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SUPPLEMENT REGISTRIES

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THE CERAMIC EXPERTS

Registries 2023 in Review

Dr. Alessandro Alan Porporati
Director Medical and Scientific Affairs
CeramTec GmbH, Germany

Dear Readers,

I am happy to share with you this new edition of the CeraNews supplement dedicated to arthroprosthetic registries, in which, as in previous editions, we gather trends on the use of articular bearings from the “real world” of total hip arthroplasty.

Not surprisingly, we focus on the use and performance of ceramic materials for hip replacements as documented by seven major national arthroplasty registries: NJR, AOA NJRR, EPRD, AJRR, NZJR, SAR, and LROI.

Readers' feedback has been extremely generous since we started, so we are thrilled to hear your feedback on this CeraNews registry supplement issue and hope that our readers will enjoy this 2024 edition as well. The previous editions have met with considerable success, and so we try each year to improve and offer new data as soon as the annual registry reports are publicly available. The lack of harmonization among registries still makes this task difficult, but we still strive year by year to improve it.
I sincerely hope you enjoy it.

Fixation

Like every year, interesting new trends are caught or trends that were weak and are strengthening to significance.Indeed, the data from 2023 reveals an interesting shift towards hybrid fixation techniques across most registries. Notably, the NJR and NZJR now report hybrid fixation as the top choice for hip replacements, indicating a clear shift away from uncemented fixation. For the first time, hybrid fixation has overtaken uncemented methods in the NZJR, covering 45% of procedures. This trend signifies a growing preference for combining the best of both worlds to improve surgical outcomes.

Ceramic Femoral Heads: The New Standard

Ceramic femoral heads confirm their popularity, becoming the preferred choice in many regions. According to the 2023 data, 54.2% of all total hip replacements (THRs) in the NJR, 90.4% in the EPRD, 27% in the SAR, and 75.9% in the LROI utilized ceramic femoral heads. The AJRR reports a cumulative usage rate of 81.4% from 2012 to 2022, reflecting a 3.4% increase from 2021. This growing adoption underscores the clinical trust in ceramic materials, known for their durability and superior performance.

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Registries 2023 in Review

Ceramic-on-Polyethylene (CoP) bearings has emerged as the most favored bearing option in the NJR, EPRD, AJRR, NZJR, and LROI. The shift towards CoP bearings is primarily at the expense of Metal-on-Polyethylene (MoP) and Ceramic-on-Ceramic (CoC) bearings despite excellent results in the registries for ceramic monobloc constructs. The preference for CoP highlights its excellent clinical outcomes it delivers.

Delta Ceramic-on-Ceramic Resurfacing

The AOA NJRR documented 346 MatOrtho ReCerf® hip resurfacing, while the NJR reported 249 Embody Ltd. H1® hip resurfacing procedures. Early results are promising, with significantly lower revision rates for BIOLOX®*delta* Ceramic-on-Ceramic (CoC) resurfacing compared to Metal-on-Metal (MoM) resurfacing, particularly in the short term. These findings are a first indication that modern ceramics could redefine the standards of hip resurfacing.

Expanding Use of Dual Mobility Bearings

Dual mobility bearings are gaining more users in both primary and revision hip arthroplasty procedures. The NJR is currently the only registry reporting the use of ceramic heads within dual mobility constructs, with 41% of these implants featuring ceramic heads in primary procedures.

While we keep observing these advancements, it's crucial to address ongoing challenges. Infection remains the leading cause of revision surgeries in both Australia (23.3%) and the United States (22.5%), highlighting the need for enhanced infection control protocols. Aseptic loosening, dislocation, and periprosthetic fractures continue to be significant concerns, requiring continuous innovation and vigilance.
Today's popularity of ceramic materials in hip arthroplasty, introduced in the 1970s by pioneers such as Prof. Boutin and Prof. Mittelmeier, is the evidence of the power of innovation and evidence-based practice. As we now anticipate the publication of the 2024 hip registries starting after this summer, we at CeramTec remain committed to advancing orthopaedic care for the benefit of healthcare systems and patient outcomes.

Happy Reading

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Executive Summary

This is the summary of the most relevant information about total hip arthroplasty procedures recorded from seven national arthroplasty registries (NJR, AOA NJRR, EPRD, AJRR, NZJR, SAR and LROI) and presented in the respective annual reports 2023. These seven registries have been chosen, because they have been defined to be the most relevant, in terms of number of procedures annually recorded and/or quality of the data collected and analysed.

Fixation - A trend toward hybrid fixation can be observed in all six national registries except the AJRR. The hybrid fixation is the most popular choice for hip replacement as recorded by the NJR and NZJR. This is the first year that hybrid fixation has overtaken uncemented fixation (45%) as the most used form of fixation in NZJR. When only considering femoral head diameter in THRs, 32mm femoral head is the most common head size according to the considered European registries and NZJR, whereas the AOA NJRR and AJRR report a larger usage of the 36mm heads. There is also a trend towards 36mm femoral heads reported by the NZJR, EPRD and AJRR.

Ceramic - According to annual data, 54.2% of all THRs registered in NJR, 90.4% in EPRD, 27% in SAR, and 75.9% in LROI were performed with ceramic femoral heads. This accounts for an increase of more than 3.2% in NJR, 1% in EPRD, and 3.1% in LROI compared to the usage rates in 2021. The AJRR reported a cumulative data of ceramic femoral heads usage (2012-2022) achieved to 81.4% in 2022, with an 3.4% of increase more than 2021. While SAR declined slightly from 27.2% in 2021 to 26.9% in 2022. The use of CoP bearings has generally increased in 2022. CoP has become the most preferred bearing option of THRs in the NJR, EPRD, AJRR, NZJR, and LROI. The increased use of CoP bearings is mainly on the expense of MoP and CoC bearings.

Dual Mobility - The use of dual mobility bearings has steadily increased over the years both in primary THRs and revision procedures. The NJR is currently the only registry reporting the use of ceramic heads within dual mobility constructs, and about 41% of the total dual mobilities implanted in a primary procedure in 2022 had a ceramic head. The NJR confirms that the CoPoM dual mobility bearings show lower revision trend than the MoPoM combinations, but with no statistical significance. 346 CoC hip resurfacing (MatOrtho ReCerf®) procedures have been documented by the AOA NJRR with a cumulative revision rate of 0.3% (0.0%, 2.1%) at 1 year, and at 3 years (0.3% (0.0%, 2.1%)), with only 1 revision of all 346 procedures, was lower than other MoM resurfacing. Revision rate of 249 CoC resurfacing procedures is recorded by the NJR for the first time in 2022, the early revision rate at 1 year for CoC resurfacing is lower compared to MoM resurfacing at 3 years (1.91% (0.71%, 5.11%) vs. 2.90% (2.74%, 3.06%)) and 5 years (1.91% (0.71%, 5.11%) vs. 5.06% (4.85%, 5.28%)).

Revision - As far as the most common reasons for revision are concerned, (aseptic) loosening, infection, dislocation and (periprosthetic) fractures top the list in varying order. Infection has become the most common reason of all revision procedures in Australia (23.3%) and the United States (22.5%, 2012-2022). Revision rates for infection in other registries have increased year on year.

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According to the NJR, the revision rates for CoP bearings remain consistently low or equivalent to those of other bearings up to 18 years. Remarkably, the NJR shows that good results were obtained with CoC and CoP bearings in young patients. The AOA NJRR Annual Report 2023 shows a statistically significant lower rate of revision of CoXLPE in comparison with MoXLPE after 2 years (HR=0.77 (0.72, 0.82), p<0.001). According to the EPRD, CoC had a significantly lower revision rate over the entire period than the other bearings, with the exception of CohXLPE+Antioxidants. Regardless of the fixation method, the NZJR shows that the revision rate for CoC bearings is lower than that for CoP and MoP. The revision rate for CoP is also lower than that of MoP. LROI also shows that CoC had a significantly lower cumulative major revision rate compared to CoP and MoP at 10 years.

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General Information of National Joint Registries

Table 1: General information of national joint registries.

Evaluation of the data by CeramTec based on the demographic information provided by Annual Reports 2023 of NJR, AOA NJRR, EPRD, AJRR, NZJR, SAR, and LROI.
[1] 1,364 institutions submitting data to the AJRR from across all 50 states and the District of Columbia are recorded by end of 2022.
* Indicates single year data only generated in 2022.

	NJR	AOA NJRR	EPRD	AJRR	NZJR	SAR	LROI
Name	National Joint Registry	Australian Orthopaedic Association National Joint Replacement Registry	Endoprothe-senregister Deutschland	American Joint Replacement Registry	The New Zealand Joint Registry	Swedish Arthroplasty Register	Dutch Arthroplasty Register
Area Coverage	England, Wales, North-ern Ireland, the Isle of Man and Guernsey	Australia	Germany	United States[1]	New Zealand	Sweden	Netherlands
Participation	Mandatory	Mandatory	Voluntary (from 2025 Mandatory)	Voluntary	Voluntary	Mandatory	Mandatory
Completeness	approx. 100%	99%	70%	___	70%	approx. 98%	approx. 98%
Duration	2003-2022	1999-2022	2012-2022	2012-2022	1997-2022	2005-2022	2007-2022
Type of Joint	Hips, knees, ankles, elbows, and shoulders	Hips, knees, and shoulders	Hips and knees	Hips and knees	Hips, knees, ankles, elbows, and shoulders	Hips and knees	Hips, knees, ankles, shoulders, elbows, wrists, and fingers
Primary hip replacement procedures	1,448,541 (All resurfacing: 2.9%; THRs: 94.3%, 2003-2022)	850,603 (THRs: 642,704, Resurfacing: 3.1%, 1999-2022)	177,826 (THR: 88.1%, 2022)*	THRs: 1,014,772 (2012-2022) (Elective primary THRs)	THRs: 173,306 (1997-2022)	Total and Hemi HRs: 541,078 (1979-2022)	THRs: 423,773 (2007-2022)
Gender	Male 40.2%	Male 45.1%	Male* 41%	___	Male 46.3%	Male 42%	Male* 36%
	Female 59.8%	Female 54.9%	Female* 59%		Female 53.7%	Female 58%	Female* 64%
Mean age years (SD)	68.2 (11.4)	67.8 (11.5)	70*	65.7 (11.3)	Male 65.9	69	69.4 (10.5)*
					Female 68.6		

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[1] 1,364 institutions submitting data to the AJRR from across all 50 states and the District of Columbia are recorded by end of 2022.
* Indicates single year data only generated in 2022.

	NJR	AOA NJRR	EPRD	AJRR	NZJR	SAR	LROI
Main Surgery Indication	Osteoarthritis (91.2%)	Osteoarthritis (88.2%)	—	—	Osteoarthritis (88.2%)	Osteoarthritis (93%)	Osteoarthritis (86.1%)*
ASA Score	ASA 1: 14.9% ASA 2: 67.7% ASA 3: 16.8% ASA 4: 0.6% ASA 5: <0.1%	ASA 1: 9% ASA 2: 52.4% ASA 3: 36.7% ASA 4: 2% ASA 5: 0	Mean ASA: 2.2%*	—	—	ASA 3-4 : 19.9%	ASA 1: 14%* ASA 2: 60%* ASA 3-5: 26%*
BMI (kg/m²)	—	Underweight: 1.1% Normal: 22.1% Pre-Obese: 36.6% Obese Class 1: 24.8% Obese Class 2: 10.4% Obese Class 3: 5.1%	Mean BMI: 27.2*	—	Mean BMI: 29.13 (5.73)	Mean BMI: 27.3	Mean BMI: 27.2 (4.6)*
Survival Rate	Cumulative Revision (95% CI): 8.17% (7.99%-8.35%) at 19-year	Revision burden in 2022 is 7.3% (lowest burden yet). Cumulative Revision (95% CI): 11.5% (11.2%-11.7%) at 20 years	Cumulative Revision of elective hip replacements with uncemented stem fixation (95% CI): 4.3% (4.2%-4.5%) at 8-year Cumulative Revision of elective hip replacements with cemented stem fixation (95% CI): 4.1% (3.8%-4.3%) at 8-year	—	85.60% at 20-year	Revision rate decreased to 9.8% in the period 2020–2022	Cumulative Revision of THRs (95% CI): 6.02% (5.88%-6.16%) at 14-year
Total number of primary hip joint replacements in 2021	99,043 (All resurfacing: 0.7% THRs: 98%)	THRs: 42,923	177,826 (THR: 88.1%, 2022)*	—	THRs: 9,207	18,339 primary elective hip replacements	THRs: 36,707

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Demographics

Total Hip Replacements (THRs) by Fixation

Apart from the AJRR's classification of fixation methods into uncemented fixation stem group and cement fixation stem group, a clear overall trend towards hybrid fixation can be observed in all six identified national registries.

In Australia, Germany, the United States, and the Netherlands, uncemented fixation is still the most commonly used method. In Sweden, the use of cemented fixation decreased over the years, but still accounts for 52% of all THR procedures.

Hybrid fixation was documented to be utilized in 40.3%, 36.2%, and 51% by NJR, AOA NJRR and NZJR, respectively. Hybrid fixation is the most popular choice for hip replacement, according to the NJR and NZJR. This is the first year that hybrid fixation has replaced uncemented fixation as the most commonly used form of fixation in New Zealand.

NJR

In 2022, 19.1% of primary hip replacements recorded in the NJR dataset were cemented fixation, 36.2% were uncemented fixation, and 40.3% were hybrid fixation. The use of cemented fixation in all hips has decreased by almost three times, from 53.5% in 2004 to 19.1% in 2022, while the percentage of uncemented fixation has increased from 18.3% in 2004 to a peak of 44.1% in 2012, then dropped to 36.2% in 2022. The usage of hybrid fixation has more than tripled, from 12.5% in 2004 to 40.3% in 2022.[1]

AOA NJRR

In Australia, there is a continuing trend for uncemented fixation to increase from 51.3% in 2003 to 61.9% in 2022. The percentage of hybrid fixation decreased slightly from 36.8% in 2020 to 36.2% in 2022, while the numbers for cemented fixation decreased significantly from 13.9% in 2003 to 1.9% in 2022. This trend stabilizes in 2022 compared to the situation in 2021.[2]

EPRD

Uncemented fixation remains the most popular fixation modality, accounting for 77.2% of procedures. Hybrid fixation increased from 15.7% in 2016 to 17.5% in 2021, then to 17.9% in 2022, while cemented fixation accounted for 3.7% in 2022.[3]

AJRR

In the United States, uncemented femoral stem fixation remains clearly the preferred

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option. It was used in 95.4% of all elective primary THR procedures in 2022. To note, 4.6% of femoral stems were cemented, which is lower than that in other international registries, and there was a significant increase in cemented fixation with advancing age ($p<0.0001$).[4]

NZJR

The usage of cemented hip replacement has fallen to about 4% in 2022. From 2010 to 2020, the use of hybrid fixation was on an upward trend, then decreasing slightly in 2021 and rising to 51% in 2022. This is the first year that hybrid fixation has overtaken uncemented fixation (45%) as the most commonly used form of fixation.[5]

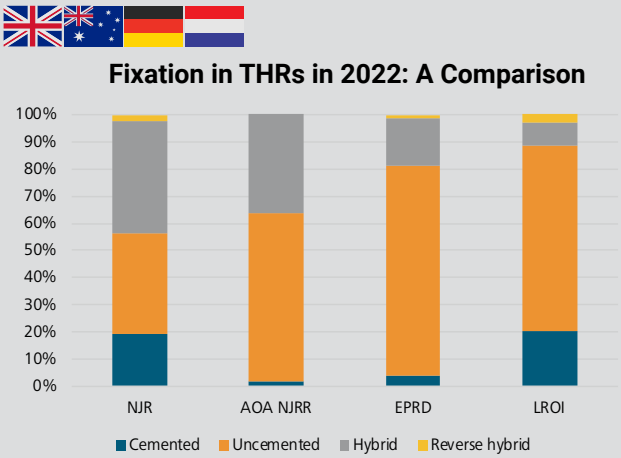
SAR

Over the past 20 years, the use of cemented fixation has declined each year until 2020. The percentage of fully cemented fixation was 52% in 2021 and again in 2022. Cemented fixation is more commonly used in female patients. The registry still encourages cemented fixation for patients over 70 years old. The percentage of uncemented fixation is about 33% in 2022, occurring mainly in the under-75 age group. The proportion of hybrid prostheses raised from 7.1% in 2020 to 8% in 2021 then to about 9% in 2022.[6]

LROI

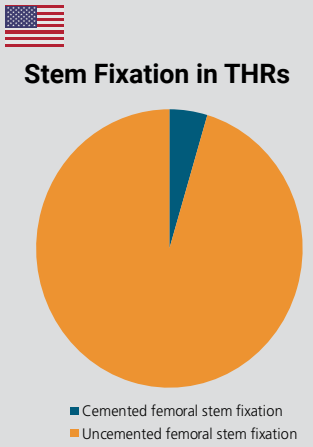
In 2022, uncemented fixation remains the preferred method of fixation in the Netherlands, with a small and sustained increase in use from 62.8% in 2013 to 68.1% in 2022. The use of cemented fixation decreased slightly each year to 20.4% in 2022. The use of hybrid fixation is on an upward trend, from 4.6% in 2013 to 8.6% in 2022.[7]

Figure 1a: Distribution of fixation methods in primary THRs in 2022 (Annual Data): in Australia, Germany, Netherlands as well as England, Wales, Northern Ireland, the Isle of Man and Guernsey.



Evaluation of the data by CeramTec is based on NJR Annual Report 2023 Page 54 Table 3.H2, AOA NJRR Annual Report 2023 Page 106 Figure HT3, EPRD Annual Report 2023 Page 30 Table 6, and LROI Annual Report 2023 Page 21 Figure Fixation. For the comparison of THR's fixation methods, unconfirmed data and all resurfacing data were excluded when analyzing datasets from the NJR and EPRD. The usage percentage of cemented, uncemented, hybrid and reverse hybrid fixations sum up to 100%.

Figure 1b: Distribution of femoral stem fixation methods in primary THRs (2012-2022) in the USA.



Evaluation of the data by CeramTec based on AJRR Annual Report 2023 Page 42 Figure 2.22.

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THRs by Femoral Head Diameter

When considering only femoral head diameters in THRs, the 32mm femoral head is the most commonly used femoral head size as reported by the European registries and NZJR, while the AOA NJRR and AJRR report a higher use of the 36mm femoral head. The EPRD, NZJR and AJRR also report a trend towards the use of 36mm femoral head.

The NJR and AOA NJRR Annual Report 2023 provide information on the size as well as the material of femoral heads used in THRs allowing for analysis of the combination. It should be mentioned that the AOA NJRR provides prosthesis-specific analysis regarding femoral head diameter restricted for modern prostheses, including mixed ceramic/mixed ceramic, and all femoral head materials (metal, ceramic, and ceramicised metal) used in combination with cross-linked polyethylene.

NJR

As in 2021, the most common head size recorded by NJR was 32mm, followed by 36mm and 28mm. According to Figure 3.H3 (e) in the Annual Report 2023, it can be observed that since 2003, there has been a transition from small head sizes (22.25mm and 26mm) in cemented hip replacements to large head sizes (>28mm) in uncemented or hybrid hip replacements can be observed since 2003. The NJR highlights that 32mm and 36mm CoP bearings are the main options for 2022.[1]

AOA NJRR

Among all non-XLPE bearings, femoral heads smaller than 32mm predominate. In the XLPE bearing group, the use of 32mm and >32mm femoral heads were about 2.5 times higher than that of small head sizes (<32mm), respectively. The Australian registry distinctly looks at the usage of "mixed ceramic" components (combination of alumina and zirconia) in THRs. During the period 2003-2022, 36-38mm mixed ceramic/mixed ceramic bearings accounted for approximately 73.6% of all primary THR procedures performed with this bearing surface in patients diagnosed for osteoarthritis.[2]

EPRD

Utilization of the 32mm (47.8%) and 36mm (47.1%) heads is similar. The 32mm femoral heads have shown a downward trend in utilization, decreasing from 61.2% of all primary THRs in 2014 to 47.8% in 2022. In contrast, the use of 36mm femoral heads increased each year, from 31.4% in 2014 to 47.1% in 2022. The use of 28mm femoral heads has remained stable over the past five years, at approximately 5%.[3]

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AJRR

Since 2012, the share of 36mm heads in primary elective THRs has been on an upward trend, from 48.1% in 2012 to 62.9% in 2022, and has remained stable over the last five years. There is a corresponding decrease in the utilization of 32mm heads from 32.8% to 17.3% during this period. The volume of treatments with head sizes larger than 40mm grows slowly, from 5.5% in 2013 to 8.8% in 2022. Utilization of small heads (<28mm) remains relatively stable over time, with only 3,441 cases by 2022.[4]

NZJR

Since 2017, New Zealand has shown a trend towards the use of 36mm heads, with 32mm remaining the most commonly used head size. 88% of procedures use a 36mm or 32mm head, 10% use a 28mm head, and approximately 2% use a >36mm head.[5]

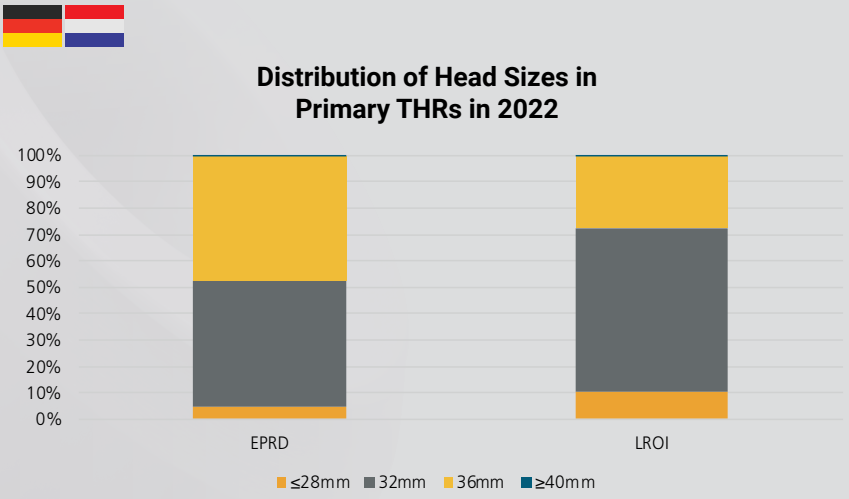
SAR

The 32mm head is the most commonly used head size, with a utilization rate of about 80% in 2022 (acc. to Figure 5.1.8 in the registry report). In contrast, the utilization of 36mm heads increases slightly in 2022, from 10% to 12.5% of all reported THRs in 2021.[6]

LROI

In 2022, the most common head size in the Netherlands remains 32mm, with a utilization rate of 62%. 36mm head usage increases slightly, from 23.4% in 2020 to 27.1% in 2022. The small head size (22-28mm) shows a significant decrease in utilization from 30.7% in 2013 to 10.6% in 2022. The share of large head sizes (≥38mm) stabilizes at around 0.3%.[7]

Figure 2a: Distribution of head sizes in primary THRs in 2022 (Annual Data): in Germany and Netherlands.



Evaluation of the data by CeramTec based on EPRD Annual Report 2023 Page 31 Table 12, and LROI Annual Report 2023 Page 23 Figure Femoral head diameter.

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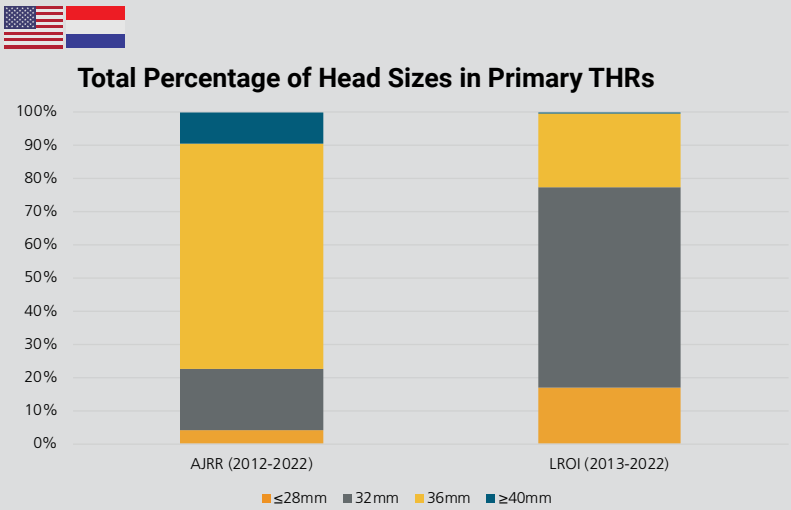
Figure 2b: Total Percentage of head sizes in primary THRs: in the United States and Netherlands.



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Distribution of Femoral Heads by Material

The following analysis focuses on primary THRs involving ceramic, metal, and ceramicised metal femoral heads, which are the most common femoral head materials used in THRs.

NJR

Ceramic femoral heads continue to exceed metal femoral heads in utilization. Ceramic femoral heads are utilized in 54.2% of all primary THRs, compared to 51.9% in 2021. Correspondingly, the use of metal femoral heads decreased from 45.6% in 2021 to 43.1% in 2022.[1]

AOA NJRR

The use of ceramic heads has grown steadily over the past decade. Consequently, the registry has recorded a decline in the use of metal heads over the same period.[2]

EPRD

The trend toward ceramic femoral heads is still increasing, accounting for 90.4% of all primary THRs in 2022, with an increase from 89.5% in 2021.[3]

AJRR

In the United States, the percentage of ceramic femoral heads in THRs continues to increase from 38.4% in 2012 to 81.4% in 2022. In contrast, the AJRR reports a sustained decline in the use of CoCr femoral heads from 55.6% in 2012 to 8.4% in 2022, explaining that this trend is due to surgeons' concerns about trunnion and taper corrosion with CoCr femoral heads. The use of ceramicised metal heads nearly doubled in 2022 (10.2%) compared to 2012 (6.1%).[4]

NZJR

According to the NZJR Annual Report 2023, the use of ceramic femoral heads has continued to increase since 2013. In 2017, the percentage of ceramic femoral heads used surpassed that of the metal femoral heads.[5]

SAR

In Sweden, the use of ceramic femoral heads has continued to increase over the years, however, a very slight decrease (-0.3%) was recorded in 2022. Metal is still the most used femoral head material in hip procedures.[6]

LROI

In the Netherlands, the use of ceramic femoral heads has been increasing since 2013, from 54.3% to 75.9% in 2022. Correspondingly, the use of metal femoral heads has

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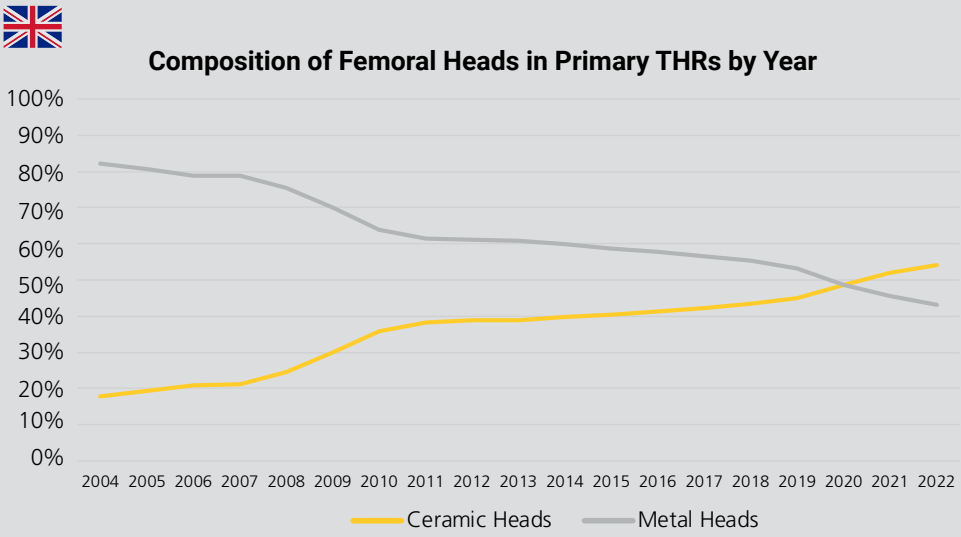
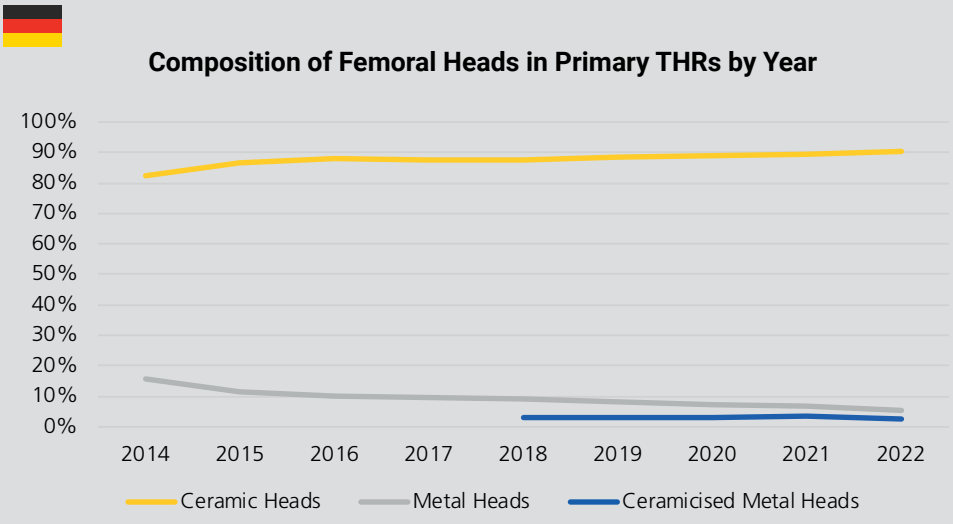
decreased from 30.5% in 2013 to 16.6% in 2022. There is a slight upward trend in the use of ceramicized metal heads, from 5.7% in 2013 to 11.6% in 2020, but then decreasing to 7.6% in 2022.[7]

Figure 3: Composition of femoral heads in primary THRs by year in England, Wales, Northern Ireland, the Isle of Man, and Guernsey.



Evaluation of the data by CeramTec based on NJR Annual Report 2023 Page 54 Table 3.H2. The usage rates of ceramic and metal heads correspond to the sum of the usage rates of the bearings containing ceramic and metal heads, respectively. In order for the total number to be equal to the number of THRs, hip resurfacing and unconfirmed data were excluded from the percentage calculation.

Figure 4: Composition of femoral heads in primary THRs by year in Germany.



Evaluation of the data by CeramTec based on EPRD Annual Reports 2014 to 2023 (For operation year 2014, the number indicates percentage of all primary hip replacements. For operation years 2015 to 2021, the numbers indicate percentage of all primary THRs). The usage rates of ceramic, metal and ceramicised metal heads correspond to the sum of the usage rates of the bearings containing ceramic, metal and ceramicised heads, respectively.

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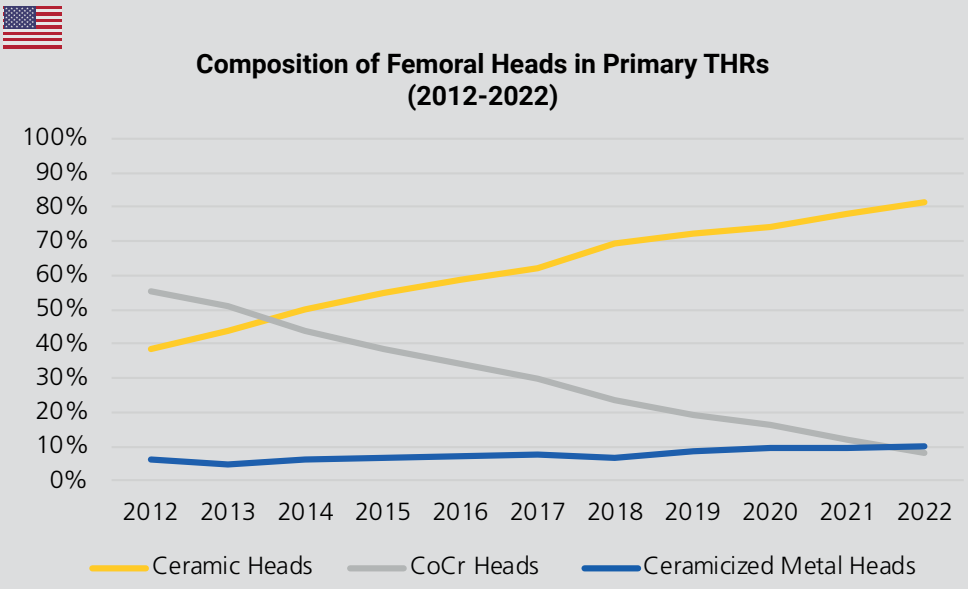
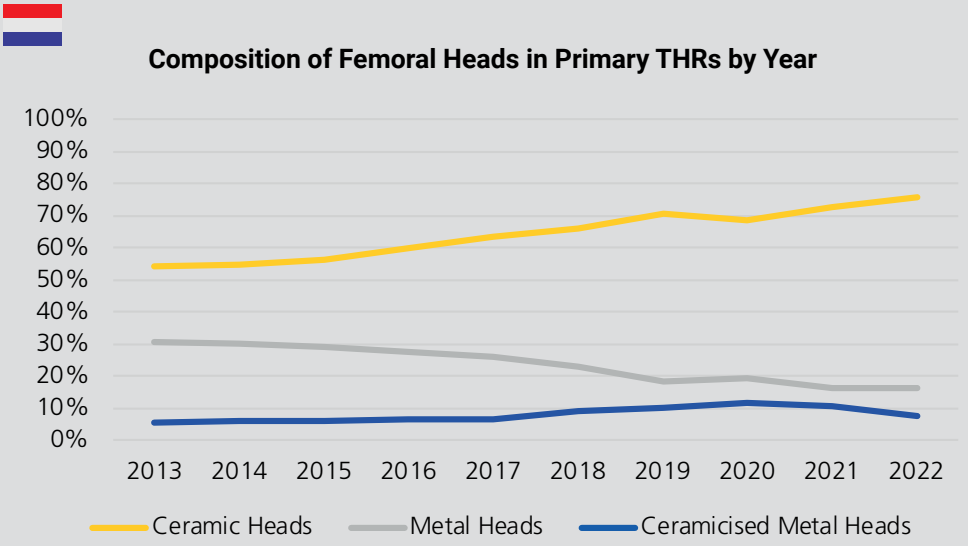
Figure 5: Composition of femoral heads in primary THRs (2012-2022) in the United States.



Evaluation of the data by CeramTec based on AJRR Annual report 2023 Page 38 Figure 2.16.

Figure 6: Composition of femoral heads in primary THRs by year in the Netherlands.



Evaluation of the data by CeramTec based on LROI Annual report 2023 Page 26 Figure Femoral head component. The usage rate of ceramic heads is equal to the percentage of Ceramics/Zo, the usage rate of metal heads is equal to the percentage of Cobalt chrome, the usage rate of Ceramicised Metal Heads is that of oxidized zirconium.

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Bearing Surfaces

CoP has become the most popular bearing option in THRs in most countries.When the analysis of bearing type is limited to CoP, MoP, CoC and CMoP only, the trend in use is as follows.

NJR

CoP bearing utilization increases from 11.4% in 2004 to 47.5% in 2021, then to 50.4% in 2022 in England, Wales, Northern Ireland, the Isle of Man and Guernsey. Correspondingly, MoP bearings utilization declines from 78.9% in 2004 to 45.6% in 2021, then to 43.1% in 2022. According to the last annual report, CoC bearings were implanted in 3.8% of all primary THRs with a known bearing type. CoP was preferred for both uncemented and hybrid hips. As in the previous two years, hybrid CoP was the most commonly implanted construct in 2022, accounting for 23% of all primary hip replacements, followed by uncemented CoP (20.3%) and hybrid MoP (15.2%).[1]

AOA NJRR

In Australia, almost the totality, 97.3%, of the bearings implanted in 2022 consisted of mixed ceramic- and metal-on-cross-linked polyethylene, and mixed ceramic-on-mixed ceramic, defined as "modern bearing surfaces" by the registry. The Australian registry distinctly looks at the usage of “mixed ceramic” components like BIOLOX®*delta*, vs. pure alumina ceramic in primary total conventional hip replacements. CoC with mixed ceramic consisted of 99.9% of all procedures with a CoC bearing. Referring to the polyethylene using in primary total conventional hip replacement, the proportion of XLPE was 97.5%. It can be observed that the use of XLPE + antioxidant increased 11.4% compared to that of 2021. The use of CoXLPE has increased during the last 10 years at the expense of CoC and MoXLPE.[2]

EPRD

Utilization of CoP bearings continues to grow, from 67% in 2014 to 82.8% in 2022. Over the same time period, CoC bearings utilization declines from 15.4% to 7.5% and MoP bearings declines from 15.8% to 5.3%. CMoP femoral head utilization remains stable at 2.7% of all primary THRs in 2022.[3]

AJRR

The use of CoP increased substantially from 33.2% in 2012 to 72.6% in 2022. During the same period, MoP declined down from 48.8% to 4.4%. The use of CMoP increased from 5.1% in 2012 to 7.7% in 2022.[4]

NZJR

In New Zealand, the CoP bearing surface continues to increase while MoP decreases, with CoP and MoP use accounting for 91% of all procedures in 2022. CoC use increases

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slightly compared to 2021, accounting for 7% of total use.[5]

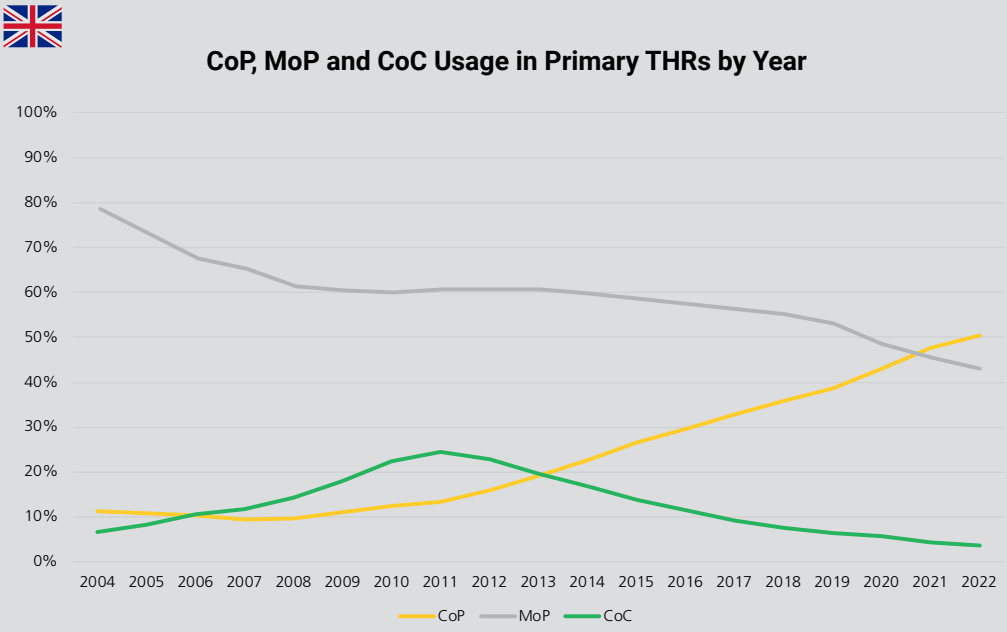
SAR

The percentage of all primary THRs using CoP in 2022 remains unchanged compared to 2021, at approximately 27%. However, due to the increase in the total number of hip replacement procedures, the registry reports a slight increase in the absolute number of CoP articulation.[6]

LROI

Among all primary THRs, the annual utilization rate of CoP increases from 54.3% in 2013 to 71.6% in 2022. Consequently, the use rate of MoP bearings decreases from 30.9% in 2013 to 15.7% in 2022. The utilization rate of CoC bearings decreases from 8.5% in 2013 to 4.6% in 2022.[7]

Figure 7: Usage of CoP, MoP and CoC in primary THRs by year in England, Wales, Northern Ireland, the Isle of Man and Guernsey.



Evaluation of the data by CeramTec based on the NJR Annual Report 2023 Page 54 Table 3.H2. The usage rates of CoP, MoP and CoC correspond to the sum of the usage rates of CoP, MoP and CoC bearings with different fixation methods, respectively. In order for the total number to be equal to the number of THRs, hip resurfacing and unconfirmed data were excluded from the percentage calculation.

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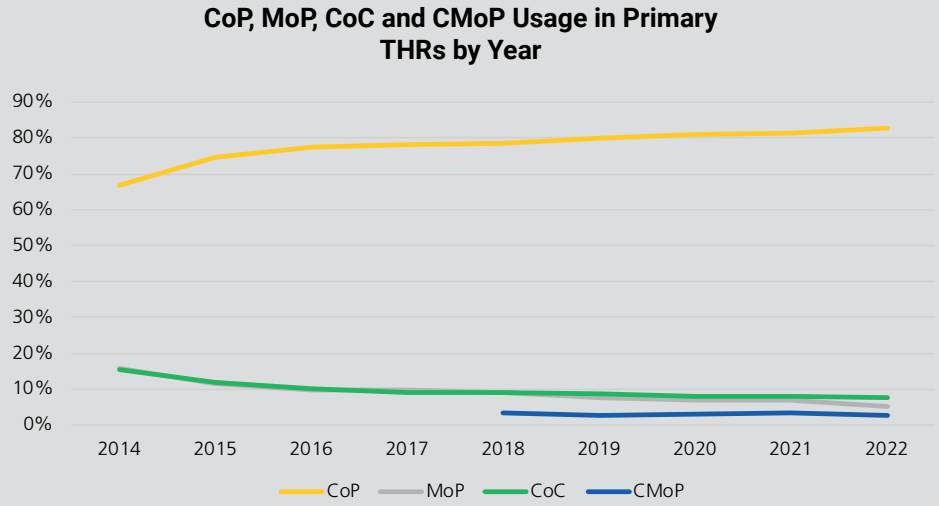
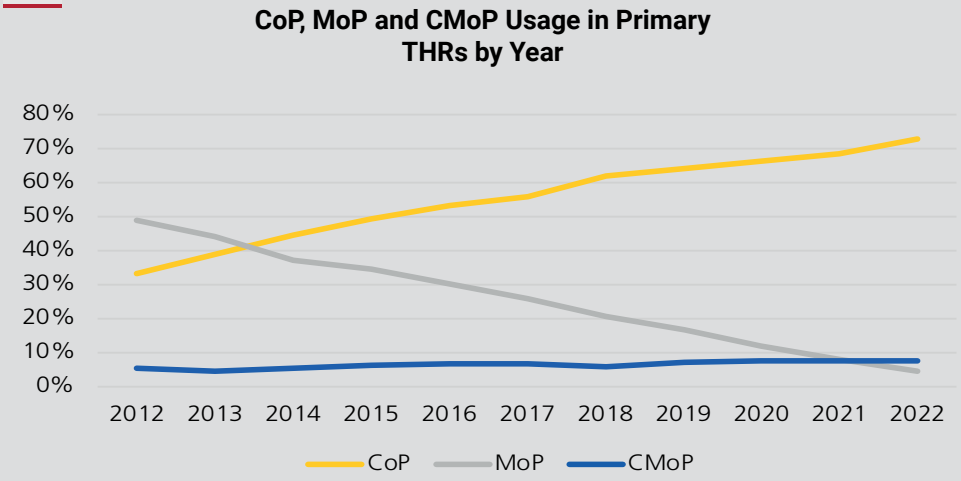
Figure 8: CoP, MoP, CoC and CMoP usage in primary THRs by year in Germany.



Evaluation of the data by CeramTec based on the EPRD Annual Reports 2014 to 2023 (For operation year 2014, the number indicates percentage of all primary hip replacements. For operation years 2015 to 2022, the numbers indicate percentage of all primary THRs). The usage rates of CoP, MoP and CMoP correspond to the sum of the usage rates of bearings containing ceramic, metal and ceramicised metal heads in conjunction with different polyethylene types, respectively.

Figure 9: CoP, MoP and CMoP usage in primary THRs by year in the United States.



Evaluation of the data by CeramTec based on the AJRR Annual report 2023 Page 39 Figure 2.18.

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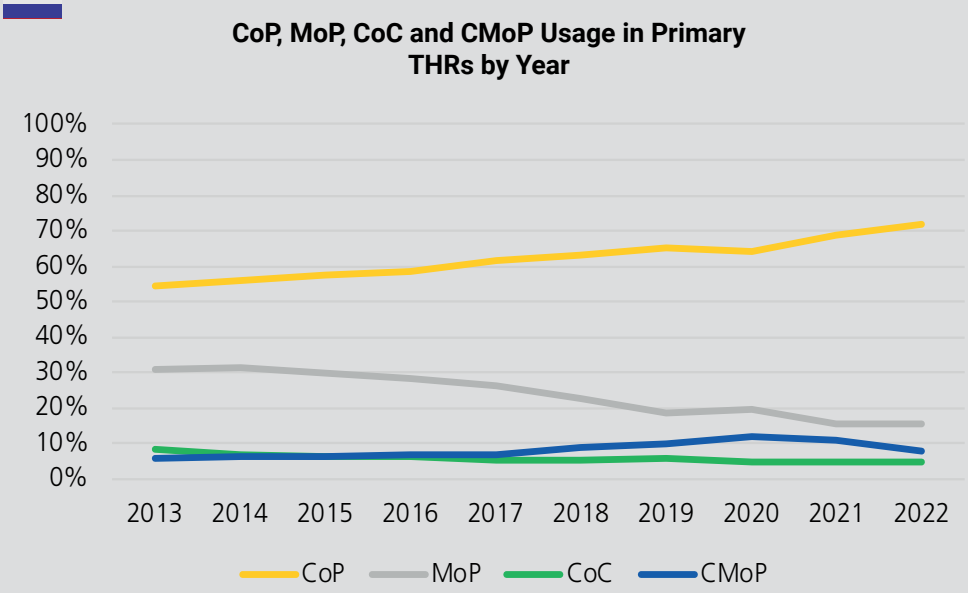
Figure 10: CoP, MoP, CoC and CMoP usage in primary THRs by year in the Netherlands.



Evaluation of the data by CeramTec based on LROI Annual Reports 2023 Page 26 Figure Articulation.

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Dual Mobility (DM)

The usage of dual mobility bearings has steadily increased over the years. The data on dual mobility bearings are reported by registries including NJR, AOA NJRR, EPRD, AJRR, SAR and LROI.

NJR

Before 2013, dual mobility was rarely used. From 2014 to the present, the use of dual mobility has steadily increased, especially in hybrid fixation group. The use of dual mobility with a metal head and with a ceramic head account for 2.76% of all primary THRs, compared to 2.46% in 2021. The use of dual mobility with a metal head (MoPoM) increased from 1.54% in 2021 to 1.63% in 2022, while with a ceramic head (CoPoM) increased from 0.92% in 2021 to 1.12% in 2022.[1]

AOA NJRR

In Australia, the annual use of dual mobility constructs is increasing. Their use has increased by 7.6% since 2021. Compared to other acetabular prostheses, dual mobility implants are most commonly used for fractured neck of femur, tumor and failed internal fixation.[2]

EPRD

EPRD included dual mobility bearing couples for the first time in its 2019 Annual Report analysis. In 2022, this implant type accounted for 1.9% of all bearings in primary THRs, the same as in 2021, while in acetabular revisions, dual-mobility cups were chosen in 38.5% of cases, increasing from 10% in 2014 to 38.5% in 2022.[3]

AJRR

In the United States, the use of dual mobility in primary and revision hip arthroplasty has continued to increase since 2012. However, after relatively stable usage rate over last three years, the use of dual mobility has declined slightly to 7.6% in 2022, from 8.8% in 2021. The registry considered this decline may be due to misclassifying dual mobility constructs as 28mm heads. This construct was most commonly used in the oldest (≥90) and youngest (<50 years) patient groups. The use of dual mobility has increased annually for hip revision due to dislocation/instability, from 12.9% in 2012 to 34.3% in 2022.[4]

SAR

Dual mobility is mainly used for revisions. Dual mobility was first reported in 2002 (one revision case) and increased to 451 revisions per year between 2017 and 2019. This number has changed only slightly since then to date.[6]

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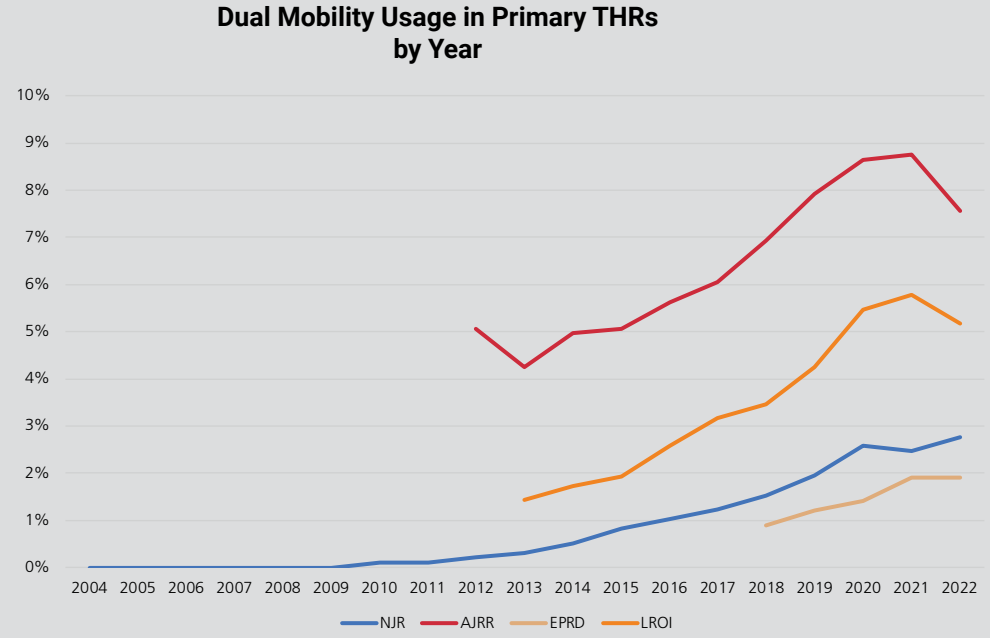
LROI

In the Netherlands, dual mobility cup is used in 5.2% of all primary THRs in 2022, up from 1.4% in 2013. This type of acetabular cup is mainly used for hip revision surgeries in Netherlands, accounting for 48.1% of all hip revision surgeries in 2022, increasing from 32.2% in 2013 to 54% in 2021, then decreasing to 48.1% in 2022.[7]

Figure 11: Annual use of dual mobility bearings in primary THRs in the NJR, AJRR, EPRD, and LROI.



Evaluation of the data by CeramTec based on the NJR Annual Report 2023 Page 54 Table 3.H2, EPRD Annual Report 2019 to 2023, and AJRR Annual Report 2023 Page 39 Figure 2.18, LROI Annual Report 2023 Page 23 Figure Dual mobility. For the data from the NJR, the usage rates of dual mobility correspond to the sum of the usage rates of dual mobility bearings with different fixation methods. In order for the total number to be equal to the number of THRs, all data relating to hip resurfacing were excluded from the percentage calculation.

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Clinical Outcomes

Reasons for Revision

With regard to the most common reasons for revision, the terminologies used in the national registries varies slightly. There are also some differences between countries in the ordering of the main reasons. (Aseptic) loosening, infection, dislocation and (periprosthetic) fractures were at the top of the list, although with the order varied.

NJR

The most common reasons for revision recorded by NJR of all the revision procedures were aseptic loosening, dislocation/subluxation, periprosthetic fracture, infection, and adverse soft tissue reaction to particulate debris.[1]

AOA NJRR

In 2022, infection (23.3%) is the most common reason for revision for all primary conventional THRs with primary diagnosis osteoarthritis (OA), followed by (periprosthetic) fracture (22.0%), prosthesis dislocation/instability (21.7%), and loosening (20.8%).

In 2022, the Australian registry conducted a comprehensive analysis of infections following primary hip, knee and shoulder replacements. The key messages on infections in hip replacement include:

- The number of revision procedures due to infection increased from 1.3% (333 revisions) of all hip surgeries in 2003 to 2.2% (1,173 revisions) in 2022. In contrast, all hip revisions for reasons other than infection decreased from 11.7% (3,111 revisions) in 2003 to 5.1% (2,690) in 2022.
- Across all age groups, revisions for infection are more common in males, while revisions for reasons other than infection are more common in females.
- For primary total conventional hip replacement with a primary diagnosis OA, the mean time to first revision due to infection is shorter than the mean time to first revision for reasons other than infection (1.8 ± 3.1 years versus 3.7 ± 4.4 years post primary procedure).
- For primary total conventional hip replacement with primary diagnosis OA, of all first revision for infection, 45.2% (1,515 procedures) of all first revisions for infection were metal/XLPE, followed by ceramic/XLPE (28.9%, 968 procedures), then ceramic/ceramic (12.6%, 422 procedures), and lastly ceramicised metal/XLPE (7.4%, 248

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procedures). Of all first revision surgeries performed for other reasons, 42.4% (4,684 procedures) were metal/XLPE, 21.6% (2,387 procedures) were ceramic/XLPE, then ceramic/ceramic (18.7%, 2,065), and finally ceramicised metal/XLPE (7.1%, 781 procedures).

- When primary hip replacements are revised due to infection, 51.1% are due to early revisions, which the AOA NJRR defined as a revision within 3 months post primary procedure. Specifically, 24.1% occurs between 7 days and 4 weeks after primary procedure, 26.6% are revised in the period between 4 weeks and 3 months after primary procedure, 25.5% happens after 2 years.
- After first revision for infection, a risk of second revision for any reason is as high as 45.3% at 10 years.[2]

EPRD

EPRD still provides data on reasons for revision based on procedures performed in the operation year. In 2022, loosening (22.7%), infection (16.4%), periprosthetic fracture (15.9%), dislocation (13.6%), and implant wear (5.8%) were the most common reasons for revision. Revision rates for loosening decreased each year, from 43.7% in 2014 to 22.7% in 2022. In contrast, revision rates due to infection increased from 10.1% in 2014 to 16.4% in 2022.[3]

AJRR

Infection and inflammatory reaction (22.5%) remain the most common reason for all revisions recorded in the American registry, followed by mechanical complications (20.8%), instability related codes (20.7%), aseptic loosening (19.7%) and pain (14.3%).[4]

NZJR

Since 1999, the six main reasons for revision after THR procedures in New Zealand are: loosening (of the acetabular and femoral component, respectively), dislocation/instability, unexplained pain, deep infection, and fracture femur. Deep infection and dislocation are more often happened within the first year after operation. On the other hand, loosening is a more common indication for revision beyond 10 years after operation.[5]

SAR

The most common reasons for revision surgery in the period 2020 to 2022 were: loosening, infection, peri-prosthetic fracture, and dislocation/instability. The percentage of revisions due to loosening has decreased, while the percentage of infection has increased. A high number of revisions due to pseudotumors (ALVAL, Aseptic Lymphocyte-dominated Vasculitis-Associated Lesions or ALTR, Adverse Local Tissue Reaction belong to this category acc. to the registry report) was noted especially at the beginning of the period from 2014 to 2016, then decreased significantly thereafter. Ten cases were reported in 2022.[6]

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LROI

The most common reasons for revision recorded by LROI of all revision procedures between 2014 and 2022 were loosening of acetabulum component (21.2%), infection (20.9%), dislocation (18.6%), loosening of femur component (18.2%), and inlay wear (16.5%). The annual revision for infection increased from 12.3% in 2014 to 23.9% in 2022.[7]

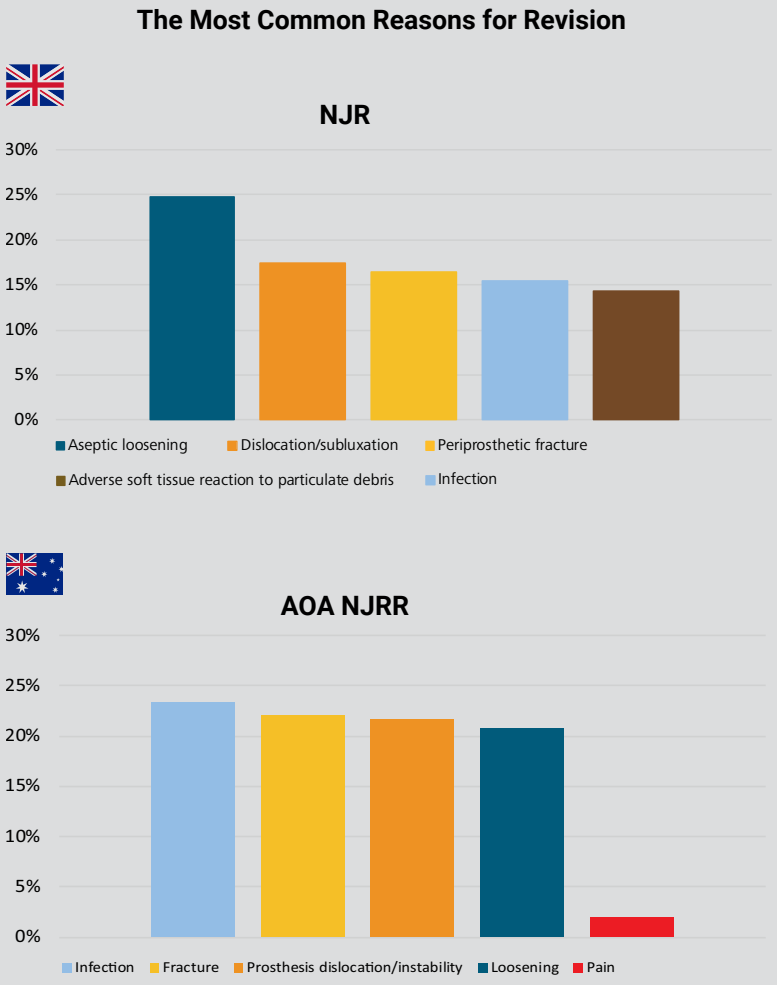

Figure 12: The most common reasons for revision in England, Wales, Northern Ireland, the Isle of Man and Guernsey, Australia, the United States and the Netherlands.

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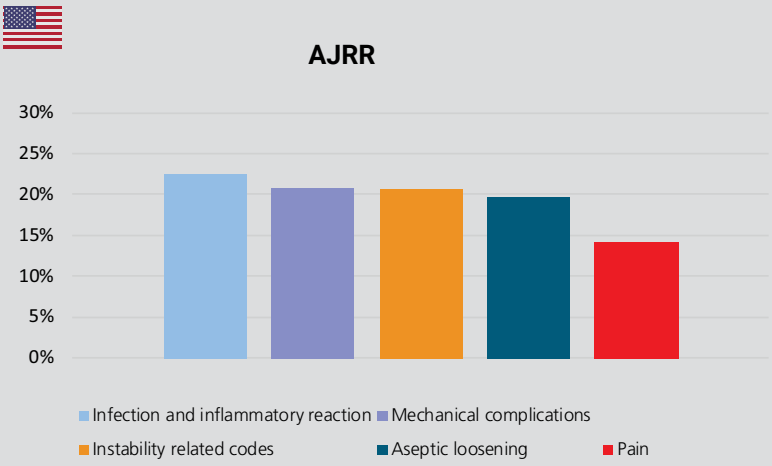

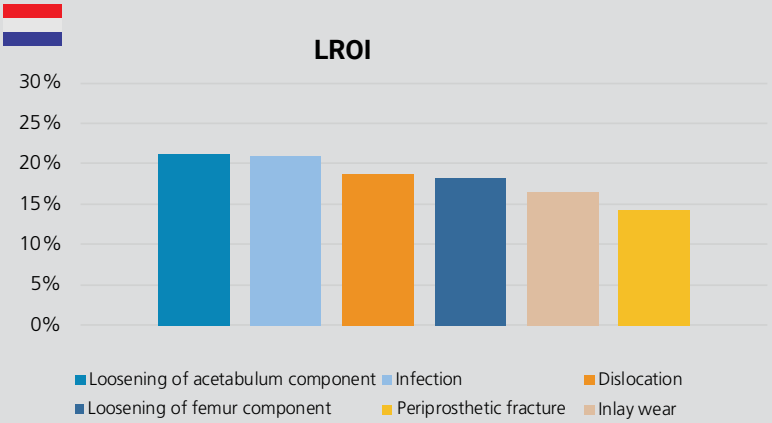

Evaluation of the data by CeramTec based on the NJR Annual Report 2023 Page 106, the reasons for revision recorded in the NJR are not mutually exclusive. AOA NJRR Annual Report 2023 Page 118 Table HT15, and AJRR Annual Report 2023 Page 56 Figure 2.32, LROI Annual Report 2023 Page 34 Figure Reasons for revision.

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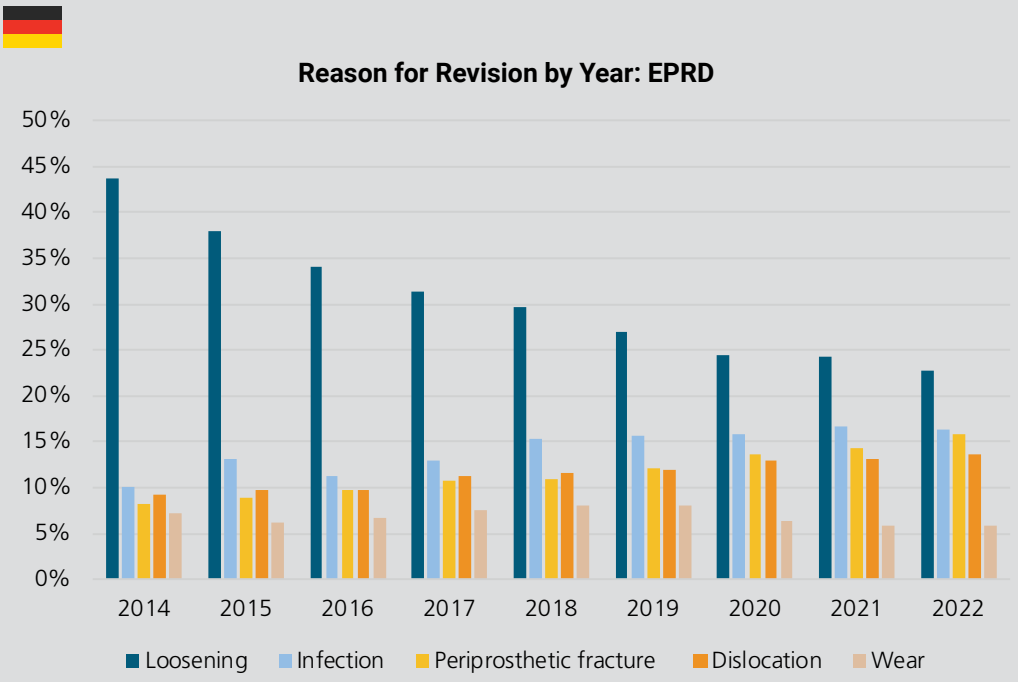
Trends in Reasons for Revision

In Annual Report 2023, EPRD shows the following developments in the percentage shares of various treatment characteristics in primary THRs from 2012/13 to 2022, such as: fixation, insert materials, head sizes, head neck length as well as reasons for revision. As shown in the EPRD, revision rate due to loosening is decreasing each year. The revisions due to infection increased from 10.1% in 2014 to 16.4% in 2022. Similarly, the revision rates due to infections documented by the AJRR varies from 10.9% to 22.6% between 2012 and 2020, and then stabilized at about 23% in 2021 and 2022 (AJRR Annual Report 2023 Page 58 Figure 2.35). In the Netherlands, the annual revision for infection increased from 12.3% in 2014 to 25.3% in 2021 and then declined slightly to 23.9% in 2022. The NZJR has also provided insight into the year-on-year trends of their six main reasons for revision. The revision rate due to deep infection increased from 8.6% in 2012 to 19.3% in 2022. The revision rate due to fracture femur has steadily increased from 9.3% in 2013 to 21.5% in 2022. On the other hand, the revision rate due to unexplained pain declined from a peak of 20.6% in 2011 to 9.4% in 2020, then to the lowest point recorded in the registry in almost a decade, namely 3.6% in 2022.

Figure 13: Reasons for revision by year in Germany.



Evaluation of the data by CeramTec based on EPRD Annual Report 2023 Page 37 Figure 7.

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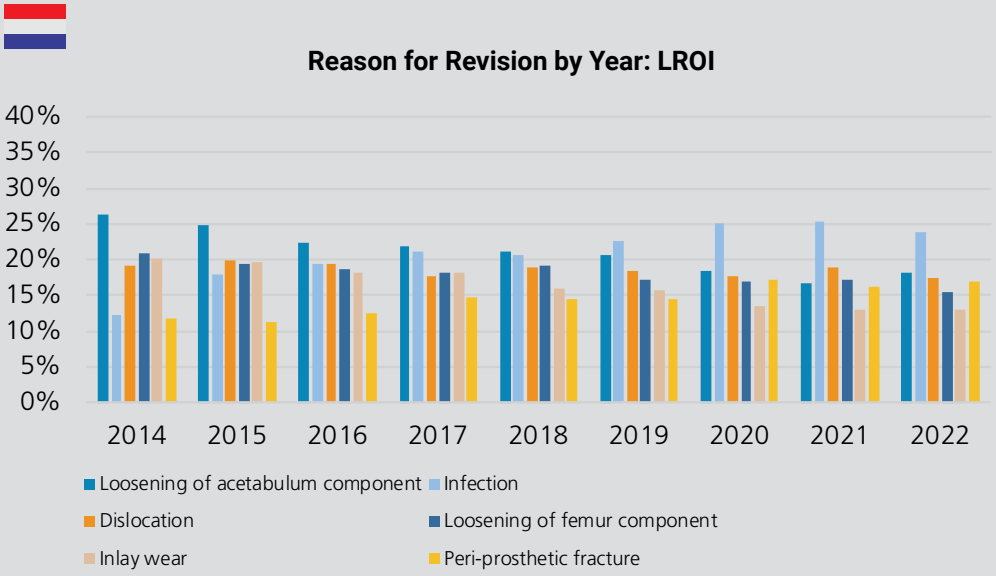
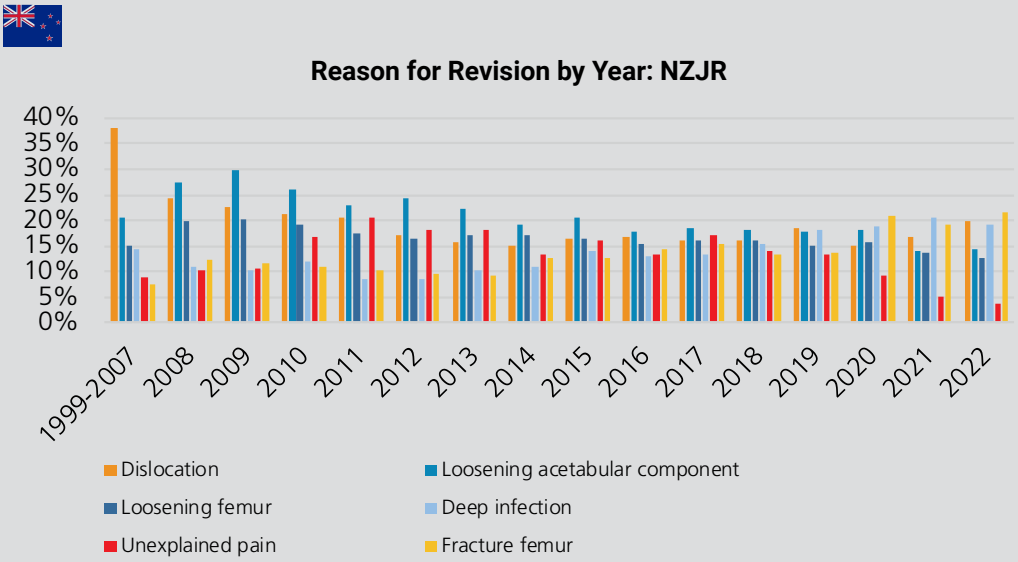
Figure 14: Reasons for revision by year in the Netherlands.



Evaluation of the data by CeramTec based LROI Annual Report 2023 Page 34 Figure Reasons for revision.

Figure 15: Reasons for revision by year in New Zealand.



Evaluation of the data by CeramTec based NZJR Annual Report 2023 Page 21 Table 1.17.

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Revision Rates

NJR

By the end of 2022, the NJR has recorded a total of 1,448,541 primary hip replacements over the lifetime of the registry, of which 43,682 (3%) were linked first revisions. It can be observed that the number of revisions increased each year from 2003 to 2008 and decreased each year from 2008 to 2022. The NJR is reporting a maximum of 19.75 years of follow-up.

Across all fixation methods, CoP bearings have consistently maintained a low or similar rate of revision to those of other bearings up to fifteen years. The excellent results encourage wider use of CoP bearings.

As the number of cases recorded by NJR increases, the confidence intervals narrow and statistical significance is reached for both genders, all age groups, and up to 18 years after implantation. This year, the results obtained in younger patients by CoC and CoP are statistically better than those obtained by MoP; the NJR 2023 Annual Report states that these results are “striking”. For male patients aged 55 to 64 years, CoP and CoC with hybrid fixation, CoP and CoC with uncemented fixation, as well as cemented CoP bearings have relatively low revision rates, about below 5% at 15 years postoperatively. In contract, the revision rate of cemented MoP bearings and uncemented MoP were 8.26% and 7.06%, respectively. For female patients aged 55 to 64 years old, the revision rates of hybrid CoC was 3.05% (95% CI 2.58%-3.59%) at 15 years.

As shown in Figure 16, in the cemented fixation group, CoP bearings with 36mm heads had higher revision rates than those with 28- and 32mm heads. Correspondingly, in the uncemented and hybrid fixation groups, CoP bearings with 32- and 36mm heads had lower revision rates than 28mm heads.

In the uncemented fixation group, there is a clear correlation between the revision rates of CoC bearings and head size: the larger the head, the lower the revision rate of the construct (except for 44mm heads after six years). In the hybrid fixation group, the revision rate of CoC bearings with 36mm heads was higher than that of 32- and 28mm heads (p=0.001).

This annual report indicates that the early failure rate of MoPoM in uncemented and hybrid group were higher than most bearings. At this point, CoPoM performs better but with a small number.

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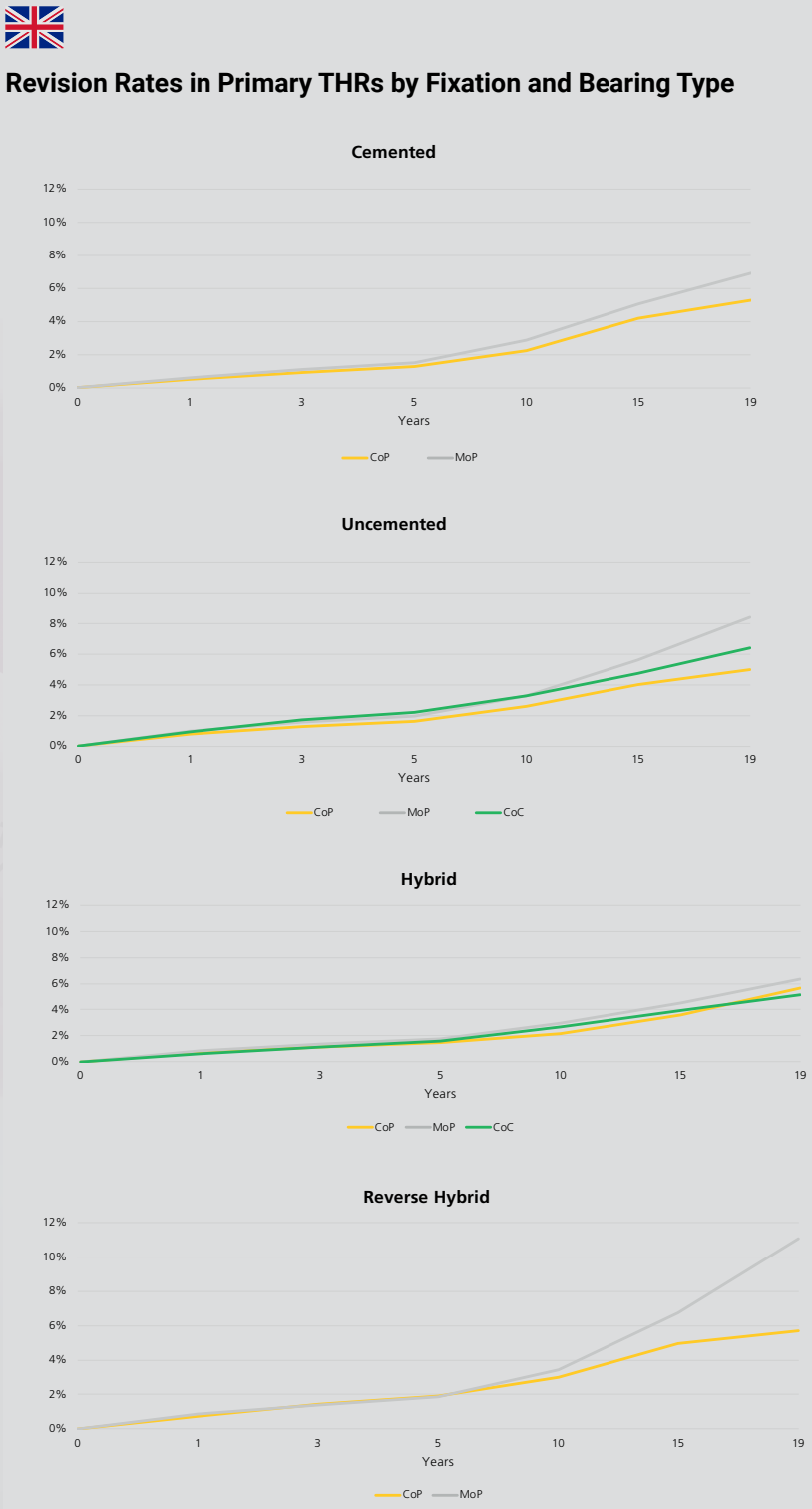
Figure 16: Cumulative revision rates in primary hip replacement with Mop, CoP, and CoC bearings in combination with different fixation methods in England, Wales, Northern Ireland, the Isle of Man and Guernsey.



Evaluation of the data by CeramTec based on the NJR Annual Report 2023 Page 69 Table 3.H5.

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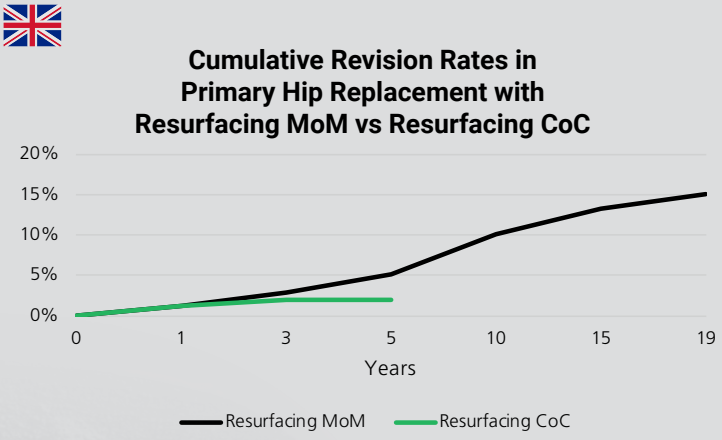
CoC resurfacing is recorded by the NJR for the first time in 2022, although this construct is still undertaken in small numbers (N=249). The early revision rate at 1 year for CoC resurfacing is similar to that for MoM resurfacing (1.27% (0.41%-3.87%) vs. 1.18% (1.08%-1.29%)), and lower at 3 years (1.91% (0.71%-5.11%) vs. 2.90% (2.74%-3.06%)) and 5 years (1.91% (0.71%-5.11%) vs. 5.06% (4.85%-5.28%)). The NJR reminds readers to be cautious in interpreting this difference due to the small number of CoC resurfacing. (Figure 17)

Figure 17: Cumulative revision rates in primary hip replacement with Resurfacing MoM and Resurfacing CoC in England, Wales, Northern Ireland, the Isle of Man and Guernsey.



Evaluation of the data by CeramTec based on the NJR Annual Report 2023 Page 69 Table 3.H5.

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AOA NJRR

According to AOA NJRR Annual Report 2023, the 20-year cumulative revision rate of all primary total conventional hip replacement procedures with primary diagnosis OA is 8.1%.

In Australia, CoXLPE shows a lower rate of revision than MoXLPE after 2 years significantly (0.77 (0.72, 0.82), p<0.001). According to the Australian registry analysis, the revision rate of CoC is not statistically different from MoXLPE at entire period (HR=0.99 (0.96,1.03), p=0.770) (Figure 18).

The lowest revision rate of revision is given by ceramicised metal heads coupled with XLPE liners, which is statistically different from MoXLPE (after 1 year: HR=0.62 (0.56,0.69), p<0.001). However, the registry urges caution in the interpretation of this result as in the previous reports since "*This bearing is a single company product, used with a small number of femoral stem and acetabular component combinations. This may have a confounding effect on the outcome, making it unclear if the lower rate of revision is an effect of the bearing surface or reflects the limited combinations of femoral and acetabular prostheses.*"

As far as the head size is concerned, the 32mm XLPE was associated with a lower rate of revision in comparison with larger heads and smaller heads (XLPE >32mm vs XLPE 32mm after one months: HR=1.13 (1.07, 1.19), p<0.001; XLPE <32mm vs XLPE 32mm after 1.5 year: HR=1.20 (1.11, 1.28), p<0.001) (Figure 19).

For CoC bearings with mixed ceramic (Figure 20), there is no significant difference in the rate of revision between 36-38mm and 32mm head sizes (HR=1.01 (0.88, 1.16), p=0.898). Further, also the revision rates of 36-38mm and ≥40mm head sizes are also not statistically different over the entire period (HR=0.95 (0.77, 1.17), p=0.634), also for ≥40mm versus 32mm head sizes (HR=1.06 (0.83, 1.36), p=0.632). However, the ≤28mm head sizes are associated with a higher revision rate within the first three months (HR=2.38 (1.36, 4.17), p=0.002) compared to 32mm head sizes.

Compared to XLPE + antioxidant, XLPE has a higher revision rate after 3 years (HR=1.29 (1.09, 1.53), p=0.002).

Dual mobility constructs have a lower revision for dislocation/instability compared to other acetabular prosthesis (HR=0.54 (0.41, 0.71), p<0.001). Female patients undergoing a hip procedure with a dual mobility construct have a lower rate of all cause revision compared to male (HR=0.75 (0.61, 0.92), p=0.005).

The revision rate (at 1 year) of the MatOrtho ReCerf® CoC resurfacing has been reported for the first time by the AOA NJRR in 2020. In 2022, 42 new procedures have been reported. The Australian Registry showed that the revision rate at 1 year of MatOrtho ReCerf® CoC resurfacing (0.3 (0.0, 2.1)) and at 3 years (0.3 (0.0, 2.1)), with only 1 revision of all 346 procedures, was lower than other MoM resurfacing.[2]

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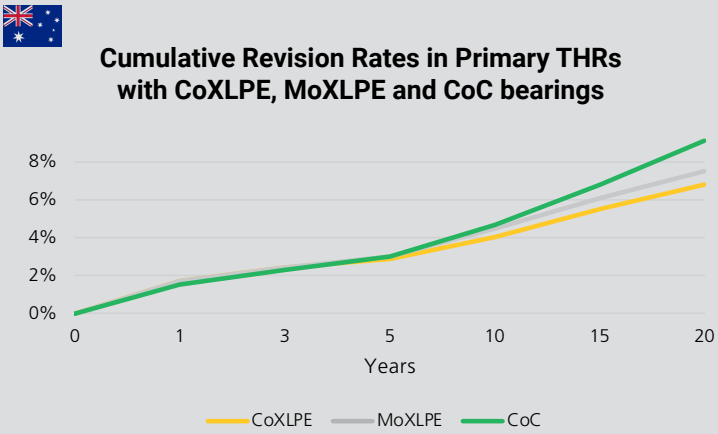
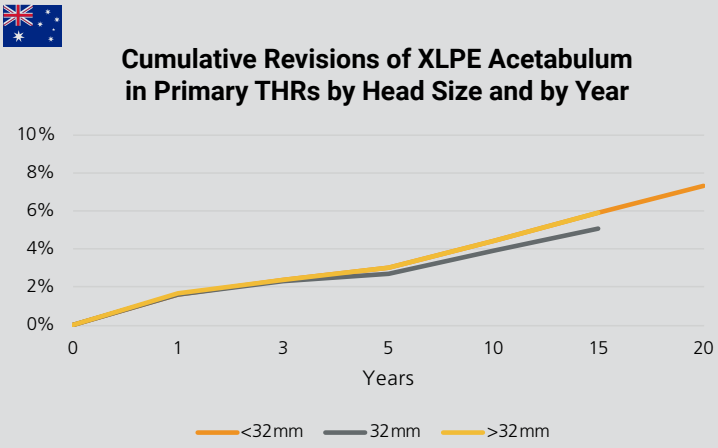
Figure 18: Cumulative revision rates in primary THRs with CoXLPE, MoXLPE and CoC bearings (Primary Diagnosis OA) in Australia.



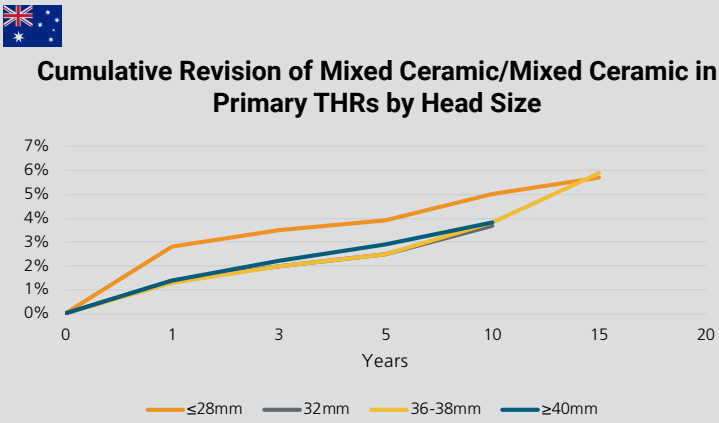
Evaluation of the data by CeramTec based on the AOA NJRR Annual Report 2023 Page 146 Table HT34.

Figure 19: Cumulative revision rates of XLPE acetabulum in primary THRs by head size (Primary Diagnosis OA, restricted to modern prostheses).



Evaluation of the data by CeramTec based on the AOA NJRR Annual Report 2023 Page 149 Table HT35.

Figure 20: Cumulative revision of mixed ceramic/mixed ceramic bearings (Primary Diagnosis OA, restricted to modern prostheses) by head size in Australia.



Evaluation of the data by CeramTec based on AOA NJRR Annual Report 2023 Page 159 Table HT40.

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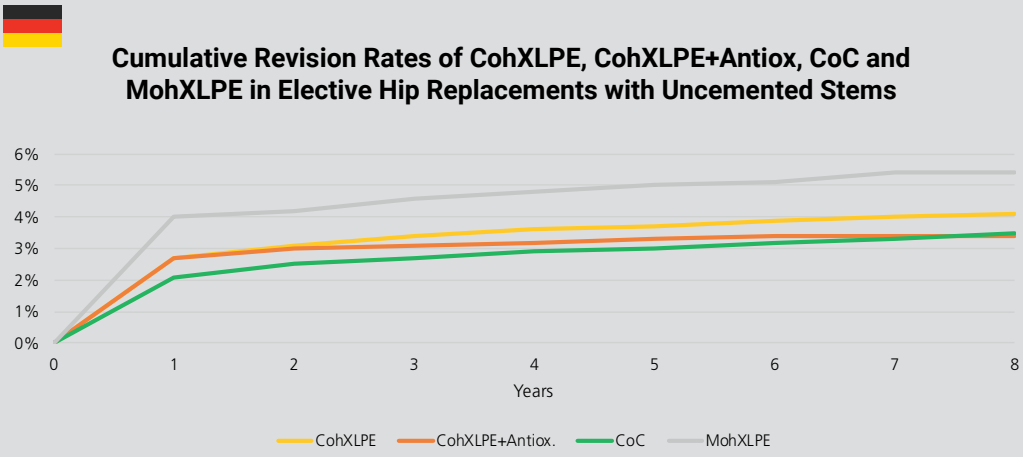
EPRD

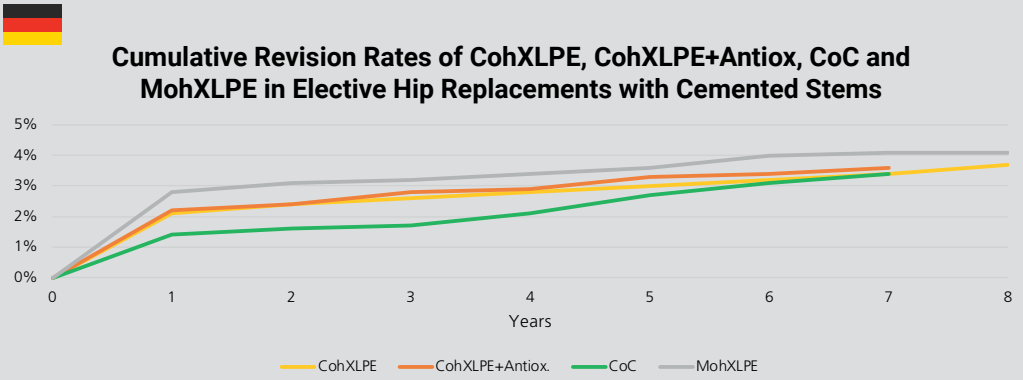
Among all bearings in elective primary THRs with uncemented stem fixation (uncemented fixation and reverse hybrid fixation), CoC had a significantly lower revision rate over the entire period than the other bearings, with the exception of CohXLPE+Antioxidants (Figure 21). Among all bearing couples in elective primary THRs, the revision rate of bearings with metal heads was significantly higher than that of bearings with ceramic heads in both cemented and uncemented stem fixation groups.

When comparing revision rates among different fixation groups, the results did not show big different between the cemented and uncemented fixation groups, which is not in line with the results observed from other registry reports (Figure 22).[3]

In both cemented stem fixation group and uncemented stem fixation group, 36mm head size show a lower cumulative revision rate along seven years (Figure 23).

Figure 21: Cumulative revision rates of CohXLPE, CohXLPE+Antiox, CoC and MohXLPE in elective hip replacements by stem fixation in Germany.





Evaluation of the data by CeramTec based on EPRD Annual Report 2023 Page 82 Table 46.

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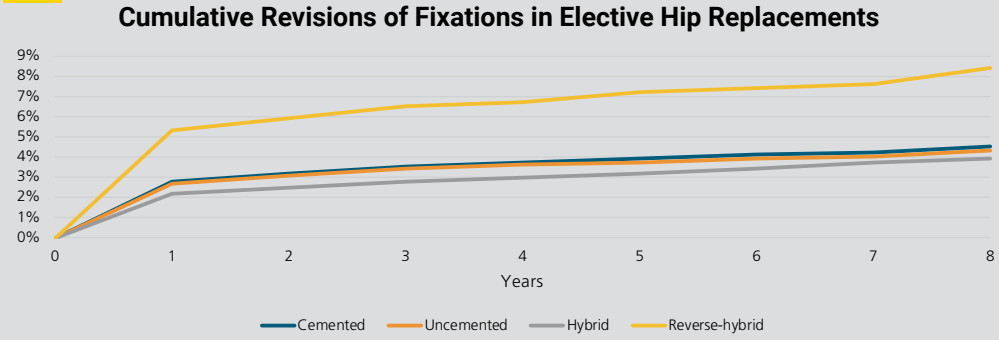
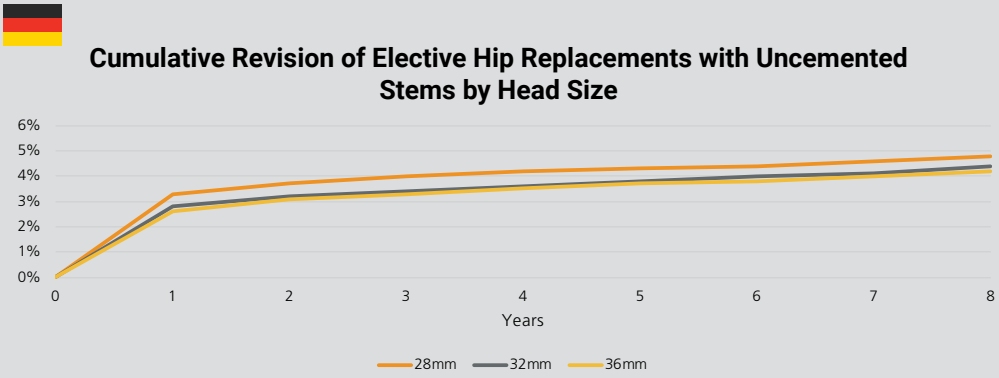
Figure 22: Cumulative revision rates of different fixations in elective hip replacements in Germany.



Evaluation of the data by CeramTec based on EPRD Annual Report 2023 Page 82 Table 46.

Figure 23: Cumulative revision rates of head size in elective hip replacements with different fixations in Germany.



Evaluation of the data by CeramTec based on EPRD Annual Report 2023 Page 82 Table 46.

AJRR

For patients above 65 years who underwent elective primary THRs, the cumulative revision rate was higher when using smaller heads (≤28mm) and larger heads (≥40mm) than those procedures with 36mm heads. No statistical difference was found between 36mm heads and 32mm heads.[4]

NZJR

The New Zealand registry uses two very specific statistical terms for revision rates that are not found in the other registries:

Observed component years: the number of registered primary procedures multiplied by the number of years each component has been in place.

Rate/100 component years: equivalent to the yearly revision rate expressed as a percentage figure derived by dividing the number of prostheses revised by the observed component years multiplied by 100.

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The NZJR shows that CoC bearings have the lowest revision rate with all head sizes in all age groups, despite the use of CoC bearings is declined.

When comparing revision rate of different head size groups, in general, 32mm head size had a lower revision rate compared to the other head sizes.[5]

Table 2: Revision data by bearing type in New Zealand.

Evaluation of the data by CeramTec based on the NZJR Annual Report 2023 Page 25 Table 1.29.

Surface	Numbers of operations	Observed component years	Number Revised	Rate/100 component years (95%)
CoC	16,050	148,342.7	710	0.48 (0.44-0.52)
CoP	50,449	334,764.7	1,963	0.59 (0.56-0.61)
MoP	92,658	811,147.1	5,279	0.65 (0.63-0.67)

Table 3: Revision data by head size in New Zealand.

Evaluation of the data by CeramTec based on the NZJR Annual Report 2023 Page 25 Table 1.30.

Head Size (mm)	Numbers of operations	Observed component years	Number Revised	Rate/100 component years (95%)
≤28mm	66,908	756,826.3	5,334	0.7 (0.69-0.72)
32mm	67,939	419,454.0	2,138	0.51 (0.49-0.53)
36mm	31,798	187,530.7	1,147	0.61 (0.58-0.65)
>36mm	4,182	35,822.4	693	1.93 (1.79-2.08)

LROI

LROI analyzed the cumulative major revision rate of THRs for OA by different bearings in 2007-2022. CoC had a significantly lower cumulative major revision rate compared to CoP and MoP at 10 years. The difference between CoC and CMoP was not significant (Figure 24).

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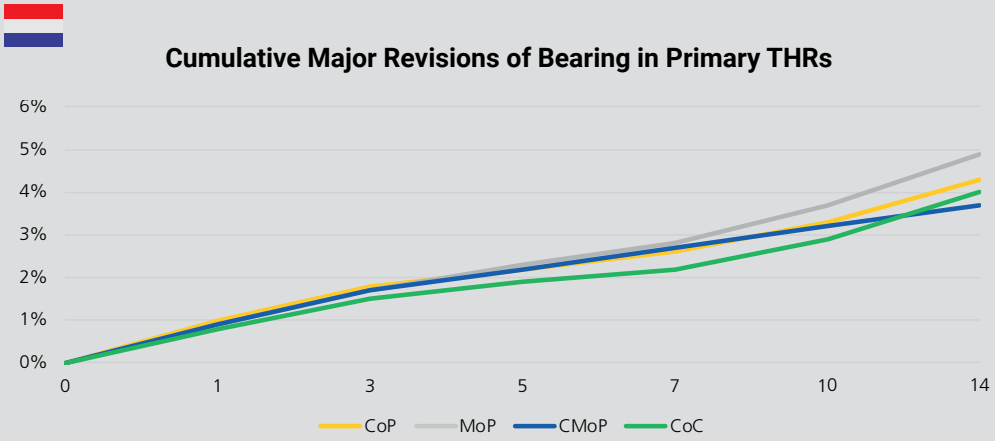
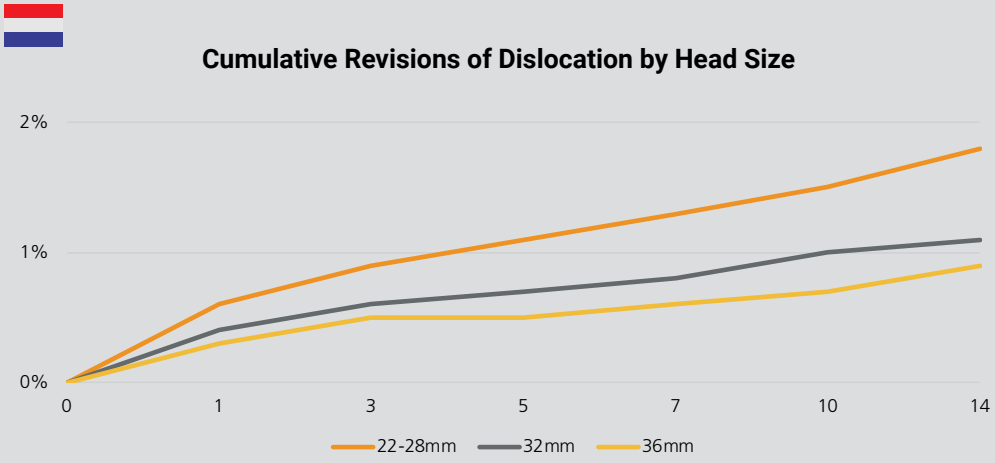
Figure 24: Cumulative major revisions of bearings in primary THRs in the Netherlands.



Evaluation of the data by CeramTec based LROI Annual Report 2023 Page 60 Table Cumulative major revision percentages.

As far as the head size is concerned, the 36mm femoral head (0.9% (0.7%-1.1%)) associated with a lower rate of revision for dislocation at a 14-year in comparison with the 32mm (1.1% (1.0%-1.2%)) head and 22-28mm head (1.8% (1.7%-2.0%)) at 14-year (Figure 25).[7]

Figure 25: Cumulative revisions for dislocation by head sizes in the Netherlands.



Evaluation of the data by CeramTec based LROI Annual Report 2023 Page 59 Table Cumulative revision percentages for dislocation.

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Patient-Reported Outcome Measures (PROMs)

PROMs calculate the health gains after surgical treatment from a patient perspective. This can contribute to the analysis of revision rates, identifying patients with persistent pain or disability as well as measuring patient satisfaction after surgery. Therefore, many registries and hospitals have started to record PROMs data. There is a growing demand for feasible methods and instruments to collect comprehensive PROMs and to enable data comparison between the registries.

NJR

In 2022, due to significant changes on processing of Hospital Episode Statistics data and its linked PROMs data, the NJR was not able to secure access to the NHS datasets, resulting a pause in reporting PROMs this year.[1]

AOA NJRR

In 2022, the Australian Registry starts to report PROMs in a supplementary report. The Australian Registry uses the EQ-VAS and EQ-5D-5L to measure quality of life and uses Oxford Hip Score (OHS) to assess pain and function. In general, a large improvement of quality of life, joint-specified pain and function has been achieved for all classes of joint replacement. Of all recorded 22,130 primary total conventional hip replacements with primary diagnosis OA, mean pre-operative EQ-VAS is 66.20 ± 20.01, and mean post-operative of 14,502 procedures is 80.86 ± 15.83. The mean pre-operative OHS of 22,139 primary total conventional is 20.92 ± 8.98 and this improves to 41.45 ± 7.23 for 14,521 total conventional post-operatively. 90.9% of patients were either very satisfied or satisfied, while 96.7% of patients believed that their hip much better or a little better post-operatively.[2]

AJRR

496 sites out of 1,364 (36%) have submitted PROMs until December 31.2022, marking a 24% increase compared to the previous Annual Report. Results of the HOOS, JR. score show that 92% of the patients achieved a meaningful improvement after elective primary THRs.[4]

NZJR

The NZJR was one of the first joint registries to collect PROMs data. The validated Oxford Hip outcome questionnaires were sent out on a random selection basis to achieve an annual response rate of 20%. Oxford-12 questionnaire which includes 12 questions with score points ranging from 0 to 4. The maximum score of 48 indicates normal function, 0 stands for most severe disability.

According to the statistic recorded in the NZJR Annual Report 2023, the average scores at six months are 40.3, 84% had an excellent or good score (>34), 89% of these patients

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achieved an excellent or good score with an average of 42.4 after 5 years, after 10 years 87% of these patients are still recognized as excellent or good function with an average of 41.9, 83% got an excellent or good score with an average of 40.7 after twenty years.[5]

LROI

The LROI uses NRS (rest), NRS (activity), EQ5D index score, EQ5D thermometer, HOOS-PS score, Oxford Hip score, Anchor question: Daily functioning to measure PROMs for patients underwent hip arthroplasty procedures. According to the LROI, the response rate of pre-operative PROMs achieved 66.7% in 2022. The response rate of all three pre-operative, 3 and 12 months postoperative in 2021 achieved 35.7%.[7]

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Current Trends and Recent Publications *(since 2023)*

Dual mobility

In all analyzed registries, the use of dual mobility bearings has steadily increased over the years. The NJR confirms that the CoPoM dual mobility bearings show lower revision than the MoPoM combinations, but with no significant difference.

Resurfacing

Metal resurfacing is still restricted to a carefully monitored patient selection. Women are mostly excluded from this procedure. Ceramic resurfacing procedures are recorded by the NJR and AOA NJRR.

Revision rate of CoC resurfacing is recorded by the NJR for the first time in 2022, although this construct is still undergone in small numbers (N=249). The early revision rate at 1 year for CoC resurfacing is similar to that for MoM resurfacing (1.27% (0.41%-3.87%) vs. 1.18% (1.08%-1.29%)), and lower at 3 years (1.91% (0.71%-5.11%) vs. 2.90% (2.74%-3.06%)) and 5 years (1.91% (0.71%-5.11%) vs. 5.06% (4.85%-5.28%)).

The revision rate (at 1 year) of the MatOrtho ReCerf® CoC resurfacing has been reported for the first time by the AOA NJRR in 2020. In 2022, 42 new procedures have been reported. The Australian Registry showed that the revision rate at 1 year of MatOrtho ReCerf® CoC resurfacing (0.3% (0.0%, 2.1%)) and at 3 years (0.3% (0.0%, 2.1%)), with only 1 revision of all 346 procedures, was lower than other MoM resurfacing.

New Publications

The following is a list of newly registry-based publications found on PubMed since 2023.

NJR

1. Orce Rodríguez A, Smith PN, Johnson P, O'Sullivan M, Holder C, Shimmin A. registry-based study of survivorship of cemented femoral components versus collared cementless femoral components in total hip arthroplasty in older patients with osteoarthritis. *Bone Joint J.* 2024;106-B(3 Supple A):121-129. doi:10.1302/0301-620X.106B3.BJJ-2023-0771.R1.

2. Paoli E, Bergadano D, Sheng S, Pandit H. National Registry data analysis on a unique highly-crosslinked polyethylene for total hip arthroplasty. *Arthroplast Today.* 2023;24:101267. doi:10.1016/j.artd.2023.101267.

3. Subbiah Ponniah H, Logishetty K, Edwards TC, Singer GC. Survivorship and risk factors for revision of metal-on-metal hip resurfacing. *Bone Jt Open*. 2023;4(11):853-858. doi:10.1302/2633-1462.411.BJO-2023-0084.R1.

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AJRR

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69. van Steenbergen LN, de Reus IM, Hannink G, Vehmeijer SB, Schreurs BW, Zijlstra WP. Femoral head size and surgical approach affect dislocation and overall revision rates in total hip arthroplasty: up to 9-year follow-up data of 269,280 procedures in the Dutch Arthroplasty Register (LROI). *Hip Int.* 2023;33(6):1056-1062. doi:10.1177/11207000231160223.

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71. van Loon J, Sierevelt IN, Spekenbrink-Spooren A, et al. Higher risk of 2-year cup revision of ceramic-on-ceramic versus ceramic-on-polyethylene bearing: analysis of 33,454 primary press-fit total hip arthroplasties registered in the Dutch Arthroplasty Register (LROI). *Hip Int.* 2023;33(2):280-287. doi:10.1177/11207000211064975.

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New Registry-based Publications about THRs with Ceramic Bearings

The following is short summary of new publications about ceramic bearings.

1. Vercruysse LYG, Milne LP, Harries DTC, de Steiger RN, Wall CJ. Lower revision rates and improved stability with a monoblock ceramic acetabular cup. *J Arthroplasty.* doi:10.1016/j.arth.2023.10.032.

This study investigates the survival rate and the reasons for revision of the DeltaMotion cup using data from the Australian Orthopedic National Joint Replacement Registry (AOANJRR) between 2001-2021. Monoblock ceramic/ceramic cups designed for LDHs have the potential to preserve acetabular bone stock, eliminating issues seen in metal-on-metal bearings.

Of 486,946 primary conventional THR procedures undertaken for any reasons, 4,033 used DeltaMotion cups and 482,913 were modular designs (107,758 CoC, 131,906 CoXLPE, 208,917 MoXLPE and 34,332 CMoXLPE). The result shows that the DeltaMotion cup had significantly lower cumulative percent revision compared to the modular bearings, also with a significantly lower revision rate for prosthetic dislocations and no revision for squeaking compared to other modular bearings. 175 ceramic breakages were recorded for the modular bearing group and only 1 ceramic breakage was recorded

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for the DeltaMotion group. This study demonstrated that DeltaMotion cup is suitable for younger and more active patients based on their ongoing follow-up, although this cup is no longer manufactured.

2. van Loon J, Sierevelt IN, Spekenbrink-Spooren A, et al. Higher risk of 2-year cup revision of ceramic-on-ceramic versus ceramic-on-polyethylene bearing: analysis of 33,454 primary press-fit total hip arthroplasties registered in the Dutch Arthroplasty Register (LROI). *Hip Int.* 2023;33(2):280-287. doi:10.1177/11207000211064975.

This study describes 2-year cup revision rates of CoC and CoPE for primary press-fit THRs with one of the three most used cups recorded in the Dutch Arthroplasty Register (LROI) between 2007-2019. A total of 33,454 of press-fit THRs used one of the three most used cup types available with both CoC and CoPE bearing were included in this study, of which 12,535 were CoC and 20,919 were CoPE. The results showed that the overall 2-year cumulative cup revision rate was 0.53% (95%CI, 0.45-0.60). Overall, 84 THRs with CoC were revised at 2 years, a revision rate of 0.67% (95%CI, 0.54-0.81). CoPE had a total of 91 revisions with a revision rate of 0.44% (95%CI, 0.34-0.54). This result remained significant (HR 0.64 (95%CI, 0.44-0.93)) after adjusting for confounders (age, gender, cup type, head size) and CoPE was favored over CoC (p=0.019). In terms of revision reasons, cup revisions were only different because more cups were revised due to loosening (p=0.030) in the CoC (26.2% vs. 13.2%) compared to CoPE. There were 19 cases of cup revision due to aseptic loosening observed in CoC, with a revision rate of 0.153% (95%CI, 0.075-0.231). Revision rate of CoPE was 0.058% (95%CI, 0.019-0.097), with a total of 12 cup revisions for aseptic loosening.

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Abbreviations, Tables and Figures

AJRR: The American Joint Replacement Registry

AOA NJRR: The Australian Orthopaedic Association National Joint Replacement Registry

CI: Confidence Interval

CMoP: Ceramicised Metal-on-Polyethylene

CoC: Ceramic-on-Ceramic

CoM: Ceramic-on-Metal

CoP: Ceramic-on-Polyethylene (including both conventional polyethylene and cross-linked polyethylene)

CoPoM: Ceramic-on-Polyethylene-on-Metal (Dual Mobility - only used by the NJR)

CoXLPE: Ceramic-on-Cross-Linked Polyethylene

CohXLPE: Ceramic-on-Highly Cross-Linked Polyethylene (only used by the EPRD)

DM: Dual Mobility

EPRD: Endoprothesenregister Deutschland (The German Arthroplasty Registry)

EQ-5D: European Quality of Life 5 Dimensions

EQ-5D-5L: European Quality of Life 5 Dimensions 5 Level Version

EQ VAS Health: EuroQol-Visual Analogue Scales

HOOS JR. Score: Hip Disability and Osteoarthritis Outcome Score for Joint Replacement Score

HR: Hazard Ratio

ISAR: International Society of Arthroplasty Registries

MoM: Metal-on-Metal

MoP: Metal-on-Polyethylene (including both conventional polyethylene and cross-linked polyethylene)

MoPoM: Metal-on-Polyethylene-on-Metal (Dual Mobility - only used by the NJR)

MoXLPE: Metal-on-Cross-Linked Polyethylene

MohXLPE: Metal-on-Highly Cross-Linked Polyethylene (only used by the EPRD)

NHS: The National Health Service

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Abbreviations, Tables and Figures

NJR: The National Joint Registry, which covers England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey

NZJR: The New Zealand Joint Registry

OA: Osteoarthritis

PROMs: Patient-Reported Outcome Measures

PROMIS-10: Patient-Reported Outcomes Measurement Information System-10

SAR: The Swedish Arthroplasty Register (Merger of the Swedish Hip Arthroplasty Register and the Swedish Knee Arthroplasty Register)

SD: Standard Deviation

THA: Total Hip Arthroplasty

THR: Total Hip Replacement

VR-12: The Veterans RAND 12 Item Health Survey

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