SoFCOT Total Hip Arthroplasty Register

Biennial Report 2020

2006-2019

Institut für Sozial- und Präventivmedizin ISPM
SwissRDL Medical Registries and Data Linkage

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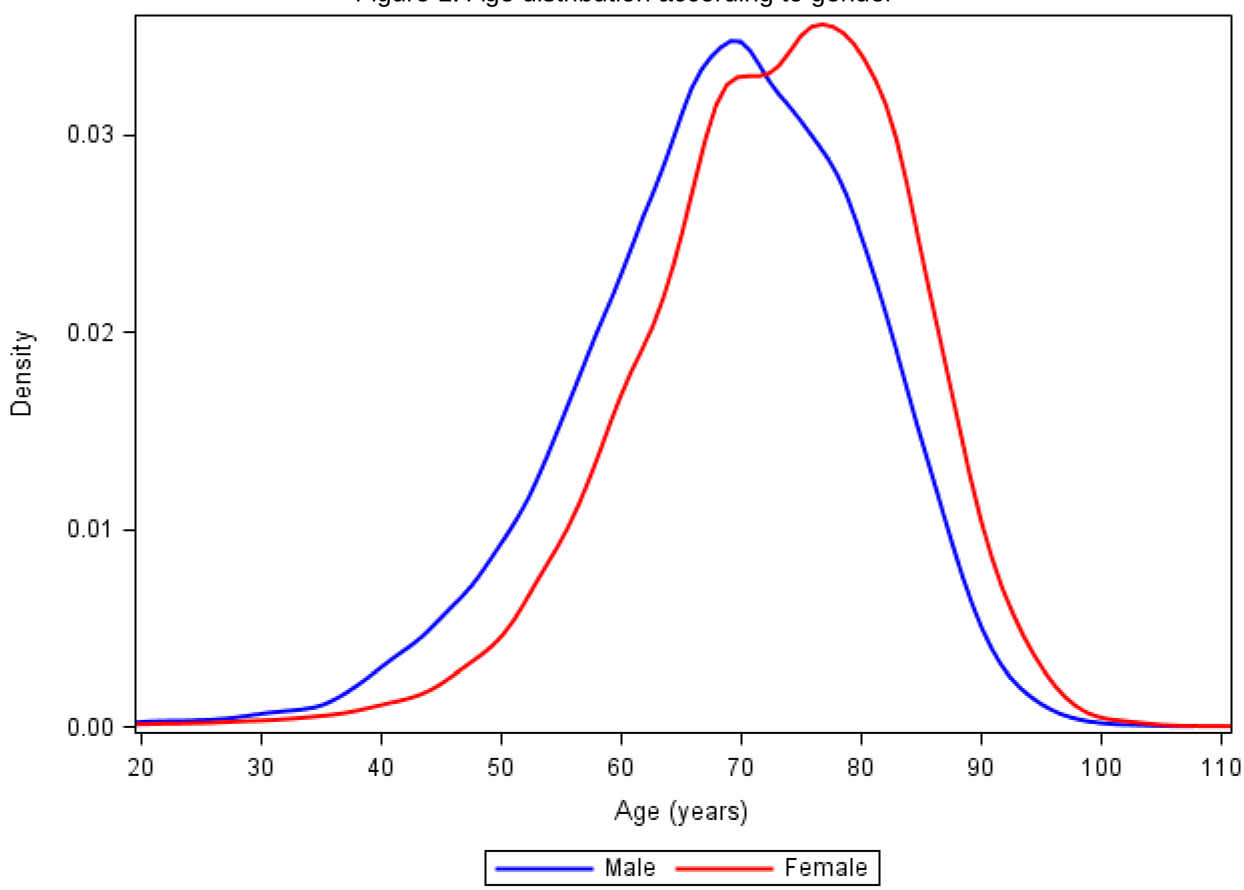
Part I: Primary Total Hip Arthroplasty

From January 1st 2006 to December 31th 2019, a total of 45'397 Total Hip Arthroplasties (THA) were registered in the SoFCOT hip register. The annual number of primary registrations peaked in 2015 at over 5'600 procedures, then remained stable at a high level in 2016 and 2017. However, that number fell to just over 5'000 annually in 2018 and 2019. The average age of the patients was 70.8 years (SD, 11.6 years). A total of 25'896 patients (57%) were female with an average age of 72.7 years, and 19'458 were male with an average age of 68.3 years (Table 1, Figure1).

Table 1. Patient age at operation

Gender	N	Min	Max	Average	Std Dev
Male	19458	17	103	68.3	11.8
Female	25896	16	113	72.7	11.1
Total	45354	16	113	70.8	11.6

Figure 1. Age distribution according to gender



Osteoarthritis is the main indication for THA (75.5%), followed by acute fracture, osteonecrosis of the femoral head and hip dysplasia (Table 2).

Table 2. Underlying diagnoses

Diagnostics	Frequency	Percentage
Primary osteoarthritis	34 288	75.5
Recent fracture	3 728	8.2
Femoral head necrosis	1 958	4.3
Hip dysplasia	1 918	4.2
Rapid destructive arthritis	1 576	3.5
Traumatic sequelae	1 036	2.3
Others	540	1.2
Rheumatoid arthritis	236	0.5
Post-Perthes Calve	117	0.3

The postero-lateral approach was used in more than half of the interventions (51.5%). The distribution of the individual approaches was relatively stable between 2009 and 2015, but in recent years, the anterior and the antero-lateral approaches have been on the increase (Figures 2a and 2b).

Figure 2a. Distribution of surgical approach

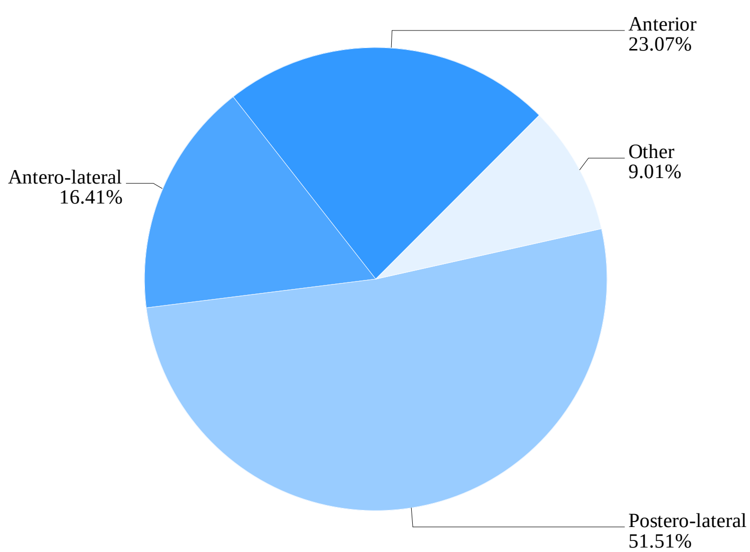


Figure 2b. Distribution of surgical approach: change over 12 years

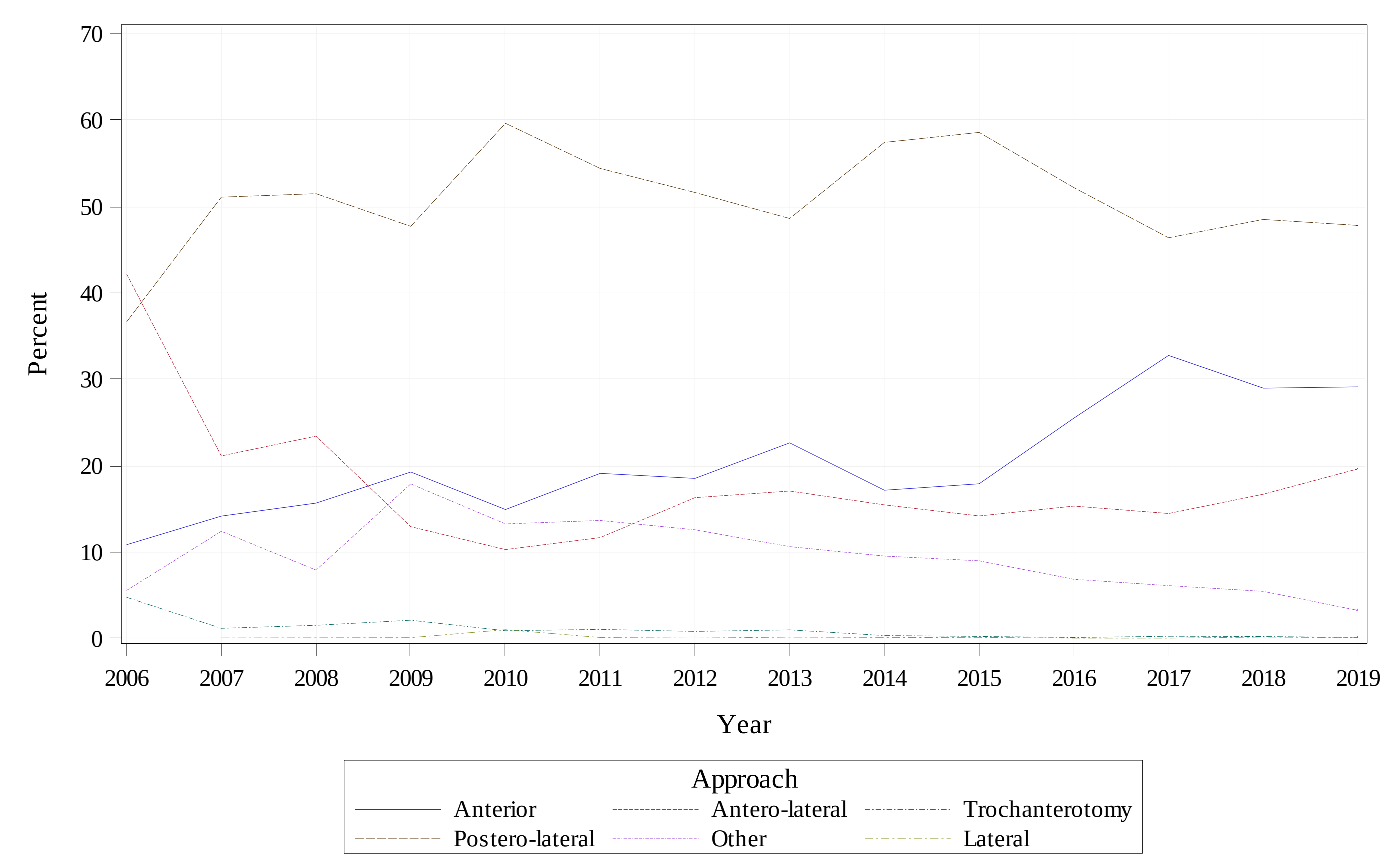


Table 3 shows that 89.4% of THAs are done conventionally and that a dual mobility cup was used in 39.3% of cases. All other types of THAs have a lower proportion (<5%). More than two thirds of THAs were fixed without cement (Figure 3a). A steady increase of the uncemented fixation type can be observed over the 13 years, which occurs in parallel to the decline of the cemented fixation in particular since 2009 (Figure 3b). When cement is used, it is in the majority of cases antibiotic-impregnated cement (up from 87.3% in 2009 to 94.4% in 2019) (Figure 4).

Table 3a. Types of THA for primary implantation

Type of Prosthesis	Frequency	Percent
Conventional THA	40 584	89.4
THA with short femoral stem	2 132	4.7
Femoral prosthesis with mobile cup (bipolar)	2 062	4.5
Total resurfacing	354	0.8
Other	252	0.6
Femoral resurfacing	8	0.0
THA with trans-cervical fixation	5	0.0
Total	45 397	100

Table 3b. Type of cups for primary implantation

Type of Cup	Frequency	Percent
Conventional	25 489	56.1
Dual mobility cup	17 824	39.3
Mobile head	2 062	4.5
Other	22	0.0

Figure 3a. Fixation of components

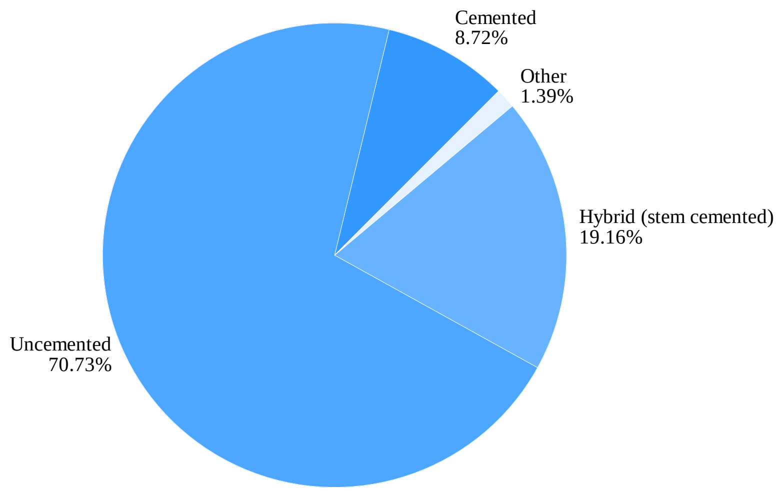


Figure 3b. Fixation of components: change over the 12 years

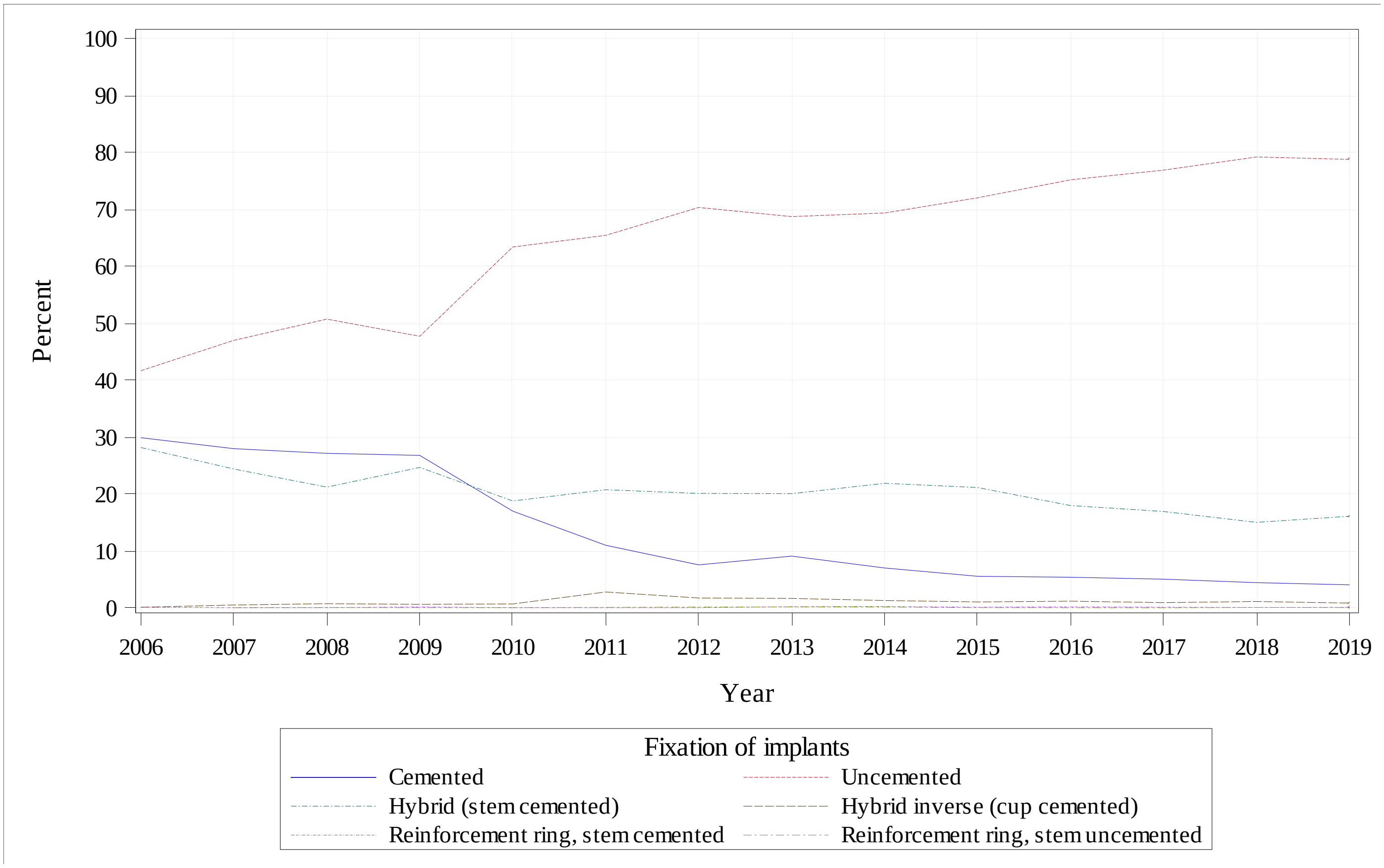
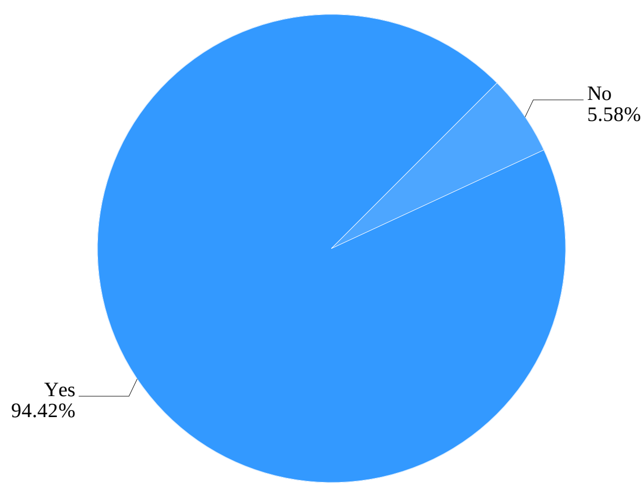


Figure 4. Use of antibiotic-impregnated cement

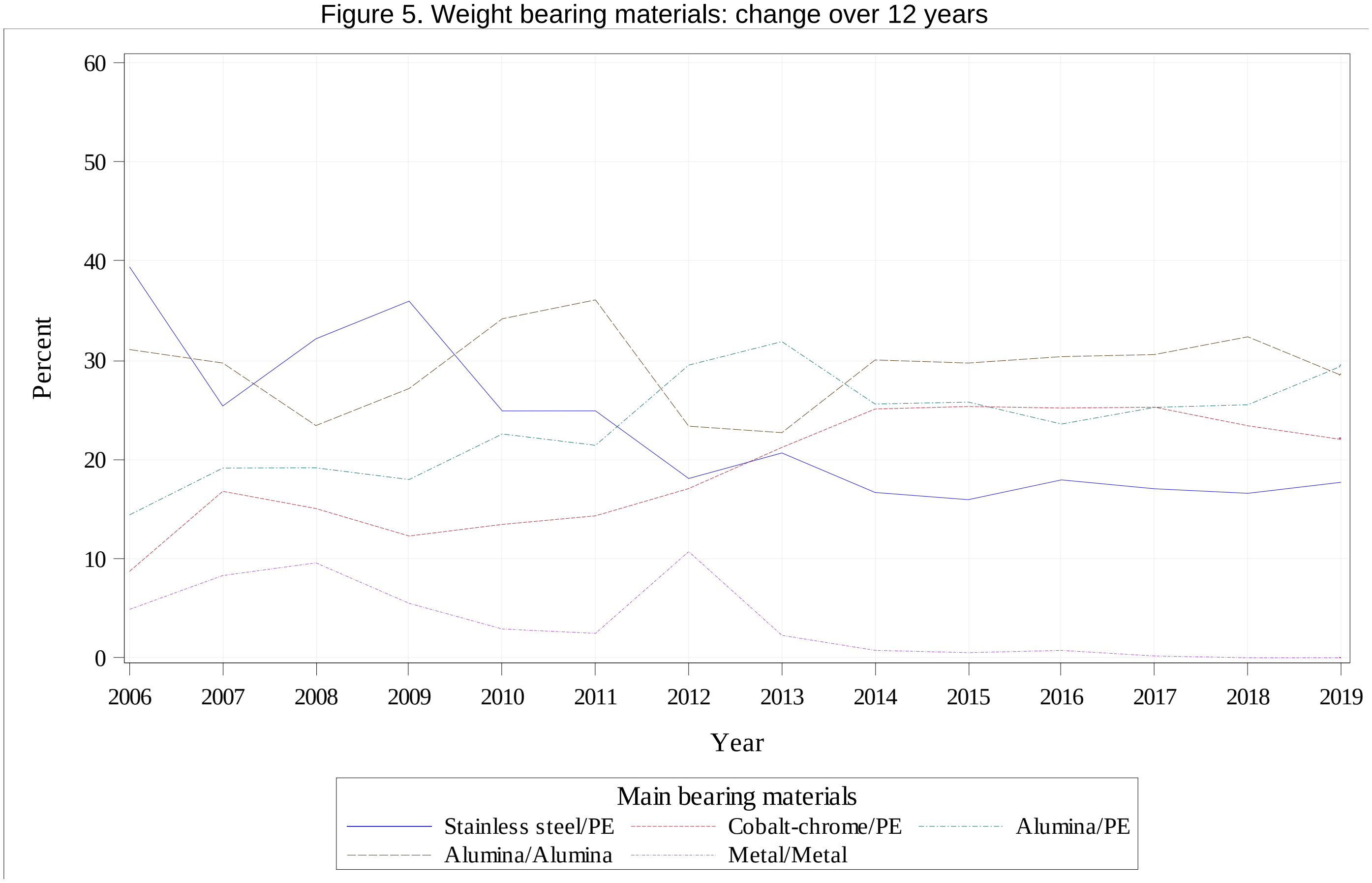


Four weight-bearing materials represent nearly 97% of THAs (Table 4). The order of frequency of the bearing materials did not change significantly since 2011, except that the proportion of Stainless steel/PE was declining between 2009 and 2015 whilst Cobalt-chrome/PE was seeing a corresponding increase. The picture has been essentially stable since 2015.

Table 4. Weight bearing materials

Material	Frequency	Percent
Alumina/Alumina	13 348	29.4
Alumina/PE	11 637	25.6
Cobalt-chromium/PE	9 915	21.8
Stainless steel/PE	9 015	19.9
Metal/Metal	959	2.1
Other	251	0.6
Zirconia/Alumina	92	0.2
Oxynium/PE	84	0.2
Titanium/PE	57	0.1
Zirconia/PE	35	0.1

Figure 5. Weight bearing materials: change over 12 years



The use of 28mm heads increased steadily (from 46.3% in 2011 to 50.0% in 2013 and further to 54.9 in 2019) and thus remains the predominant femoral head size. On the other hand, the use of 32mm and 22.2mm heads decreased, from 21.7% in 2011 to 19.4% in 2013 and further to 18.2% in 2019, and from 22.4% in 2011 to 18.7% in 2013 and further to 11.4% in 2019, respectively (Table 5).

Table 5. Size of femoral head

Size	Frequency	Percent
28 mm	24 915	54.9
32 mm	8 260	18.2
36 mm	6 300	13.9
22.2 mm	5 155	11.4
Other	703	1.5
26 mm	60	0.1

The most commonly used implants are listed below by type of fixation and restricted to at least 50 primary implantations (Tables 6, 7, 8 & 9). Please note that this only covers implants that could be reliably identified in the SwissRDL/SoFCOT implant library (see methodological notes below). Owing to the decreasing use of cemented implants, there is little change in Tables 6 and 8 compared to the previous biennial report.

Table 6. Most frequently used cemented cups (>=50)

Implant name	N
MKIII	562
Original Mueller	470
INITIALE	326
NOVAE	163
CHIRULEN	174
SATURNE	107
EXAFIT	81
Total	1 883

Table 7. Most frequently used uncemented cups (>=50)

Implant name	N
PINNACLE	3 666
NOVAE	3 188
RM PRESSFIT	2 329
QUATTRO	2 011
SATURNE	1 987
CERAFIT	1 487
AVANTAGE	1 314
ALLOFIT	1 181
VERSAFITCUP	1 126
ADM	1 024
TRIDENT	966
GYROS	660
TREGOR	723
ADES	601
SYMBOL	561
CONTINUUM	548
LIBERTY	533
ABG 2	482
HYPE	465
APRIL	398
CAPITOLE	333
DELTA	323
STAFIT	307
EVORA	300
HORIZON	289
MUST	260
SELENE	229
ETERNITY	228
ATLAS 4	201
X.CUP	195
ALLOCLASSIC	186
POLARCUP	169
SELEXYS DS	132
SELF CENTERING	124
ATLAS 3	121
STANDARD cup Aston Medical	114
LAGOON	97

Implant name	N
DELTAMOTION	90
EVOLUTION	89
CARGOS	87
MIXT	71
HIP AND GO	69
Total	29 264

Table 8. Most frequently used cemented stems (>=50)

Implant name	N
INITIALE	1 378
STANDARD stem Avenir Zimmer	935
EXAFIT	930
ABG 2	719
STANDARD stem PF Zimmer	702
LEGEND	426
AMISTEM	368
DEDICACE	301
CCA	297
OSTEAL	292
CMK MOD	226
GENERIC	213
STANDARD stem INSTITUTION Groupe Lépine	206
STANDARD stem Tornier	186
OCEANE	178
CENTRIS	75
STANDARD stem EXCEPTION Biomet	73
HARMONY	68
CORAIL (unspecified)	60
Total	7 633

Table 9. Most frequently used uncemented stems (>=50)

Implant name	N
STANDARD stem CORAIL 2 DePuy	5 614
STANDARD stem Avenir Zimmer	3 520
STANDARD stem EXCEPTION Biomet	2 271
STANDARD stem HAP TARGOS (130° & ctc 135°) Groupe Lépine	1 350
HAP TARGOS mini stem	1 079
THELIOS	1 000
INTEGRALE	964
AMISTEM	701
ALLOCLASSIC	531
STANDARD stem OPTIMYS Mathys	431
TWINSYS	367
ACCOLADE II	361
RMIS	340
HELMED	281
STANDARD stem HYPE Serf	267
ABG 2	245
LINEA	231
SPS EVOLUTION	205
STANDARD stem SL-Plus Smith & Nephew	202
STANDARD stem CORAIL Arthrosurface	183
STANDARD stem PAVI Groupe Lépine	182
H-MAX	171
AURA	169
HARMONY	168
FITMORE	153
CORAIL (unspecified)	142
STANDARD stem LIBRA Serf	137
VALMER	134
STANDARD stem LOUXOR SEM	123
ABG 2 MODULAR	101
LIBRA	101
CERAFIT-MULTICONE	68
BHS	66
STANDARD stem Polar Smith & Nephew	66
Total	21 660

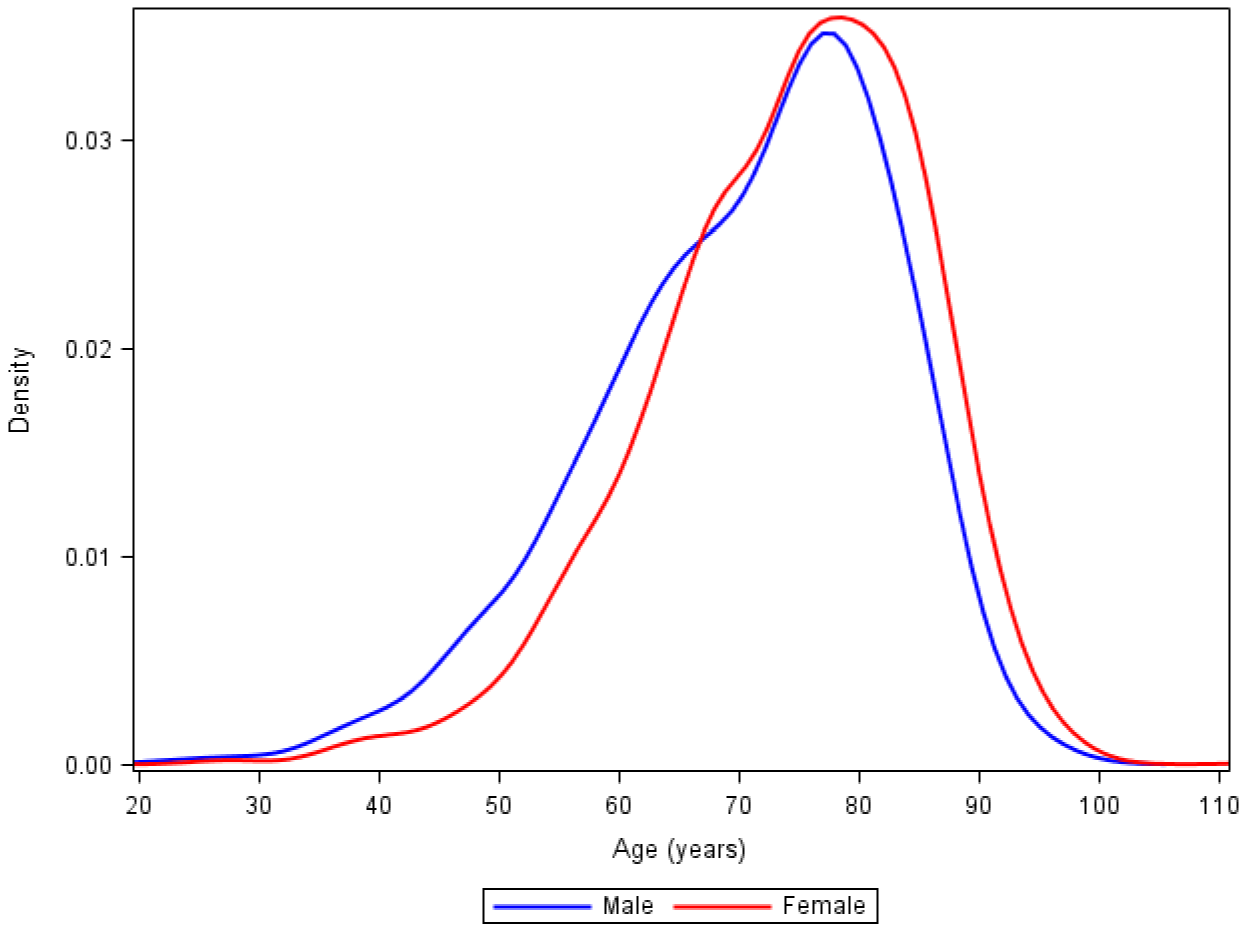
Part II: Re-intervention and THA Revision

Between January 1st 2006 and December 31th 2019, 4’872 re-interventions of THAs were registered in SoFCOT. The average patient age was 72.5 years (SD, 11.7) at revision. A total of 2’755 patients (56.6%) were female with an average age of 73.9 years, and 2’117 patients were male with an average age of 70.5 years (Table 10, Figure 6).

Table 10. Age of the patients at the re-intervention/THA revision

Gender	N	Min	Max	Mean	SD
Male	2 117	21	98	70.5	12.1
Female	2 755	26	113	73.9	11.2
Total	4 872	21	113	72.5	11.7

Figure 6. Age distribution at the time of re-intervention/revision according to gender



Aseptic loosening remains the principal cause of re-interventions. However, it decreased from 53.4% in 2011 to 45.1% in 2019. Hip dislocation represents the second most common cause of re-interventions. Reinterventions due to wear and osteolysis have only marginally increased over the last years, and the same is true for the periprosthetic fractures. Other causes of re-interventions worth mentioning are acute infection, pain, septic loosening and fracture of the implant, with frequencies between 3.1% and 7.3% (Table 11).

Table 11. Causes of re-intervention and THA revisions

Diagnosis	Frequency	Percent
Aseptic loosening	2 196	45.1
Dislocation	598	12.3
Peri-prosthetic fracture	518	10.6
Wear and/or osteolysis	383	7.9
Septic Loosening - chronic infection	357	7.3
Deep acute infection	232	4.8
Pain	203	4.2
Other	188	3.9
Implant fracture	151	3.1
Peri-operative fracture	19	0.4
Head and neck resection	17	0.3
Calcifications	9	0.2
Removal of material	3	0.1

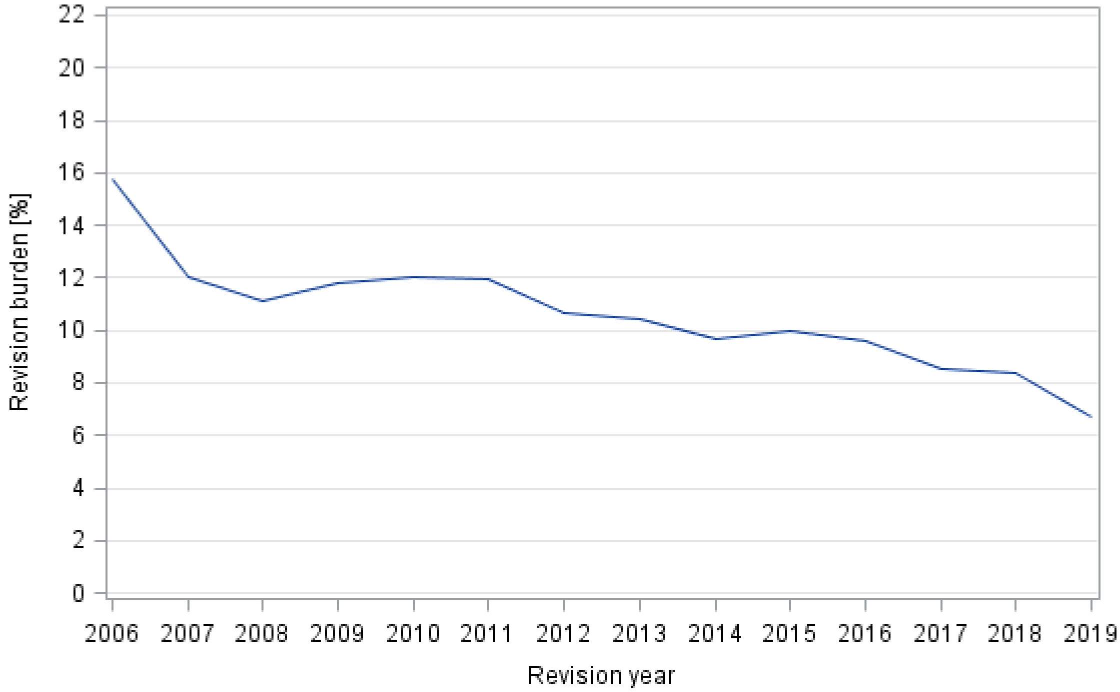
In accordance with the causes of revision, the most common reintervention remains the change of both the acetabular and femoral components, albeit with slightly decreasing frequency since 2009. The proportion of isolated replacement of acetabular or femoral components did not change significantly since the last report (Table 12).

Table 12. Types of re-interventions / revisions

Intervention	Frequency	Percent
Complete exchange	2 191	45.0
Acetabular implant only	1 509	31.0
Femoral implant only	659	13.5
Head and liner	224	4.6
Reimplantation after resection	102	2.1
Others	56	1.1
Totalisation	48	1.0
Head only	26	0.5
Implant removal+spacer	24	0.5
Liner only	15	0.3
Head-neck resection	9	0.2
Osteosynthesis	7	0.1
Prosthetic lavage	4	0.1

We can calculate an annual revision burden according to the formula "N annual revisions/ (N annual primaries + N annual revisions)". Currently, with 4'874 revisions recorded compared with 45'354 primary THAs registered since January 1st 2006, the overall 13-year revision burden is 10.7%. The annual revision burden between 2008 and 2011 was relatively stable at around 12%, but there appears to be a relatively steady decline in the revision burden since then (Figure 7). It should be noted that this statistic does not represent a true "revision rate" of the implants used, but merely provides an indication of the relative burden caused by revision procedures in participating services.

Figure 7. Annual revision burden during the 13-year period 2006 and 2019 (%)



Part II-A: Characteristics of the revised implants

Unsurprisingly, the majority of the revised THAs are of the conventional type with a femoral stem and an acetabular component, either with conventional or dual mobility cups (DMC). Given the growing use of dual mobility cups in this register, their share of cups withdrawn is also growing steadily. The other arthroplasty types represent only 11% of the total THAs revised (Table 13).

Table 13a. Characteristics of the revised implants

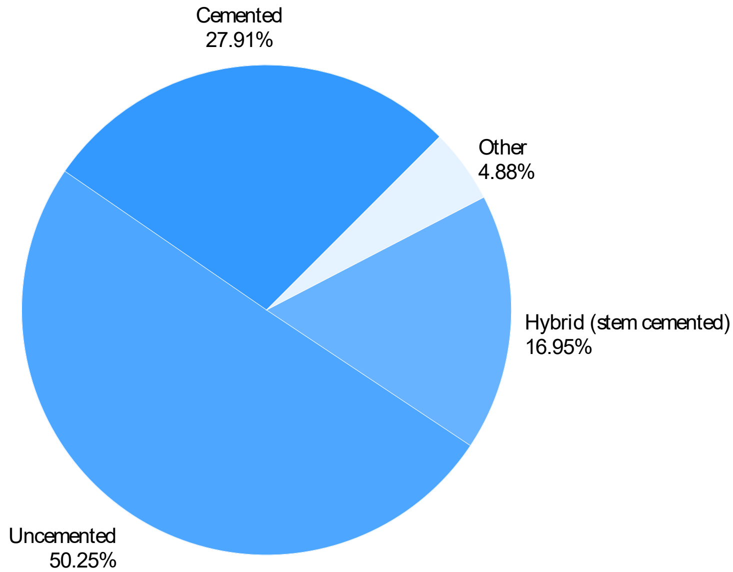
Revised	Frequency	Percent
THA with femoral stem	4 338	89.0
Femoral prosthesis with mobile cup	211	4.3
Others	180	3.7
Spacer	89	1.8
THA with short femoral stem	42	0.9
Femoral head resurfacing	7	0.1
Total resurfacing	6	0.1
THA a trans-cervical fixation	1	0.0

Table 13b. Type of cups withdrawn

Cup type	Frequency	Percent
Conventional	3 720	76.3
Dual mobility cup	915	18.8
Mobile head	211	4.3
Other	28	0.6

Just over half of the implants revised were uncemented and that proportion has steadily increased over the last years (Figure 8).

Figure 8. Fixation of the revised implants



Most of the revised acetabular cups or inlays are still made of conventional polyethylene (PE). Its proportion has marginally decreased over the last years, as have the proportions of the bulk alumina or Co-Cr sandwich cups (Table 14). Reflecting its growing market share in primary procedures, the share of highly cross-linked PE (HXLPE) is also growing in revised components.

Table 14. Material of revised cups or inlays

Insert	Frequency	Percent
Conventional PE	3 121	68.8
Bulk alumina	562	12.4
Highly cross-link PE	428	9.4
None	135	3.0
CoCr-sandwich	123	2.7
Alumina-sandwich	83	1.8
Others (or unclear)	56	1.2
Non-modular CoCr	31	0.7

In contrast to the revised inlays, the distribution of the replaced heads has seen more pronounced changes after 2011, but has been rather stable over the past two years. Compared to 2011, the proportion of the revised stainless steel heads decreased by 5 percentage points, down to a level of 27.6%. The alumina heads still represent 34.4% of the replaced heads, and the proportion of the revised Co-Cr heads increased by 4 percentage points to its current level of 26.9%. The proportion of revised zirconia heads has also increased since 2009, to a current level of 8.5% (Table 15)

Table 15. Material of revised heads

Bille	Frequency	Percent
Alumina	1 560	34.4
Steel	1 251	27.6
CoCr	1 222	26.9
Zirconia	386	8.5
Other	89	2.0
Titanium	26	0.6
Oxynium	3	0.1

Part II-B: Type of implant, fixation and cups used for revision

In about one fifth of all acetabular revisions the implant was supported by a reinforcement ring. Another quarter of acetabular revisions were cemented, and slightly more than the half were uncemented (Figure 9). This indicates a slight increase of the use of reinforcement rings in cemented acetabular revisions, and an even more accentuated increase in uncemented revisions in general (Figure 10). In cases with cementation, an antibiotic-impregnated cement was used in 92.7% (Table 16).

Figure 9. Implant fixation of acetabular revisions

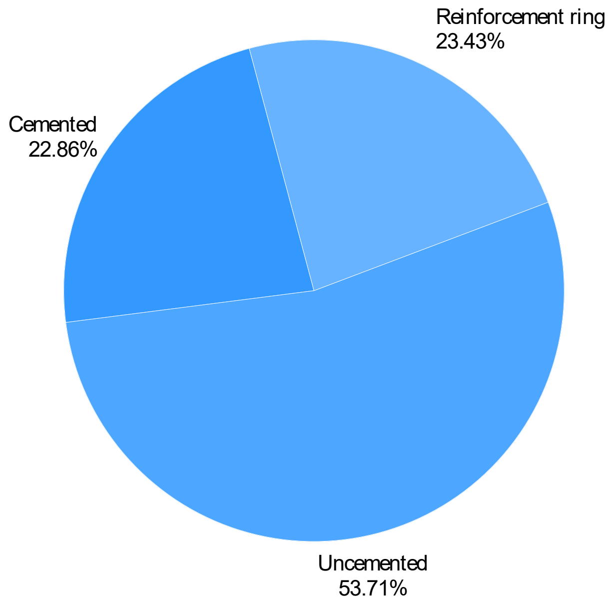


Figure 10. Use of cement in all revisions

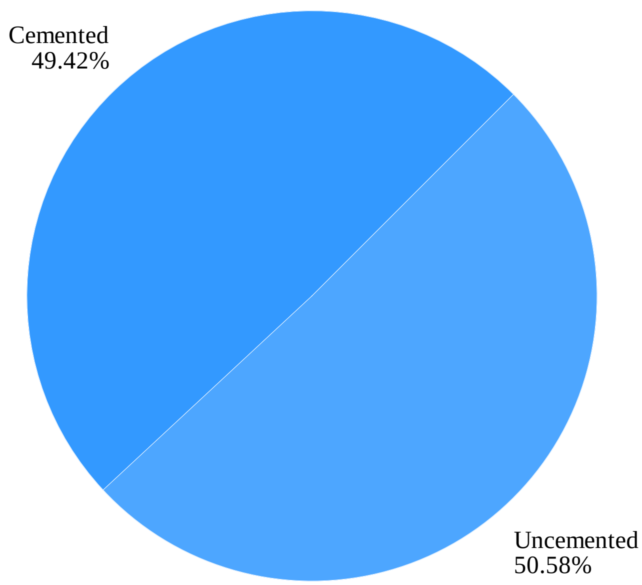
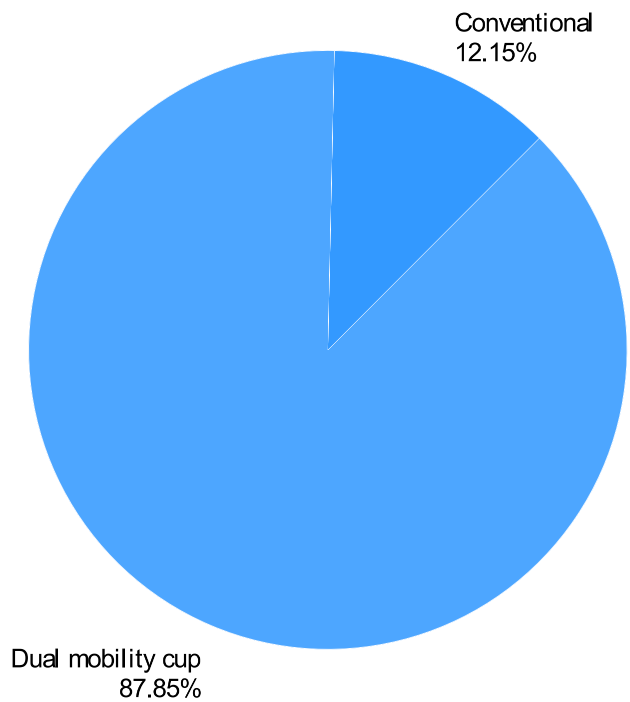


Table 16. Cemented revisions with and without antibiotics

Antibiotics	Frequency	Percent
Yes	1 905	92.7
No	150	7.3

The vast majority (87.9%) of cups used in revisions since 2017 were of the dual mobility type, which, perhaps, is not surprising given the increasing use of DMC in primary procedures, but still exceeds the share of DMC in recent primary THAs by a large margin.

Figure 11. Type of cup used in revision (data available since 2017)



Four weight-bearing materials are mainly used in revisions. The classic combination of stainless steel/PE is not the dominant anymore, losing that position to Cobalt-chrome/PE (Figure 11). Figure 12 shows a significant increase of the combination Co-Cr/PE at the cost of Alumina/PE since 2011.

Figure 12. Weight bearing materials used in revisions

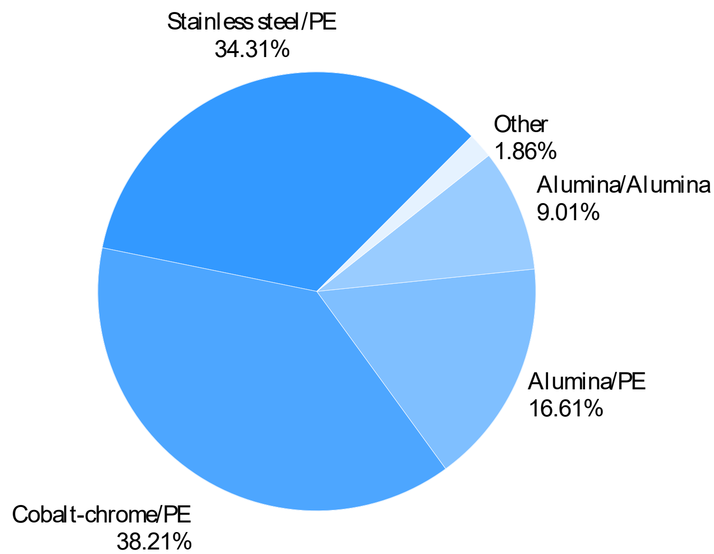
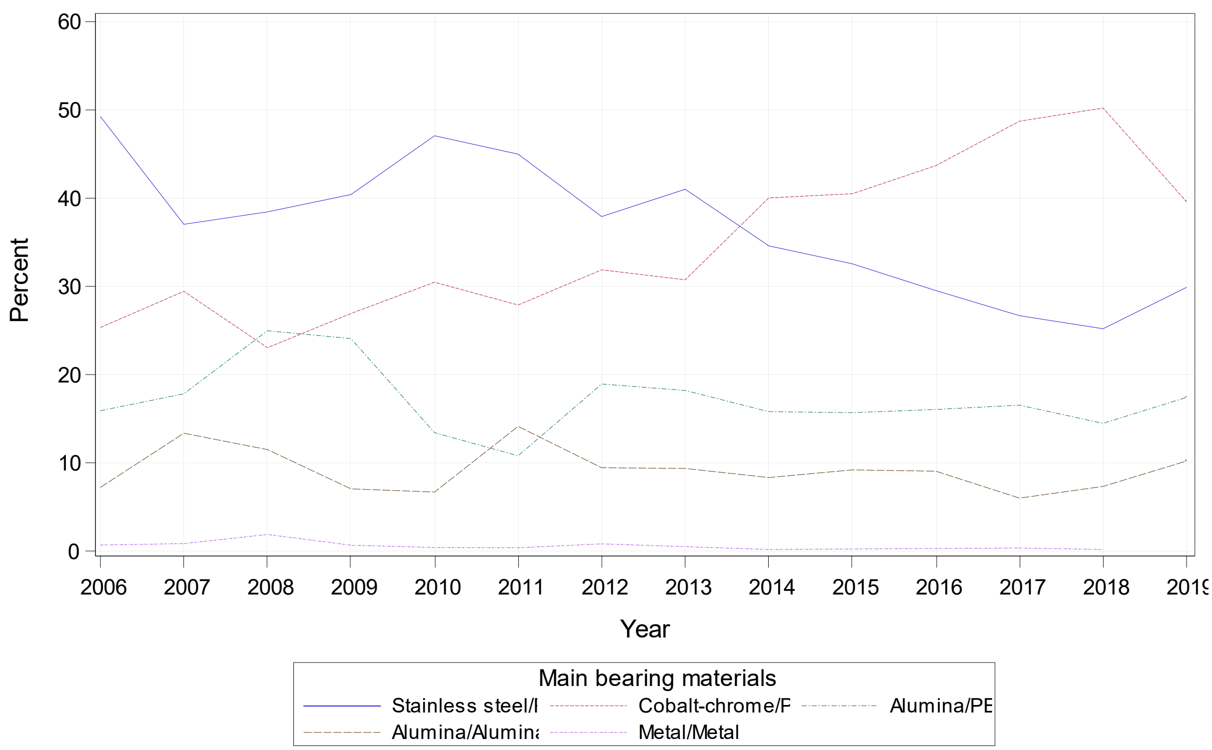


Figure 13. Main weight bearing materials used in revisions: change over 13 years



Part II-C: Analysis of the revision coefficients

The most important group of patients, those requiring a revision due to aseptic loosening, is composed of females in 58% of the cases. In contrast, other revision groups such as “deep infections” or “septic loosening” have more male patients in them. Intra-operative or periprosthetic fractures usually occur in patients of high age. One half of the revised implants due to aseptic loosening was cemented. The vast majority of other revised implants was uncemented (Table 17). Another type of fixation at revision was used in less than 4% of the patients.

Table 17. Patient characteristics and type of fixation in revised THAs

Revision diagnosis	N	Age	% female	% cemented	% uncemented	% hybrid
Aseptic loosening	2 196	72.6	58.5	41.3	36.3	17.8
Deep acute infection	232	72.8	47.8	20.3	49.1	12.5
Dislocation	598	73.2	61.0	27.1	58.5	12.0
Perioperative fracture	19	73.2	57.9	10.5	73.7	10.5
Implant fracture	151	70.3	37.1	19.2	66.9	11.3
Peri-prosthetic fracture	518	78.1	64.1	13.7	73.2	12.0
Septic Loosening - chronic infection	357	69.4	38.4	26.6	33.3	23.5
Wear and/or osteolysis	383	71.8	51.4	14.1	56.7	28.2
Pain	203	65.8	64.5	11.8	75.9	11.3
Calcifications	9	69.8	55.6	11.1	77.8	0.0
Removal of material	3	70.0	66.7	0.0	66.7	0.0
Head and neck resection	17	67.7	52.9	17.6	0.0	5.9
Other	188	68.9	61.2	8.0	76.1	11.2
Total	4 874	72.4	47.0	24.8	39.3	14.2

Table 18 (a,b,c,d,e). Predictors influencing the 8 main causes for revision
(Odds ratio and 95% confidence intervals)

a / Influence of age and gender of the revised patients

Co-variables	Aseptic loosening	Dislocation	Wear and/or osteolysis	Periprosthetic fracture	Pain	Acute deep infection	Septic loosening/ chronic infection	Implant fracture
Age	n.s.	n.s.	n.s.	1.07 (1.06-1.08)	0.96 (0.95-0.97)	n.s.	0.98 (0.97-0.99)	n.s.
Female vs male	n.s.	1.29 (1.07-1.56)	n.s.	n.s.	1.96 (1.41-2.72)	0.63 (0.46-0.86)	0.54 (0.42-0.7)	0.45 (0.32-0.65)

- Age is a significant risk factor, influencing the revisions due to periprosthetic fractures and pain: for each additional year of age, the risk of a periprosthetic fracture increases by approx. 7% while the risk of a revision due to pain decreases by approx. 4%.

- Gender significantly influences the risk of revision due to dislocation, pain, acute infection, septic loosening and implant fracture. Females are more prone to experience dislocation, and nearly twice as likely to require a revision due to pain than males, but somewhat less likely than males to require revision due to an acute infection, septic loosening and implant fracture.

b / Fixation of removed THA implants

Co-variables	Aseptic loosening	Dislocation	Wear and/or osteolysis	Periprosthetic fracture	Pain	Acute deep infection	Septic loosening/ chronic infection	Implant fracture
Support ring vs uncemented	2.06 (1.38-3.08)	n.s.	n.s.	0.1 (0.03-0.34)	n.s.	n.s.	5.71 (3.5-9.31)	n.s.
Cemented vs uncemented	3.21 (2.72-3.78)	0.76 (0.6-0.97)	0.19 (0.13-0.27)	0.21 (0.15-0.29)	0.32 (0.18-0.59)	n.s.	1.98 (1.38-2.83)	n.s.
Hybrid vs uncemented	1.51 (1.27-1.79)	0.61 (0.46-0.81)	n.s.	0.44 (0.33-0.59)	0.58 (0.36-0.92)	n.s.	2.77 (2.02-3.81)	n.s.
Reverse hybrid vs uncemented	3.53 (2.35-5.31)	n.s.	0.24 (0.09-0.66)	0.12 (0.04-0.38)	n.s.	n.s.	n.s.	n.s.

- The risk of a revision due to aseptic loosening is more than 3 times higher in primary THAs with cemented fixation compared to uncemented fixation of the implants. However, cemented fixation compared to uncemented fixation reduces the risk for revision due to a dislocation, wear/osteolysis and periprosthetic fracture by factors 0.76, 0.19 and 0.21. It is also less associated with pain.

- Compared to uncemented fixation of both components, the standard hybrid fixation (cup uncemented, stem cemented) presents a 1.5 times higher risk of revision due to an aseptic loosening, while the risk due to periprosthetic fracture is 0.44-times lower.

- Compared to uncemented fixation of both components, the reverse hybrid fixation (cemented cup, uncemented stem) presents 3.5 times higher revision risk due to aseptic loosening, while the risk due to wear/osteolysis and periprosthetic fracture is 0.24 and 0.12-times lower.

- In most cases, the risk of septic loosening follows a similar pattern to aseptic loosening.

c / Type of removed acetabular implant

Co-variables	Aseptic loosening	Dislocation	Wear and/or osteolysis	Periprosthetic fracture	Pain	Acute deep infection	Septic loosening/ chronic infection	Implant fracture
Conventional (std & DM) vs other	2.25 (1.17-4.34)	n.s.	n.s.	n.s.	n.s.	0.33 (0.14-0.79)	0.37 (0.17-0.81)	n.s.
Dual mobility cup vs standard cup	n.s.	0.4 (0.3-0.54)	0.44 (0.32-0.62)	1.62 (1.27-2.05)	2.1 (1.44-3.05)	2.08 (1.51-2.86)	n.s.	n.s.

- Compared to standard cups, dual-mobility cups reduce the risk of revision for dislocation and for wear and osteolysis by a factor of 0.4. Conversely, the risk of revision for periprosthetic fracture and pain is 1.6 and 2.1 times lower with standard cups.

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d / Type of removed acetabular insert

Co-variables	Aseptic loosening	Dislocation	Wear and/or osteolysis	Periprosthetic fracture	Pain	Acute deep infection	Septic loosening/ chronic infection	Implant fracture
Cross-linked PE (HXLPE) vs conventional PE	0.33 (0.26-0.42)	2.23 (1.66-2.98)	0.17 (0.08-0.36)	2.18 (1.6-2.98)	n.s.	n.s.	2.45 (1.73-3.46)	n.s.
Bulk alumina vs conventional PE	0.41 (0.32-0.52)	n.s.	0.02 (0-0.08)	2.5 (1.73-3.6)	2.57 (1.6-4.13)	n.s.	3.15 (1.97-5.04)	3.42 (1.96-5.98)
Sandwich alumina vs conventional PE	0.36 (0.21-0.61)	n.s.	0.07 (0.01-0.5)	2.95 (1.56-5.58)	2.75 (1.2-6.32)	n.s.	n.s.	7.67 (3.7-15.89)
Bulk CoCr vs conventional PE	n.s.	n.s.	n.s.	n.s.	9.42 (3.44-25.79)	n.s.	n.s.	n.s.
Sandwich CoCr vs conventional PE	1.54 (1.04-2.29)	n.s.	n.s.	n.s.	n.s.	n.s.	0.25 (0.1-0.63)	n.s.

- Compared to conventional PE liner, cross-linked PE (HXLPE) reduce the risk of revision for Aseptic loosening and wear and osteolysis by a factor of 0.3 and 0.17, respectively, but may approximately double the risk of dislocation, chronic infection and peri-prosthetic fracture.
- Alumina liners are associated with an increased risk of revision due to periprosthetic fractures, pain and implant fractures, but they are relatively rarely associated with aseptic loosening and wear and osteolysis.
- Bulk CoCr liners are particularly associated with pain as a revision reason.
- The picture for removed femoral heads shows less of a pattern, but one noteworthy observation is that CoCr-heads are associated with strongly increased risk of revision due to septic loosening/chronic infection versus alumina heads.

e / Type of removed femoral head

Co-variables	Aseptic loosening	Dislocation	Wear and/or osteolysis	Periprosthetic fracture	Pain	Acute deep infection	Septic loosening/ chronic infection	Implant fracture
Metal vs alumina	n.s.	n.s.	1.5 (1.09-2.07)	n.s.	n.s.	n.s.	n.s.	n.s.
CoCr vs alumina	0.7 (0.58-0.84)	n.s.	n.s.	n.s.	n.s.	n.s.	3.67 (2.48-5.42)	0.34 (0.16-0.72)
Titanium vs alumina	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Zirconium vs alumina	n.s.	0.28 (0.16-0.48)	2.89 (2.03-4.1)	0.44 (0.25-0.81)	n.s.	0.29 (0.09-0.96)	0.23 (0.07-0.75)	2.04 (1.1-3.77)

PE = polyethylene, n.s. = not significant

NB. The multivariable analyses could only adjust for covariates that were recorded in the SoFCOT registry. Other important co-factors may exist. The precision of some risk estimates needs to be interpreted with care, as the partially wide confidence intervals demonstrate.

Part III: Preliminary analysis of revisions of patients with documented primary THA

This section is expected to develop bit by bit as the number of registered revisions for which information about the primary THA is available in the SoFCOT registry grows. The social security number of the patient, gender and operated side allows establishing a link between the primary and revision interventions, if a revision occurs in one of the participating hospitals. However, as this register only covers a limited selection of hospitals in France it is very unlikely that documentation (or coverage) of revisions occurring after included primaries is complete.

By late February 2020, 516 first revisions (495 from 1 January 2008 to 31 December 2019) could be linked to primary THAs previously registered in SoFCOT. Not surprisingly, the first and most frequent causes of an early revision are hip dislocation, followed by periprosthetic fractures, acute deep infection, aseptic loosening, other causes, cobalt allergy, and implant fracture (Table 19).

Table 19. Characteristics of first revisions of patients with documented primary THA

	Demographics of re-operated patients					Fixation of the revised implants		
Revision cause	**N**	**%**	**Age**	**% female**	**Average interval (years)**	**Cemented**	**Uncemented**	**Hybrid and reverse hybrid**
Aseptic loosening	41	8.3	69.3	63.4	1.4	6	30	5
Deep acute infection	64	12.9	73.0	46.9	0.3	7	49	7
Dislocation	146	29.5	69.4	55.5	0.8	32	104	10
Peri-operative fracture	9	1.8	72.9	66.7	0.2	0	7	2
Implant fracture	12	2.4	59.7	33.3	3.1	3	9	0
Peri-prosthetic fracture	110	22.2	74.6	66.4	0.5	7	86	17
Septic Loosening - chronic infection	24	4.8	64.3	37.5	1.6	1	12	8
Wear and/or osteolysis	4	0.8	61.0	25.0	5.6	0	3	1
Pain	29	5.9	62.9	48.3	1.7	1	27	1
Calcifications	2	0.4	67.5	50.0	1.2	0	2	0
Other	54	10.9	66.9	59.3	1.3	3	50	1
Total	**495**	**100.0**	**69.9**	**49.9**	**0.9**	**60**	**379**	**52**

Revision risk can be assessed by different means. Kaplan-Meier estimates of cumulative revision risk have become an internationally accepted method for reporting and comparing revision risks for different groups, especially if documentation rates are high and mortality information is available to improve the quality of reporting in the presence of so-called censoring (e.g. if a group of older patients due to their higher mortality risk are less and less at risk of implant revision over time). Please see the section on methodological notes below for more details on their limited use in this report.

Alternatively, the revision rate per 100 observed component years (Rp100ocy) was introduced by the Australian joint registry and has gained international acceptance as a measure for implant revision in registries with lower documentation rates.

The formula for the calculation of rp100ocy is:

$$\frac{\text{Number of cases of revision surgery for any reason x 100}}{\text{Number of observed components x observation time in years}}$$

The calculation of this index allows for some basic comparison of different implants even in the absence of more sophisticated survival-type analyses. A systematic review of reports from national registers and clinical studies analysed with respect to revision rates has established that, after primary hip replacement, a mean of 1.29 revision per 100 observed component years may be expected as a norm value[1].

Table 20. Cumulative annual revisions per 100 observed component years (Rp100ocy)

Year (t)	Total THAs (up to year t)	Observed component Years (up to year t)	Number Revised (up to year t)	Rp100ocy	Exact 95% Confidence interval	
2008	3780	5066	26	**0.51**	0.35	0.75
2009	4870	9372	35	**0.37**	0.27	0.52
2010	6552	15036	57	**0.38**	0.29	0.49
2011	8368	22435	84	**0.37**	0.30	0.46
2012	11326	32234	127	**0.39**	0.33	0.47
2013	14356	44995	185	**0.41**	0.36	0.47
2014	18541	61253	221	**0.36**	0.32	0.41
2015	24183	82327	291	**0.35**	0.32	0.40
2016	29705	109169	364	**0.33**	0.30	0.37
2017	35300	141397	398	**0.28**	0.26	0.31
2018	40308	178809	443	**0.25**	0.23	0.27
2019	45397	221289	495	**0.22**	0.20	0.24

Note: Wilson score intervals were used to calculate the limits of 95% Confidence Intervals.

At the end of 2019, after 13 years of observation, the average follow-up of the 45 397 primary THAs registered is 4.9 years.

[1] *G. Labek,M. Thaler,W. Janda,M. Agreiter,B. Stöckl. Revision rates after total joint replacement. CUMULATIVE RESULTS FROM WORLDWIDE JOINT REGISTER DATASETS. J Bone Joint Surg [Br] 2011;93-B:293-7.*

Table 21 presents the various Rp100ocy that can be calculated by creating different implant strata by type of implant and type of implant fixation. In the previous report, standard cups featured slightly better Rp100ocy than Dual Mobility cups. However, the difference between standard cups and dual mobility cups has been narrowing and is now statistically insignificant. All-cemented fixation THAs show slightly better Rp100ocy than all cemented ones, but that difference also is statically insignificant.

Table 21. Overall Rp100ocy by implant type and fixation used in primary THA

By type of implant	Total THAs	Observed component years	Number revised	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
Conventional THA	40584	203094	447	5.0	**0.22**	0.20	0.24
Femoral prosthesis with mobile cup (bipolar)	2062	8048	28	3.9	**0.35**	0.24	0.50
Full resurfacing	354	2654	0	7.5	**0.00**	0.00	0.14
By type of cup							
Standard cup	25489	141816	306	5.6	0.22	0.19	0.24
Dual mobility cup	17824	71365	161	4.0	0.23	0.19	0.26
By type of implant fixation	**Total THAs**	**Observed component years**	**Number revised**	**Average FU (years)**	**Rp100ocy**	**Exact 95% Confidence interval**	
Cemented	3958	28915	57	7.3	**0.20**	0.15	0.26
Uncemented	32111	142928	381	4.5	**0.27**	0.24	0.29
Hybrid (uncemented cup, stem cemented)	8697	46345	51	5.3	**0.11**	0.08	0.14
Reverse hybrid (cemented cup, stem uncemented)	528	2626	3	5.0	**0.11**	0.04	0.34

Table 22 shows the Rp100ocy by type of the five most common bearing combinations in primary THA. Note that Metal-Metal bearings (either conventional THA with 28 or 32mm head size and resurfacing) show a lower Rp100ocy than the other categories, despite the longer follow-up. This is likely due to a mixture of “survivor effect” and “censoring effect”. As the average follow-up time in years shows, these are rather old implants and many of the patients may not actually be at risk of revision anymore. Furthermore, as the cumulative risk curve is rather flat after a few years, the rp100ocy index tends to be considerably depressed compared to relatively young implants (as observation years are added much faster than additional revisions).

Table 22. Overall Rp100ocy by bearings used in primary THA by number of inclusions

By bearing type	Total THAs	Observed component years	Number revised	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
Alumina / alumina	13348	64061	155	4.8	**0.24**	0.21	0.28
Alumina / PE	11506	53079	111	4.6	**0.21**	0.17	0.25
Stainless steel / PE	8853	49199	103	5.6	**0.21**	0.17	0.25
Cobalt-chrome / PE	9897	42989	112	4.3	**0.26**	0.22	0.31
Metal / metal	962	8518	6	8.9	**0.07**	0.03	0.15

A different perspective can be gained by comparing cumulative revision risks.

Figure 14 shows that the risk of revision is initially very similar for dual mobility cups and standard cups. However, from the second year after implantation onwards standard cups show a steeper increase in cumulative revision risk, leading to a relatively pronounced difference by year six after primary implantation.

In Figure 15, we see that the revision risk of bipolar femoral prostheses (hemi-arthroplasties) in acute fractures appears to be initially much higher than that of conventional THAs in acute fractures. By year 5, however, this difference has shrunk considerably as conventional THAs appear to catch up, rendering the initial difference entirely statistically insignificant.

However, caution must be applied to the interpretation of both figures as the groups differ in their age distribution. Both DM cups and bipolar cups are used in older patients than conventional cups. In the absence of group-specific mortality data, the “older” groups will show an increasing downward bias due to the disproportionate loss of members that are not at risk of revision anymore at some point. In other words, if a patient dies his or her implant cannot be revised anymore. It is for this reason that we restrict these Kaplan-Meier curves to just a few years. The impact of mortality on the results shown is limited in the first 5-6 years after implantation as the vast majority of patients are likely to survive this time period.

Figure 16 highlights that there is no apparent difference in the revision risk associated with conventional PE liners versus cross-linked (HXLPE) PE. In terms of raw figures, HXLPE liners are slightly above conventional PE liners, but the difference is not statistically significant at any time point after primary operation.

Figure 14. KM estimate of cumulative revision risk for standard cups vs. dual mobility cups

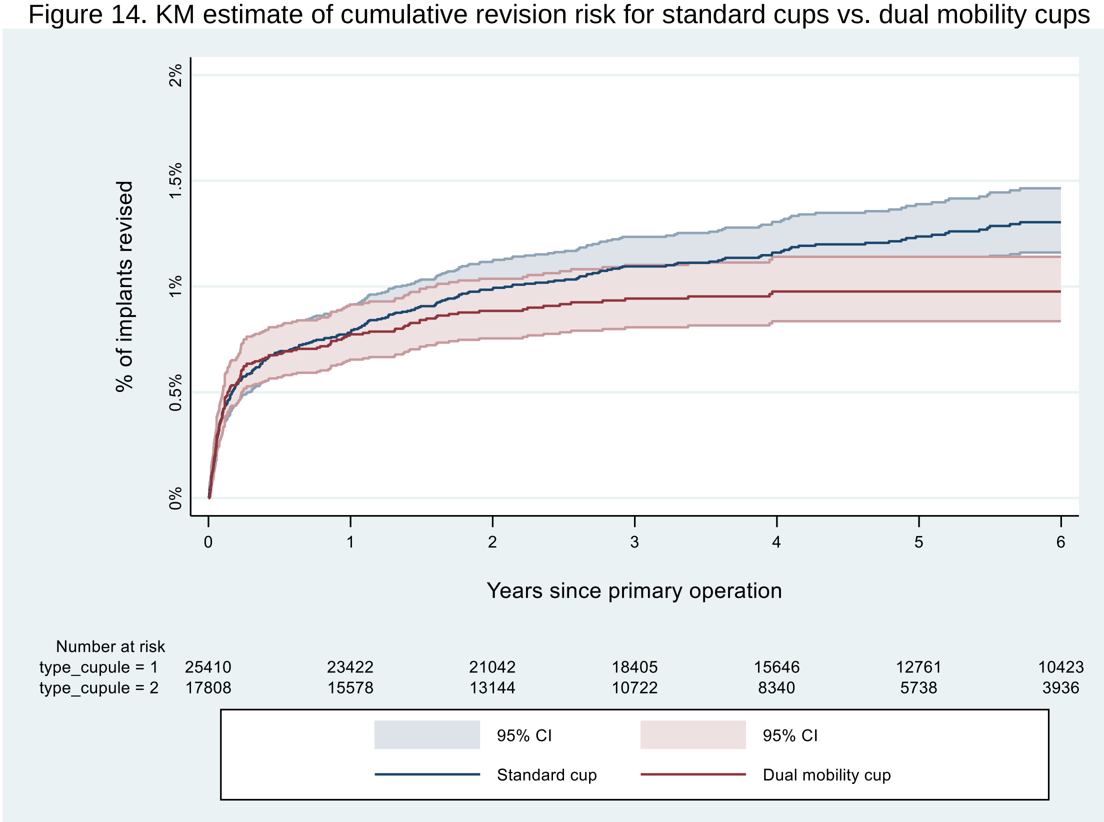


Figure 15. KM estimate of cumulative revision risk for THA vs. Hemi-arthroplasty with mobile cups in acute fractures

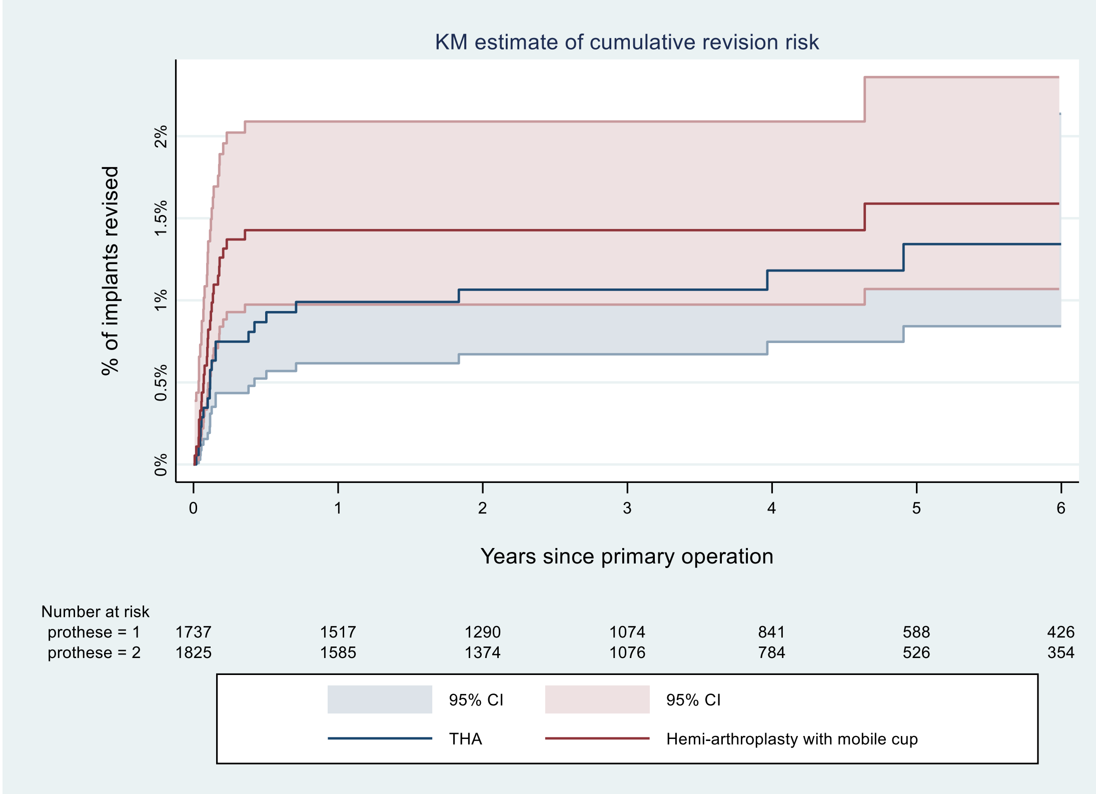
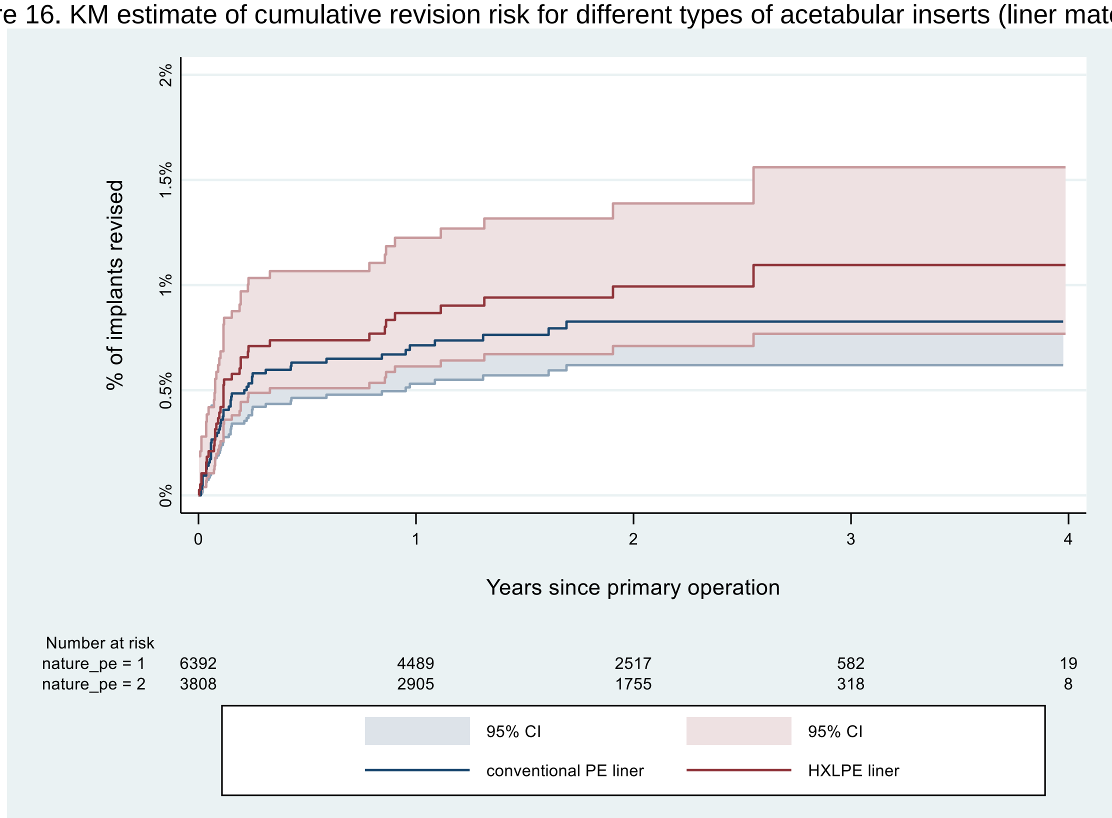


Figure 16. KM estimate of cumulative revision risk for different types of acetabular inserts (liner material)*



* Data available since 2016

We conducted an analysis for all implant brands used in primary THA. Components with less than 50 primary implantations were excluded from the Rp100ocy calculation.

Considering the aforementioned Rp100ocy norm value of 1.3, all corresponding implants showing an Rp100ocy above this value might raise concern.

Table 23. Rp100ocy of standard acetabular implants used in primary THA by decreasing order

Standard CUP cemented	Total THAs	Number revised	Observed component years	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
MKIII	562	9	5854	10.4	0.154	0.081	0.292
INITIALE	326	2	2276	7	0.088	0.024	0.32
Original Mueller	470	4	3760	8	0.106	0.041	0.273
CHIRULEN	174	5	371	2.1	1.348	0.577	3.116
EXAFIT	81	1	684	8.4	0.146	0.026	0.824
Standard CUP uncemented	**Total THAs**	**Number revised**	**Observed component years**	**Average FU (years)**	**Rp100ocy**	**Exact 95% Confidence interval**	
PINNACLE	3666	24	16499	4.5	0.145	0.098	0.216
RM PRESSFIT	2329	27	10468	4.5	0.258	0.177	0.375
CERAFIT	1487	23	8818	5.9	0.261	0.174	0.391
ALLOFIT	1181	11	6559	5.6	0.168	0.094	0.3
VERSAFITCUP*	1038	17	3661	3.4	0.464	0.286	0.716
TRIDENT	966	7	6695	6.9	0.105	0.051	0.216
TREGOR	724	4	5894	8.1	0.068	0.026	0.174
CONTINUUM	548	2	1349	2.5	0.148	0.041	0.539
ABG 2	482	21	3642	7.6	0.577	0.377	0.88
HYPE	465	0	1154	2.5	0	0	0.332
APRIL	398	5	893	2.2	0.56	0.239	1.304
DELTA	323	3	2056	6.4	0.146	0.05	0.428
HORIZON	289	2	826	2.9	0.242	0.066	0.879
MUST	260	5	1063	4.1	0.47	0.201	1.096
SELENE	229	6	2606	11.4	0.23	0.106	0.501
ETERNITY	228	8	1688	7.4	0.474	0.24	0.932
SYMBOL*	206	3	525	2.6	0.571	0.291	1.004
ATLAS 4	201	8	1168	5.8	0.685	0.348	1.346
ALLOCLASSIC	186	4	1820	9.8	0.22	0.085	0.564
SELEXYS	167	3	921	5.5	0.326	0.111	0.953
SELF CENTERING	124	10	595	4.8	1.68	0.915	3.065
ATLAS 3	121	3	667	5.5	0.45	0.153	1.315
X.CUP*	117	1	339	2.6	0.29	0.11	0.723
LAGOON	97	0	1260	13	0	0	0.304
DELTAMOTION	90	0	418	4.6	0	0	0.911
CARGOS	87	1	627	7.2	0.159	0.028	0.897
MIXT	71	1	333	4.7	0.3	0.053	1.679

* This cup also has a DMC variant

Table 24. Rp100ocy of Dual Mobility acetabular components used in primary THA by decreasing order

Double mobility CUP cemented	Total THAs	Number revised	Observed component years	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
NOVAE	163	1	572	3.5	0.175	0.031	0.984
SATURNE	107	4	387	3.6	1.033	0.402	2.625
Double mobility CUP uncemented	**Total THAs**	**Number revised**	**Observed component years**	**Average FU (years)**	**Rp100ocy**	**Exact 95% Confidence interval**	
NOVAE	3188	22	11655	3.7	0.189	0.125	0.286
QUATTRO	2011	6	7799	3.9	0.077	0.035	0.168
SATURNE	1987	11	7947	4	0.138	0.077	0.248
AVANTAGE	1314	29	5558	4.2	0.522	0.364	0.748
ADM	1024	13	3357	3.3	0.387	0.226	0.661
TREGOR	723	4	5891	8.1	0.068	0.026	0.174
GYROS	660	9	3448	5.2	0.261	0.137	0.495
ADES	601	5	2028	3.4	0.247	0.105	0.576
LIBERTY	527	8	2103	4	0.38	0.193	0.749
SYMBOL*	355	3	918	2.6	0.327	0.111	0.956
CAPITOLE	333	4	1028	3.1	0.389	0.151	0.997
STAFIT	307	1	2122	6.9	0.047	0.008	0.266
EVORA	300	1	1361	4.5	0.073	0.013	0.415
POLARCUP	169	3	695	4.1	0.432	0.147	1.262
SELEXYS DS	132	1	790	6	0.127	0.022	0.713
STANDARD cup Aston Medical	114	0	597	5.2	0	0	0.639
EVOLUTION	89	0	181	2	0	0	2.074
Double mobility CUP uncemented	**Total THAs**	**Number revised**	**Observed component years**	**Average FU (years)**	**Rp100ocy**	**Exact 95% Confidence interval**	
VERSAFITCUP*	88	0	190	2.2	0	0	1.983
X.CUP*	78	3	167	2.1	**1.796**	0.613	5.146
HIP AND GO	69	1	317	4.6	0.315	0.056	1.763

* This cup also has a standard variant

Table 25. Rp100ocy of Femoral components used in primary THA by decreasing order

STEM cemented	Total THAs	Number revised	Observed component years	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
INITIALE	1378	2	6191	4.5	0.032	0.009	0.118
STANDARD stem AVENIR Zimmer	935	2	2638	2.8	0.076	0.021	0.276
EXAFIT	930	7	7334	7.9	0.095	0.046	0.197
ABG 2	719	5	2426	3.4	0.206	0.088	0.482
STANDARD stem PF Zimmer	702	2	5731	8.2	0.035	0.01	0.127
LEGEND	426	5	4576	10.7	0.109	0.047	0.256
AMISTEM	368	6	1310	3.6	0.458	0.21	0.996
DEDICACE	301	4	2669	8.9	0.15	0.058	0.385
CCA	297	4	1449	4.9	0.276	0.107	0.708
OSTEAL	292	3	1920	6.6	0.156	0.053	0.458
CMK MOD	226	1	768	3.4	0.13	0.023	0.733
GENERIC	213	5	541	2.5	0.925	0.396	2.146
STANDARD stem INSTITUTION Groupe Lépine	206	0	1169	5.7	0	0	0.328
STANDARD stem Tornier	186	1	1051	5.7	0.095	0.017	0.537
OCEANE	178	0	843	4.7	0	0	0.454
CENTRIS	75	1	440	5.9	0.227	0.04	1.275
STANDARD stem EXCEPTION Biomet	73	1	250	3.4	0.4	0.071	2.23
HARMONY	68	0	195	2.9	0	0	1.934
CORAIL (unspecified)	60	1	198	3.3	0.505	0.089	2.806
STEM uncemented	**Total THAs**	**Number revised**	**Observed component years**	**Average FU (years)**	**Rp100ocy**	**Exact 95% Confidence interval**	
STANDARD stem CORAIL 2 DePuy	5614	53	25125	4.5	0.211	0.161	0.276
STANDARD stem Avenir Zimmer	3520	45	14561	4.1	0.309	0.231	0.413
STANDARD stem EXCEPTION Biomet	2271	34	11225	4.9	0.303	0.217	0.423
STANDARD stem HAP TARGOS (130° & ctc 135°) Groupe Lépine	1350	6	6645	4.9	0.090	0.041	0.197
HAP TARGOS mini stem	1079	5	4263	4.0	0.117	0.050	0.274
THELIOS	1000	9	6456	6.5	0.139	0.073	0.265
INTEGRALE	964	8	2824	2.9	0.283	0.144	0.558
AMISTEM	701	10	2655	3.8	0.377	0.205	0.692
ALLOCLASSIC	531	7	3950	7.4	0.177	0.086	0.365
STANDARD stem OPTIMYS Mathys	431	3	1006	2.3	0.298	0.101	0.873
TWINSYS	367	5	1623	4.4	0.308	0.132	0.719
ACCOLADE II	361	11	516	1.4	2.133	1.195	3.779
RMIS	340	3	1520	4.5	0.197	0.067	0.579
HELMED	281	4	1668	5.9	0.24	0.093	0.615
STANDARD stem HYPE Serf	267	1	657	2.5	0.152	0.027	0.857
ABG 2	245	12	1629	6.7	0.737	0.422	1.283
LINEA	231	6	2601	11.3	0.231	0.106	0.502

STEM uncemented	Total THAs	Number revised	Observed component years	Average FU (years)	Rp100ocy	Exact 95% Confidence interval	
SPS EVOLUTION	205	2	375	1.8	0.533	0.146	1.923
STANDARD stem SL-Plus Smith & Nephews	202	4	1461	7.2	0.274	0.107	0.702
STANDARD stem CORAIL Arthros	183	0	600	3.3	0	0	0.636
STANDARD stem PAVI Groupe Lépine	182	2	656	3.6	0.305	0.084	1.104
H-MAX	171	0	821	4.8	0	0	0.466
AURA	169	5	1066	6.3	0.469	0.201	1.094
HARMONY	168	2	539	3.2	0.371	0.102	1.343
FITMORE	153	0	722	4.7	0	0	0.529
CORAIL (unspecified)	142	3	922	6.5	0.326	0.111	0.953
STANDARD stem LIBRA Serf	137	0	597	4.4	0	0	0.639
VALMER	134	1	500	3.7	0.2	0.035	1.123
STANDARD stem LOUXOR SEM	123	0	431	3.5	0	0	0.883
ABG 2 MODULAR	101	20	794	7.9	2.518	1.636	3.857
LIBRA	101	0	636	6.3	0	0	0.6
CERAFIT-MULTICONE	68	2	777	11.4	0.257	0.071	0.934
BHS	66	1	302	4.6	0.331	0.058	1.849
STANDARD stem POLAR Smith & Nephews	66	0	318	4.8	0	0	1.194

Methodological notes

Register coverage/documentation rate: The SoFCOT THA register covers a relatively small fraction of all hip arthroplasties done in France each year. However, its participants represent a stable group of mostly very experienced orthopaedic surgeons (n=108) in more than 80 hospitals that have made a commitment to entering all relevant primary and revision procedures.

Implant library: Implants are registered as individual components, e.g. femoral stems, acetabular cups/inserts etc., allowing for detailed analyses of relevant components or component combinations (e.g. a stem/cup combination). As of 2020, the SwissRDL implant library, of which SoFCOT represents a part, only allows entering (or scanning) implants that are already recognised by the data entry system, or directs the user to a formal procedure for registering new implants. Prior to this new arrangement, entering new implants was a much more flexible business that led to an abundance of individual implant entries that were often inconsistent and incomplete. This made grouping and analysing implants a more difficult task and especially the implants registered in the earlier days of the register suffer from relatively low recognition rates, by which we mean that they could not be reliably assigned to named brands as analysed in this report. However, building the SwissRDL implant library is an ongoing project and we keep adding manufacturer's catalogue information to the library and we write ever more refined "implant recognition scripts" to pick out previously unrecognised implants. Therefore, recognition rates could still improve even for older implants.

Estimation of revision rates: The first requirement for estimating revision rates is that revision procedures are actually captured by the register. Revisions undertaken by the same orthopaedic surgeon who did the primary implant should generally find their way into the SoFCOT register. We do not know, however, how likely it is in the case of the participating surgeons that a patient will undergo a revision procedure elsewhere. From the Swiss hip and knee register SIRIS we do know that on average 78% of revisions are undertaken in the same hospital that provided the primary operation. In the absence of national coverage of all hip arthroplasties, we can thus be certain that the revision rates reported in this report represent a certain underestimate of unknown extent. Another factor affecting revision rates is patient mortality. If a patient dies, a revision of his or her implant cannot be observed anymore. If mortality data is not linked to a register, observed long-term revision rates of a cohort of patients will become increasingly underestimates of the true revision rate because the denominator (number of patients in cohort) will increasingly be made up of individuals that are not at risk of revision anymore. When using Kaplan-Meier estimates of cumulative revision risk this can result in misleading comparisons between patient groups with different age distributions, unless death or other reasons for loss-to-follow-up are entered as censoring events into the analysis (and even then, high mortality figures may require so-called competing risk analyses). We do not currently link mortality data to the SoFCOT register, but we do draw on the Swiss SIRIS data for comparison purposes. This allows us to make informed choices on whether to present or not to present certain group comparisons and for which time spans.

The steering group of the SoFCOT THA register would like to extend its sincere gratitude to all French orthopedic surgeons who are collaborating or have collaborated regularly to keep this register updated.

To join the register, please find more information on the SoFCOT web page

http://www.sofcot.fr/Pages/Registre-des-protheses-de-hanche

Heading: « COMMENT OBTENIR VOTRE MOT DE PASSE »
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