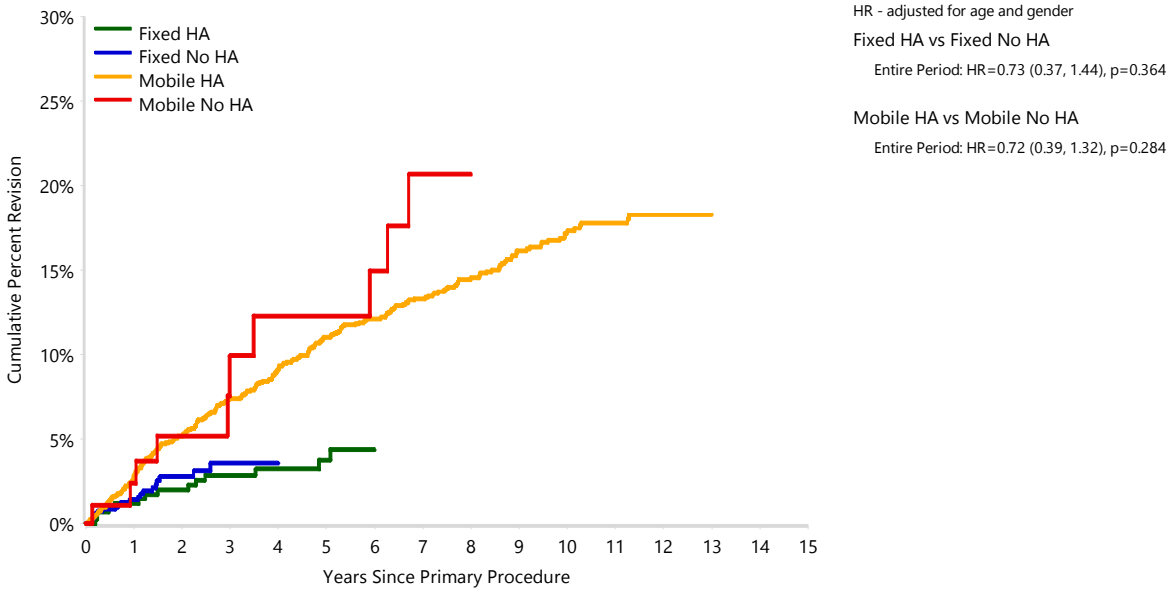


Number at Risk	0 Yr	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
HA	2065	1937	1724	1394	1081	581	124
No HA	1099	697	188	50	26	2	0

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

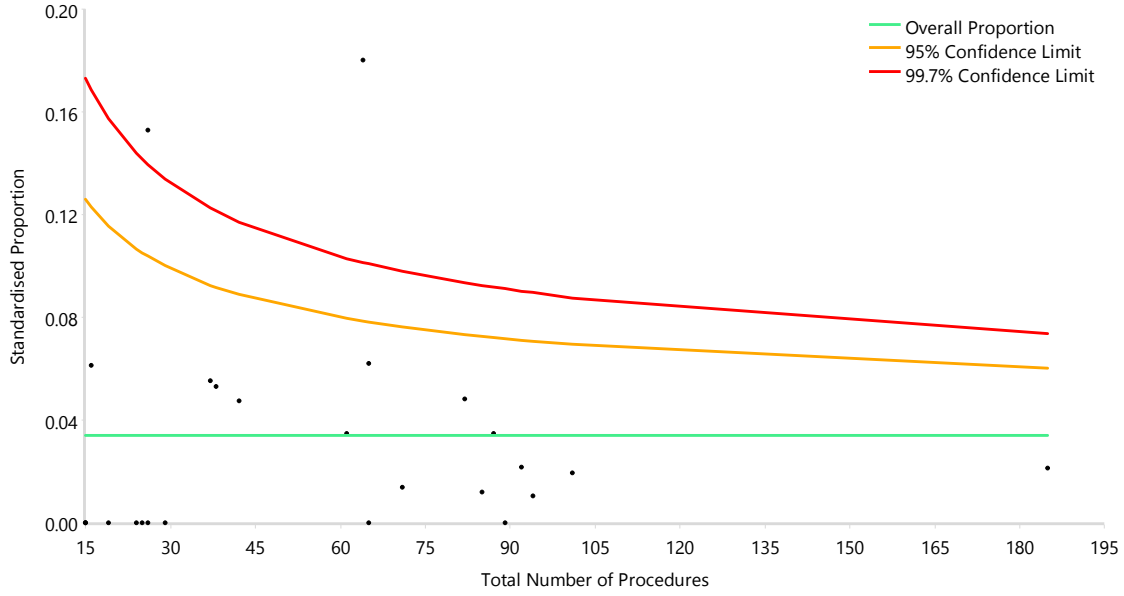
Mobility	Coating	N Revised	N Total	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs	13 Yrs
Fixed	HA	14	428	1.2 (0.5, 2.9)	2.9 (1.6, 5.1)	3.8 (2.2, 6.5)			
	No HA	21	1003	1.4 (0.8, 2.5)	3.6 (2.2, 5.7)				
Mobile	HA	245	1637	2.8 (2.1, 3.8)	7.4 (6.2, 8.8)	11.0 (9.6, 12.7)	13.3 (11.7, 15.1)	17.3 (15.4, 19.5)	18.3 (16.2, 20.6)
	No HA	11	96	2.4 (0.6, 9.2)	9.9 (4.4, 21.6)	12.3 (5.8, 25.0)	20.7 (11.2, 36.2)		
TOTAL		**291**	**3164**						

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	13 Yrs
Fixed	HA	428	385	304	164	29	1	1
	No HA	1003	623	150	14	0	0	0
Mobile	HA	1637	1552	1420	1230	1052	580	123
	No HA	96	74	38	36	26	2	0

Figure A16 Funnel Plot of Primary Total Ankle Replacement Since 2015 by Surgeon (Primary Diagnosis OA)



DEMOGRAPHICS OF ALL REVISIONS

This report analyses 639 revisions of ankle replacements with a procedure date up to and including 31 December 2021.

Type of Revision

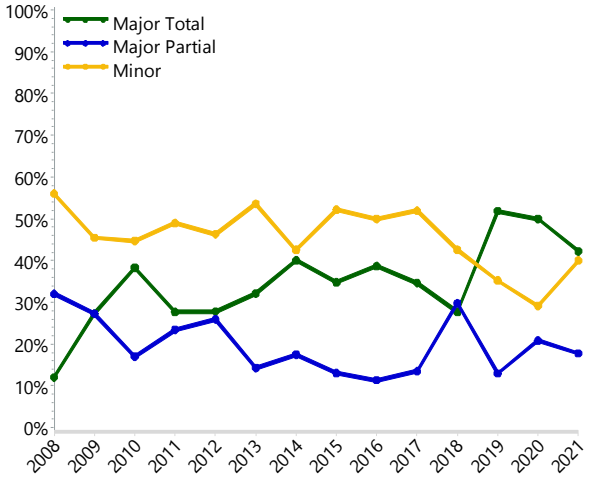
The majority of revisions recorded by the Registry are major revisions (54.6%) (Table A25).

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 17.8% in 2021. 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 42.2% of revisions performed in 2021(Figure A17).

Reason for Revision

Overall, the most common reasons for revision are loosening (31.1%), infection (11.7%), implant breakage ankle insert (11.3%), and lysis (9.4%) (Table A25)

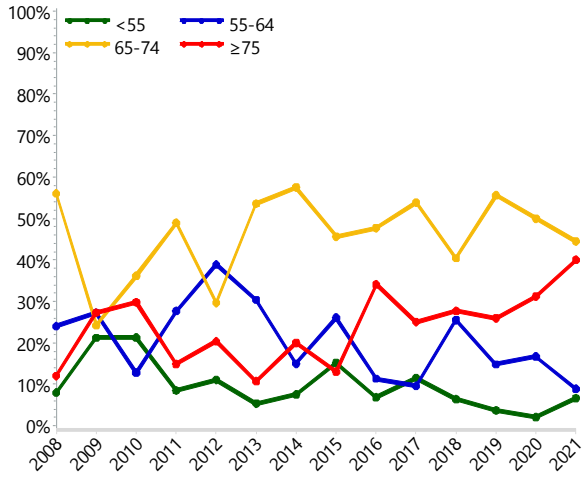
Figure A17 Revision Ankle Replacement by Class



Age and Gender

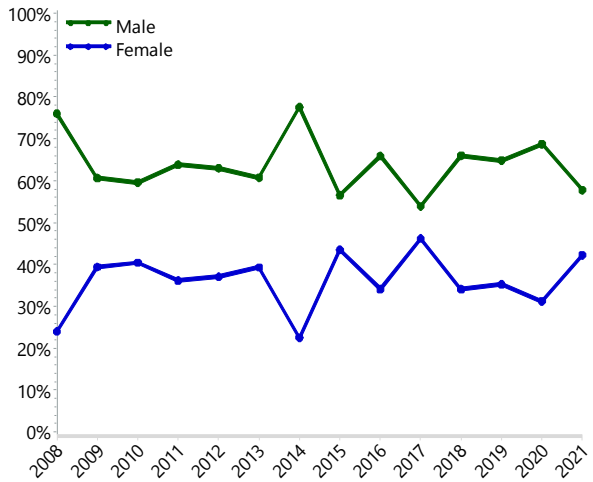
Compared to 2008, there has been an increase in the proportion of revision procedures in patients aged ≥75 years and a decrease in the proportion of procedures in patients aged 55-64 years (Figure A18).

Figure A18 Revision Ankle Replacement by Age



Revision ankle replacement is more common in males (63.2%). There has been a decrease in the proportion of males undergoing revisions since 2008 (Figure A19).

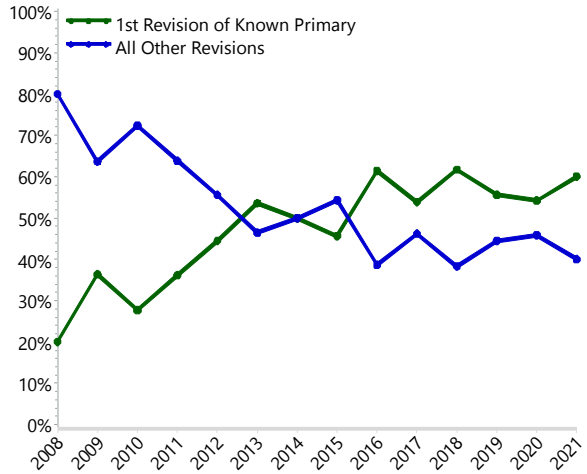
Figure A19 Revision Ankle Replacement by Gender



DEMOGRAPHICS OF 1ST REVISIONS OF KNOWN PRIMARY PROCEDURES

There have been 309 1st revision procedures where the primary procedure has been recorded by the Registry. This includes revisions of all primary total ankle replacements (Figure A20).

Figure A20 Revision Ankle Replacement by Revision



Type of Revision

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

The '1st revisions of known primary procedures' group has a smaller proportion of major revisions (49.2%) compared to the 'all revisions' group (54.6%). There are less arthrodesis, tibial/talar and talar only replacements, but more tibial only revisions (Table A24).

There are a higher proportion of minor revisions in the '1st revisions of known primary procedures' group (50.8%) compared to the 'all other revisions' group (45.4%) (Table A24).

Reason for Revision

There are differences in the reasons for revision between the '1st revisions of known primary procedures' group and the 'all other 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 (27.8% compared to 31.1%). There is a smaller proportion of implant breakage ankle insert in the 1st revisions group (8.7%) compared to the all other revisions group (11.3%). Other diagnoses such as infection, lysis, instability and pain are slightly higher in the '1st revisions of known primary procedures' group (Table A25).

Table A24 Revision Ankle Replacement by Type of Revision

	1st Revision of Known Primary		All Revisions	
Type of Revision	Number	Percent	Number	Percent
Arthrodesis	44	14.2	123	19.2
Tibial/Talar	39	12.6	104	16.3
Tibial Only	33	10.7	42	6.6
Talar Only	18	5.8	38	5.9
Cement Spacer	14	4.5	28	4.4
Removal of Prostheses	4	1.3	14	2.2
N Major	**152**	**49.2**	**349**	**54.6**
Insert Only	152	49.2	283	44.3
Minor Components	5	1.6	7	1.1
N Minor	**157**	**50.8**	**290**	**45.4**
TOTAL	**309**	**100.0**	**639**	**100.0**

Table A25 Revision Ankle Replacement by Reason for Revision

	1st Revision of Known Primary		All Revisions	
Reason for Revision	Number	Percent	Number	Percent
Loosening	86	27.8	199	31.1
Infection	38	12.3	75	11.7
Lysis	32	10.4	60	9.4
Instability	31	10.0	55	8.6
Implant Breakage Ankle Insert	27	8.7	72	11.3
Pain	21	6.8	37	5.8
Impingement	17	5.5	38	5.9
Fracture	15	4.9	21	3.3
Prosthesis Dissociation	8	2.6	17	2.7
Malalignment	6	1.9	10	1.6
Wear Ankle Insert	6	1.9	10	1.6
Arthrofibrosis	5	1.6	10	1.6
Heterotopic Bone	4	1.3	5	0.8
Synovitis	3	1.0	3	0.5
Implant Breakage Tibial	2	0.6	2	0.3
Incorrect Sizing	2	0.6	2	0.3
Metal Related Pathology	1	0.3	1	0.2
Osteonecrosis	1	0.3	3	0.5
Tumour	1	0.3	2	0.3
Avascular Talus			1	0.2
Fusion/Arthrodesis			1	0.2
Malposition			1	0.2
Prosthesis Dislocation			1	0.2
Valgus Deformity			1	0.2
Other	3	1.0	12	1.9
TOTAL	**309**	**100.0**	**639**	**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 are 205 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.

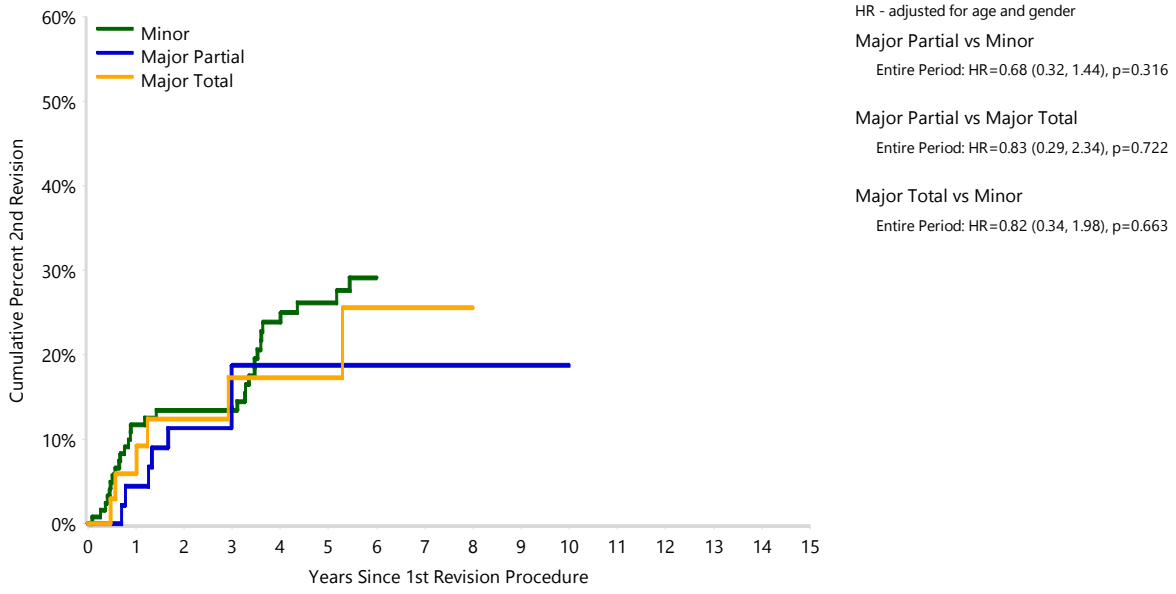
There is no difference in the rate of 2nd revision when the classes of 1st revision are compared (Table A26 and Figure A21).

Table A26 Cumulative Percent Revision of 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	13 Yrs
Minor	30	124	11.7 (7.1, 19.0)	13.5 (8.5, 21.0)	26.2 (18.8, 35.8)			
Major Partial	9	47	4.4 (1.1, 16.6)	18.7 (9.8, 34.0)	18.7 (9.8, 34.0)	18.7 (9.8, 34.0)	18.7 (9.8, 34.0)	
Major Total	6	34	6.0 (1.5, 21.8)	17.3 (7.4, 37.5)	17.3 (7.4, 37.5)	25.6 (11.2, 52.0)		
TOTAL	**45**	**205**						

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

Figure A21 Cumulative Percent Revision of 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	13 Yrs
Minor	124	102	86	52	29	6	1
Major Partial	47	43	33	25	22	10	0
Major Total	34	29	17	10	5	1	0

List of Tables

List of Figures