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Catalan Arthroplasty Register. Second report (2005-2010)

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Catalan Arthroplasty Register. Second report (2005-2010)

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ABSTRACT

Background and objectives

The Catalan Arthroplasty Register (RACat, from its acronym in Catalan) is a population-based register designed to assess the clinical effectiveness of hip and knee arthroplasties in Catalonia. The aim of this report is to present the results of the information sent to the RACat corresponding to the 2005-2010 period, in terms of quality of the data, characteristics of the operated patients, types of surgical procedures, prosthesis used, and patient survival at 1 year and at mid-term up to 4 years after surgery. Factors relating to a better/worse prognosis of primary arthroplasties of knee and hip arthroplasties are also included in this report.

Methodology

A total of 52 healthcare centres from the Public Use Hospital Network (XHUP, from its acronym in Catalan) participated in the described period. Data were collected prospectively by means of a computer application system from the Catalan Health Service (CatSalut, from its acronym in Catalan), which also includes information from the Central Register of Insured Persons (RCA, from its acronym in Catalan). These data were linked to the data on hip and knee arthroplasties from the Minimum Basic Data Set at Hospital Discharge (MBDSHD) and from the prosthesis catalogue of the Catalan Agency for Health Information, Assessment and Quality (AIAQS, from its acronym in Catalan). The volume of data sets sent by each healthcare district and by each centre for the three time periods (2005-2006, 2007-2008 and 2009-2010) was described for each joint (knee and hip). The exhaustiveness of all the data sent to the RACat for each period were compared with the data available at the MBDSHD. The percentage of classified arthroplasties and the laterality reported was also described. The characteristics of operated patients (sex, age, reason for the surgery, comorbidities, mean hospital stay, and referral to a rehabilitation and recovery centre at discharge), the characteristics of the arthroplasties (type of arthroplasty, fixation technique) and the most frequently used models, were all described. The percentages of revision surgery and the accumulated probability of death after a primary arthroplasty were assessed and the role of mortality as a competitive risk of revision was examined. Multivariate models were used to analyse the accumulated incidence of revision adjusted by age, sex and probability of death.

Results

Knee arthroplasties

- During 2005-2010, the RACat recorded a total of 36,951 knee arthroplasties, the replacement burden being 9.0%. Exhaustiveness increased from 52.1% to 86.6% between 2005-2006 and 2009-2010. The percentage of arthroplasties that were classified also increased (from 58.8% to 89.9%) in the said time period, as did the number of registers that had reported laterality available (from 58.7% to 97.2%).
- In the 2009-2010 time period, approximately 98% of the patients who had had a primary arthroplasty was due to arthrosis; while in those who had had a revision surgery, 90%

were operated on due to complications derived from the primary surgery; on the other hand, 67.3% of the patients who had had primary arthroplasty surgery presented one or more comorbidities and approximately 7%, were referred to a rehabilitation and recovery centre on hospital discharge.

- As regards the type of total knee arthroplasty (TKA), the most frequently performed procedures were those that preserved the posterior cruciate ligament (cruciate retaining) and those that were posteriorly stabilized (posterior stabilized design), with a 46.8% and 48.4%, respectively. Seventy four percent of primary knee arthroplasties were cemented, with a similar distribution per periods, sex and age groups.
- The incidence of revision at 4 years (adjusted by age, sex and probability of exitus) was 3.4%. The accumulated probability of death at 1 year was 0.8% and 4.1% at 3 years. In the multivariate Cox models (age and sex-adjusted), the percentage of revision was higher in primary knee arthroplasties with cemented fixation compared to hybrid arthroplasties (HR: hazard ratio 0.7; CI95%:0.5-0.8); however, no significant differences were detected between cemented and non-cemented arthroplasties.
- Finally, variability in the number of different prosthesis models was observed during the last period, with a mean of 10.6 models per centre (range: 1-22 models).

Hip arthroplasties

- During 2005-2010, the RACat recorded a total of 26,477 hip arthroplasties, with a revision burden of 10.2%. Exhaustiveness increased from 45.0% to 73.2% between 2005-2006 and 2009-2010. The number of arthroplasties that were classified also increased (from 56.6% to 83.4%), as did the number of registers that had reported laterality available (from 55.6% to 93.1%).
- In the 2009-2010 time period, approximately 80% of the patients with a total hip arthroplasty (THA) were operated on due to arthrosis; in partial hip arthroplasties (PHA), 95% were due to fracture of the neck of the femur; and in revision arthroplasties, 91% were due to complications arising from the primary surgery. Fifty nine percent, 78.0% and 63.8% of the patients presented one or more comorbidities in relation to total arthroplasties, partial arthroplasties and revisions, respectively. Approximately 31.5% of the patients with a PHA were referred to a rehabilitation and recovery centre on discharge.
- Sixty four percent of the primary hip arthroplasties were conventional and 15.7 were partial bipolar. In the 2005-2010 time periods, 62.3% and 46.2% of the THA and PHA were non-cemented, respectively. As patient age increased, the percentage of non-cemented THA decreased (from 84.2 to 32.1%, in the group below the age of 65 or over the age of 85 years, respectively). As for partial arthroplasties, as patient age increased, the percentage of cemented prosthesis decreased (from 78.5 to 44.5%, respectively).
- The overall incidence of revision at 4 years in THA (adjusted by age, sex and probability of exitus) was 3.2%; and in partial hip arthroplasties it was 1.7%. The accumulated probability of death at 1 year was 1.8% and 6.6% at 3 years in THA, while in PHA it was 25% and 53%. On multivariate Cox models, age and sex-adjusted incidence of revision in THA and PHA did not show statistically significant differences depending on the type of fixation used.

- Finally, as in the knee results, variability in the number of different models per centres was observed, with a mean of 15.6 models per centre (range: 3-35 models).

Conclusions

The data provided in this report have permitted to analyse the clinical effectiveness of primary knee arthroplasties and primary total and partial hip arthroplasties up to 4 years of followup, showing results consistent with the international literature. The results have shown that the register can be a useful tool to follow up trends in knee and hip arthroplasties in order to describe and identify factors related to the failure of surgery, as well as to analyse variations in patient characteristics and prosthesis among hospitals or health districts in Catalonia and, it can therefore be considered an instrument to assess Orthopaedic Surgery and Traumatology, which might prove of great utility in decision-making. The main limitations were the short followup period of the patients that still does not allow obtaining robust results at long term as in Northern European registries. Finally, the strengths of the project incorporate the continued interest of decision-makers and stakeholders associated to hip and knee orthopaedic surgery, as well as the availability of computerized data from hospitals and the Catalan Health Service. The RACat is a groundbreaking initiative of the National Health Service as a population-based register of the public health system that has now been in operation for over 5 years, similar to other arthroplasty registers in other countries (England and Wales, Denmark, Finland, Italy, Norway and Sweden, among others). The involvement of RACat key stakeholders, specially the Catalan Society of Orthopaedic Surgery and Traumatology in the dissemination and implementation of their results and the research that may arise thereof, can foster, as has happened in other countries, the improvement of health care. Finally, the RACat offers a post-market surveillance system of the implants.

PRESENTATION

The Catalan Arthroplasty Register (RACat) has been in operation for 7 and a half years. The RACat is a useful tool that has just started to yield some important results for planning and assessment of orthopaedic surgery, and for identifying aspects of health care improvement in centres belonging to the Public Use Hospital Network (XHUP, from its acronym in Catalan) where hip and knee arthroplasties are performed. This continuity is the result of the joint effort and interest of all professionals associated with the development of the project. It can also be attributed to the involvement of professionals over time, in both the sending and revision of data, and revision of its clinical and epidemiological consistency, as well as the dissemination of results throughout centres, health care regions and other institutions. Furthermore, it is important to emphasize the development of data management tools for hospitals, as with the Applications Portal of the Catalan Health Service-CatSalut or the Catalan Agency for Health Information, Assessment and Quality (AIAQS).

The results presented in this second report with data on the RACat provide information to different audiences regarding the selection of prosthesis, surgical technique, or other aspects of the surgery, based on patient needs and center characteristics (age, sex or volume of health-care activity). As it has been previously mentioned, the RACat involves the participation of physicians, managers and care directors, healthcare executives, manufacturers and prosthesis distributors, patients and their relatives as well as investigators in health services. It also involves the collaboration of orthopaedic surgery and traumatology professionals, who are familiar with the techniques, procedures and implants used in Catalonia, based on patient profiles and centers. It provides information to hospitals about the use of its resources and quality level of the care services they provide. It helps patients and relatives by providing them with better assistance in line with their expectations. It is intended to be used as a help tool by health system managers responsible for planning the needs and for decision-making regarding funding and optimizing resources, control and quality assurance, efficiency and equity. This joint effort includes prosthesis companies that enhance the quality of their implants to justify and recover the investment made in research; and, finally, researchers in health services assessment as a dissemination tool and strong assessment tool of the quality and management in the research field.

We are pleased to make use of this tool as well as the results from other European arthroplasty registers.

1. INTRODUCTION

In recent years in Catalonia, hip and knee arthroplasties have represented the second and the fifth most common inpatient surgical procedure. Thus, 14,132 and 14,086 knee arthroplasties and 8,655 and 8,745 hip arthroplasties were performed in the years 2008 and 2009, respectively.¹ Moreover, variability in clinical practice, waiting list problems, and significant healthcare costs have been highlighted.¹⁻² The response of health systems to assess this type of frequent, complex and costly surgery incorporates the definition of explicit criteria for the indication for surgery based on health needs, analysis of the adequacy of the health care provided or the study of arthroplasty effectiveness at mid and long term.³ These tools are some of the most noteworthy in the field of orthopaedic surgery and trauma assessment to reduce the variability of this surgery, improve continuity of care, and ultimately ensure the quality and efficiency of the care process.

The RACat was created in 2005 in response to the shared interest of the Catalan Health Service-CatSalut, the SCCOT and the AIAQS to assess the clinical effectiveness of hip and knee arthroplasties in Catalonia, and to describe the characteristics of the operated patients, types of procedures, as well as variability.² The RACat is a groundbreaking initiative of the National Health Service as a population-based register of the Public Health System that has recorded data from the majority of patients who have undergone a knee or hip intervention.^{4,5} This second annual report that corresponds to the 2005-2010 period, describes RACat's data in terms of the completeness and quality of the information, and provides an overview of its evolution in time and improvement over the compared periods. Moreover, for the first time, RACat's data has been linked to the Minimum Basic Data Set at Hospital Discharge (MBDSHD), improving the information available on demographic characteristics of the operated population and patient health, as well as the care delivery process. In addition, a comparison has been made by centres and survival results are presented at short-, mid-, and long-term. The characteristics associated with a better prognosis of the surgery have also been compared.

1 Minimum Basic Data Set at Hospital Discharge (MBDSHD), Healthcare Activity of the Catalan Health Network (Xarxa Sanitària de Catalunya. 2009). http://www10.gencat.cat/catsalut/archivos/cmbd/cmbd_2009.pdf

2 <http://www.gencat.cat/salut/depsan/units/aatrm/html/ca/dir214/doc8748.html>

2. OBJECTIVES

The objective of this second report is to present the results of the information sent to the RACat during the period 2005-2010 regarding the characteristics of the patients, arthroplasties and implanted prostheses, the early (at 1 year) and mid-term survival (at 4 years), the same way as the related factors with a better/worse prognosis of the primary knee and hip arthroplasties.

The specific objectives are:

1. To describe data sent to the RACat in terms of the completeness and quality of the information, as the temporary evolution of arthroplasties and the variability per center.
2. To describe the characteristics of the patients undergo a knee or hip intervention, the fixation technique, model and characteristics of the implanted prosthesis and the temporary evolution.
3. To analyse the survival of the knee and hip prosthesis and the characteristics associated with a better/worse prognosis of the surgery at short- and mid-term.

3. METHODOLOGY

3.1. Study population

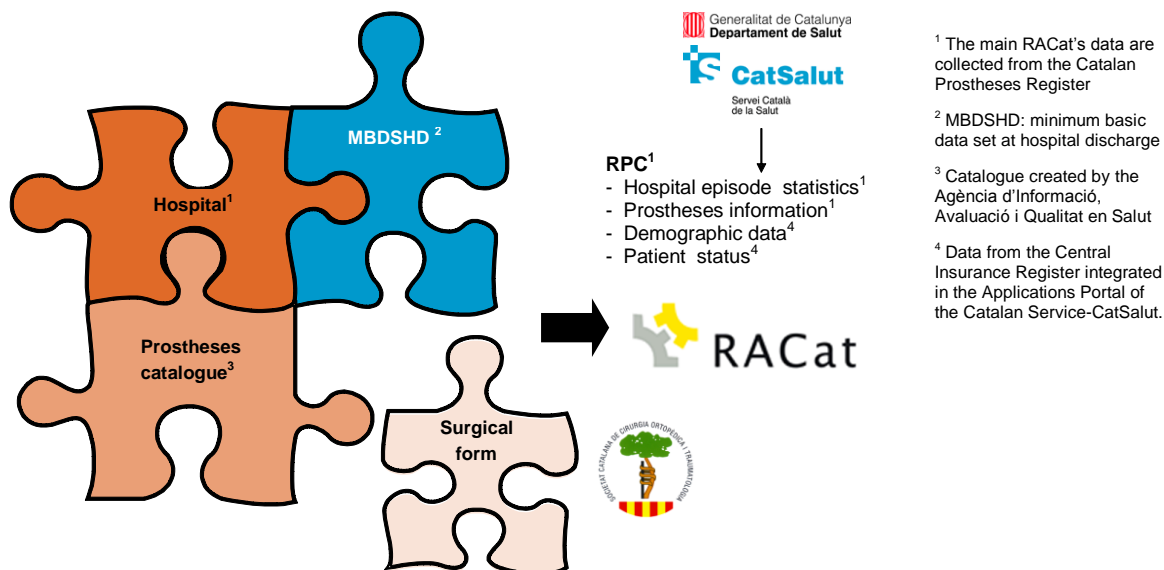
The study population comprises all insured citizens by CatSalut who undergone hip or knee arthroplasty in the period 2005 to 2010 in a collaborating center of the RACat.³ During this period 52 of 69 centres of the XHUP participated and sent data to the RACat. The information provided on this report concerns the characteristics of primary arthroplasties given that they represent the majority of interventions, versus revisions.

3.2. Flowchart and sources of information

The RACat project was designed to make the best use of information already available in the centres' information systems.⁶ The hospitals send information to the RACat through the CatSalut Applications Portal of the Catalan Health Service-CatSalut, using the Register Prosthesis application (RPC, from its acronym in Catalan). The quality of the information sent to the RACat is reviewed periodically. The results of this data review process data are included in a document that is sent to the members of the Technical Group of every centre to correct errors and the information is sent back to the RACat. RPC application integrates information on demographic data (date of birth, gender, place of residence) and status of patients (alive, dead or living outside Catalonia) from the Central Insurance Register (RCA, from its acronym in Catalan). The data obtained from the RPC are cross-checked with the data from the AIAQS's prosthesis catalogue (it contains for each one of the manufacturers and prosthesis suppliers contacted, the information on the reference number and the description of the main product characteristics), and with data available at the MBDSHD (Minimum Basic Data Set at Hospital Discharge). A project is currently being developed for data collection of the RACat's surgical form. This surgical form was consensuated by the Catalan Society of Orthopedic Surgery and Traumatology (SCCOT) in 2006 and consisted of two forms for primary arthroplasties and two for revision arthroplasties (one for each joint).(Figure 1).

³ More information on the RACat website:
<http://www.gencat.cat/salut/depsan/units/aatrm/html/ca/dir214/doc8748.html>

Figure 1. Flowchart and sources of information in the RACat



Prospective data provided by centres are: a) patient's Personal Identification Code (PIC), b) date of admission, c) date of intervention, d) whether it is a primary prosthesis or a revision, e) whether it is a hip or knee prosthesis, f) operated side (right or left), g) name of the manufacturer, h) reference number and batch number of every component of the prosthesis, Table 1).

Table 1. Variables collected from RACat's source information

Variables sent by hospital	Variables RCA	Variables MBDSHD
Personal Identification Code (PIC)	PIC	PIC
Centre	Sex	Centre
Clinical history number (CHN)	Date of birth	CHN
Date of admission	Status patient	Date of admission and discharge
Date of intervention	Basic health unit	Health care region
Type of arthroplasty (primary, revision)	Health sector	Sex
Join (knee, hip)	Health care region	Principal and secondary diagnosis (reason for surgery; comorbidities)
Operated side (right, left)		Principal procedure
Prosthesis information (manufacturer, reference number and batch number of every component informed)		Discharge from social and health services centers
		Level of hospital complexity
		Hospital stay

RCA: Central Insurance Register; MBDSHD: Minimum Basic Data Set at Hospital Discharge. RACat: Catalan Arthroplasty Register

3.3. Prosthesis catalogue⁴

At present, this catalogue offers information on 26,470 reference numbers pertaining to the primary components of hip (stem, acetabulum, insert and head) and knee (femoral, tibial, tibial insert, patella) prostheses of 69 manufacturers. Prosthesis information sent by hospitals are cross-checked with the prosthesis catalogue to identify the type of implants and additional characteristics. The information on identified implants made possible to group the type of arthroplasty following the AIAQS's classification system (table 2), fixation technique (cemented, uncemented or hibryd), friction device in total hip arthroplasties (THR), and

⁴ The AIAQS has elaborated a prosthesis catalogue with the information provided by manufacturing and distribution companies on their products.

prosthesis models (trademark which the implant is marketed). The RACat website provides information on all of the models and manufacturers for each type of arthroplasty, by component and joint.

3.4. Primary arthroplasty classification system

In order to group the different types of arthroplasties implanted, centers must send the necessary information regarding prosthesis components. As mentioned in previous reports, the RACat's classification system was adapted from the Australian Orthopaedic Association National Joint Replacement⁷.

Primary knee arthroplasties

The knee joint is divided into three major compartments: the patellofemoral joint, the medial tibiofemoral joint and lateral tibiofemoral joint. The type of arthroplasty is defined depending on the number of compartments replaced (Table 2): a) unicompartmental (UKA), when a single compartment is replaced (patellofemoral or tibiofemoral), b) total knee arthroplasty (TKR), when two or three compartments are replaced. Furthermore, total arthroplasties are classified into different groups, depending on the joint range of motion and whether cruciated and collateral ligaments are preserved or not: cruciate retaining (CR), cruciate substituting or posterior stabilized (PS), constrained, hinged and tumoral (in these latter two categories collateral ligaments are not preserved).

Primary hip arthroplasties

Two large groups of arthroplasties have been defined: partial and total arthroplasty, when a part or all of the joint is replaced, respectively a) partial hip arthroplasty (PHA), where femoral joint is replaced, and b) total hip arthroplasty (THA) where acetabulofemoral joint is replaced (Table 2). In addition, partial arthroplasties are grouped as: unipolar monoblock when an only stem is implanted, unipolar modular, when a stem and a cephalic component is implanted, and bipolar, where a stem and a bipolar head component are implanted. In the case of total arthroplasties, they are grouped as: conventional, when a stem, head and acetabulum are implanted and resurfacing, with the same components as conventional arthroplasty but using a resurfacing head.

Table 2. Classification system for primary hip and knee arthroplasties

Type of arthroplasty	
Hip	Knee
Partial hip arthroplasty (PHA)	Total knee arthroplasty (TKA)
Unipolar monoblock	Cruciate retaining (CR)
Unipolar modular	Posterior stabilised (PS)
Bipolar	Constrained
	Hingue
Total hip arthroplasty (THA)	Tumoral
Conventional	
Resurfacing	Unicompartmental knee arthroplasty (UKA)
	Femoropatellar
	Unicompartmental femorotibial

3.5. Statistical analysis

Completeness and quality of the information

Minimum Basic Data Set at Hospital Discharge (MBDSHD) is a clinical and administrative comprehensive useful database on all health and morbidity activity conducted in public and private hospitals in Catalonia⁸ Thus, the activity of the 52 hospitals participating in the RACat project has been recorded. In order to assess the exhaustivity and completeness of the RACat, the information of both registers were linked together using the patient's PIC, centre, date of birth, sex, year and month of patient's admission, and type of arthroplasty (primary or revision) carried out.

A descriptive analysis of the patient volume included in the RACat per year and period (2005-2006; 2007-2008; 2009-2010) was carried out. As a result of linking together the data sent to the RACat and the data available at the MBDSHD, the exhaustivity and the global completeness of the RACat's data, per centre and year, were calculated.

Exhaustivity is considered to be the ratio between the arthroplasties volume sent to the RACat and the arthroplasties volume sent to the MBDSHD by participating hospitals during the 2005-2010 period. Completeness is considered to be the ratio between the arthroplasties volume sent to the RACat (all participating hospitals) compared with the all hospital admissions recorded in the MBDSHD for the same period (including those which are not included in the RACat, as private hospitals) with a principal procedure of arthroplasty. A funnel plot between the exhaustivity of every centre and the case volume sent to the RACat, in an anonymized way, is shown. To do this, the overall exhaustivity of all participating centres of the RACat with a 95 % confidence interval was used as a reference.

Two indicators were defined to assess the quality of the data: the percentage of primary knee and hip arthroplasties that were identified following the classification system used in the RACat (Table 2) and the percentage of cases sent to the RACat with the operated side informed (right or left). A funnel plot for each indicator with the result of every centre and the case volume sent to the RACat, was also anonymous. It was used as a reference for the overall result with a 95 % confidence interval.

The funnel plot is recommended as a visual aid to benchmark centers. In this type of graph, an estimate of an indicator versus an interpretable precision measure is drawn. The limits of control draw the shape of a funnel over the objective result control. In the case of centers that are above or below the limits of control, the value of the indicator will be interpreted as being above or below the set or target outcome.

Descriptive analysis of patients and arthroplasties

For each type of joint (hip and knee), a descriptive analysis was carried out (first by overall data and then by health care regions) of the patient characteristics included in the RACat (volume, sex, age and type of arthroplasty). At the same time, and only for those patients included in the RACat and linked with the MBDSHD, other questions related to morbidity and the care delivery process, were described (reason for surgery, comorbidities, hospital stay and percentage of referrals to a convalescence centre at hospital discharge).

The global burden of revision, the percentage of revisions sent to the RACat compared to total number of interventions sent (primary and revisions), was calculated. This index provides the percentage of revisions undertaken in a given period in relation to the total number of interventions. In contrast with the cumulative revision rate, revision procedures described in the burden revision during 2005-2010, do not necessarily correspond to patients who underwent a primary arthroplasty in the same period (it is a cross-sectional cut without a followup). Fixation technique (cemented, uncemented and hybrids) and the type of arthroplasty used were described per age groups and period; and, in the case of conventional THA, the friction device (metal-metal, metal-polyethylene, ceramic-polyethylene and ceramic-ceramic) was also described overall and per age groups. The most five common implant models have been described by type of arthroplasty and fixation technique. The number of the different models used by each centre together with the percentile distribution of the different models by centre have also been anonymously described. In the latter case, the sum of the different models was calculated by centre and adjusted by the health care activity volume.

Implant survival analyses of primary arthroplasties and the cumulative probability of death

The object of study in survival analyses is the time lapse from the date of the primary arthroplasty until an event occurs, in this case, the replacement of the prosthesis.^{9,10} The starting point for all the patients is the date when the primary arthroplasty was performed, regardless of when this occurred between 2005 and 2010. RACat data enables to link together the different episodes of one given patient, making it possible to ascertain the time lapse between the primary arthroplasty and its replacement. Hence, these analyses allow assessing the clinical effectiveness of the arthroplasties and factors of better or worst prognosis.

The majority of the patients with a primary arthroplasty included in the RACat did not have an informed report of their replacement surgery at the time of closing the inclusion and review of data for this report (31st of December, 2010). Data for these patients were considered as “censored”. When the censorship was due to the death of the patient, only the time between the date of the primary arthroplasty and the date of death was taken into account.

The vital status of the patients included in the RACat is regularly updated through the RCA. On the other hand, with the information available at the RACat, it was also possible to obtain information on patients no longer affiliated to the CatSalut due to their relocation to other Spanish Autonomous Communities. Data from these patients were also processed as censored data in the survival analyses of the prostheses.

Survival analyses presented in this second report are based on the reference of the ones carried out in the arthroplasties registries of England and Wales and Sweden.^{11,12} The cumulative rate of replacement was estimated as a whole and by the type of fixation. For knee arthroplasties, this rate was also estimated according to the type of arthroplasty (comparison between TKA in which the anterior cruciate ligaments had been preserved and those in which the posterior ligaments had been stabilized). For hip arthroplasties, differentiated analyses were carried out for PHA and for THA. For the latter ones, the cumulative rate by type of friction component was also taken into account. When calculating

the accumulated replacements rates, the actuarial adjustment by the number of patients at risk of replacement was taken in to account for every time interval.

To find out the replacement rates at short term or on a year to year basis, the following intervals of time were used: 0 to 30 days, 30 to 90 days, 90 days to 1 year, 1 to 2 years, 2 to 3 years, 3 to 4 years, 4 to 5 years, and from 5 years or more.

On the other hand, a Cox proportional-hazard regression model was used to explore the effects of different factors in the replacement of prostheses adjusted by different covariates.¹² The hazard ratio (HR) of the replacement was estimated depending on the type of fixation, adjusted by patient age and sex. These models allow taking into account the elapsed time until the event or the censorship, with proportional risk assumption. The reading of a HR corresponds to that of a relative risk. Therefore, a $HR > 1$, where 1 is not included in the 95% CI, measures how high the risk for replacement in patients with the factor is, in relation to the ones that do not have it.

The accumulative probability of death was calculated in patients with knee or hip primary arthroplasty, 30 days after the procedure (considered hospital mortality), after 1 year, and at 3 years, overall and per age groups (under the age of 65, from 65 to 74, from 75 to 84, and over the age of 85). The death of a patient is presented as a competing event in the prosthesis replacement process, implying that the patient dies before the replacement is carried out, especially in patients over the age of 75. For analytical purposes, obviating this fact could bias prosthesis survival estimates, as well as the magnitude of the different risk factors associated with the replacement. The Cox proportional-hazard model for competing risks of Fine and Grey was the method applied to adjust the analyses by risk of patient death to estimate the accumulated incidence of replacement.^{13,14,15}

4. KNEE ARTHROPLASTIES RESULTS

4.1 Scope and quality of data

In the period described, data from 33,639 patients with primary arthroplasty and from 3,312 patients with knee replacement arthroplasty were received. As shown in Table 3, the volume of data received increased through the course of the three periods in all of the health regions, especially in Camp de Tarragona, Lleida, Catalunya Central, and in the Barcelona area: Vallès, Barcelonès Nord, and Maresme.

Table 4 shows the volume of primary and revision arthroplasties data sent during the 2005-2008 period (data included in the first report) in comparison with the 2009-2010 period, per center. The overall burden of revisions, understood as the percentage of revision arthroplasties compared to the total number of events sent to the RACat, was 9%. Remarkable disparities can be found between centers with a minimum burden of 0% and a maximum of 18%. Furthermore, 25% of the centers showed a burden that did not reach 4% and 25% presented a burden that was higher than 11%.

Table 3. Number of knee arthroplasties by health care region, period and whether they are primary or revision arthroplasties. (Source: RACat)

Health care region	1st period 2005-2006		2nd period 2007-2008		3rd period 2009-2010		% increase 1st/ 3rd period*	Total 2005-2010	
	Primary	Revision	Primary	Revision	Primary	Revision	Total	Primary	Revision
Alt Pirineu i Aran	97	3	116	--	135	3	38%	348	6
Barcelona	5,598	474	7,494	761	9,192	1,175	71%	22,284	2,410
Barcelona Ciutat	2,650	244	2,622	333	3,845	616	54%	9,117	1,193
Barcelonès Nord i Maresme	627	42	1,087	68	1,495	133	143%	3,209	243
Garraf i Alt Penedès	364	42	443	90	379	97	17%	1,186	229
Llobregat	1,239	58	1,328	63	1,438	126	21%	4,005	247
Vallès	718	88	2,014	207	2,035	203	178%	4,767	498
Camp Tarragona	127	3	816	30	1,019	45	718%	1,962	78
Catalunya Central	607	41	1,119	93	1,209	163	112%	2,935	297
Girona	1,186	86	1,503	123	1,813	163	55%	4,502	372
Lleida	209	15	500	30	591	47	185%	1,300	92
Terres de l'Ebre	--	--	--	--	307	57	--	308	57
Total	7,824	622	11,548	1,037	14,266	1,653	88%	33,639	3,312

*The percentage of increase in the volume of knee data sent to the RACat corresponding to the 1st period ((2005-2006) compared to the 3rd period (2009-2010) was calculated: [The volume of data 2005-2006 primary and revision procedures/ volume of data 2005-2006+2009-2010 primaries and revisions]*100; RACat: Catalan Arthroplasty Register

Table 4. Number of knee arthroplasties by health care region, centre, period and whether they are primary or revision arthroplasties. (Source: RACat)

Health care region	Centre*	2005-2008		2009-2010		Total Revision	%
		Primary	Revision	Primary	Revision		
Alt Pirineu i Aran	Fundació Sant Hospital -Seu Urgell	96	1	51	3	151	2.6
	Hospital Comarcal del Pallars	71	0	64	0	135	0.0
	Hospital de Puigcerdà	46	2	20	0	68	2.9
Barcelona	Clínica Plató, Fundació Privada	131	7	150	10	298	5.7
	Corporació Sanitària Parc Taulí	869	116	621	74	1,680	11.3
	Hospital de la Santa Creu i Sant Pau	0	0	224	31	255	12.2
	Hospital Sant Joan Déu Martorell	395	26	270	30	721	7.8
	Fundació Privada Hospital de Mollet	280	18	153	4	455	4.8
	Hospital Clínic de Barcelona	2,670	449	1,232	320	4,671	16.5
	Hospital Comarcal de l'Alt Penedès	167	13	164	29	373	11.3
	Hospital de l'Esperança i Mar	137	26	499	88	750	15.2
	Hospital de l'Esperit Sant	488	38	388	50	964	9.1
	Hospital de l'Hospitalet	1,055	66	348	43	1,512	7.2
	Hospital de Mataró	527	30	449	27	1,033	5.5
	Hospital de Sant Boi	530	29	237	31	827	7.3
	Hospital de Sant Celoni	269	24	130	25	448	10.9
	Hospital de Sant Jaume de Calella	388	14	259	5	666	2.9
	Hospital de Terrassa	257	27	287	27	598	9.0
	Hospital de Viladecans	0	0	108	13	121	10.7
	Hospital Dos de Maig de Barcelona	228	15	230	11	484	5.4
	Hospital General de Granollers	672	63	83	11	829	8.9
	Hospital Municipal de Badalona	664	39	286	20	1,009	5.8
	Hospital Mútua de Terrassa	385	47	576	50	1,058	9.2
	Hospital Residència Sant Camil	640	119	215	68	1,042	17.9
	Hospital Sant Rafael	0	0	378	54	432	12.5
	Hospital Sant Joan Despí	0	0	185	12	197	6.1
	Hospital Sant Joan Déu Esplugues	0	0	1	0	1	0.0
	Hospital Universitari de Bellvitge	587	0	474	9	1,070	0.8
	Hospital Universitari G. Trias Pujol	35	3	372	36	446	8.7
	Hospital Universitari Sagrat Cor	806	80	540	49	1,475	8.7
Hospital Universitari Vall d'Hebron	1,300	0	592	53	1,945	2.7	

RACat: Catalan Arthroplasty Register

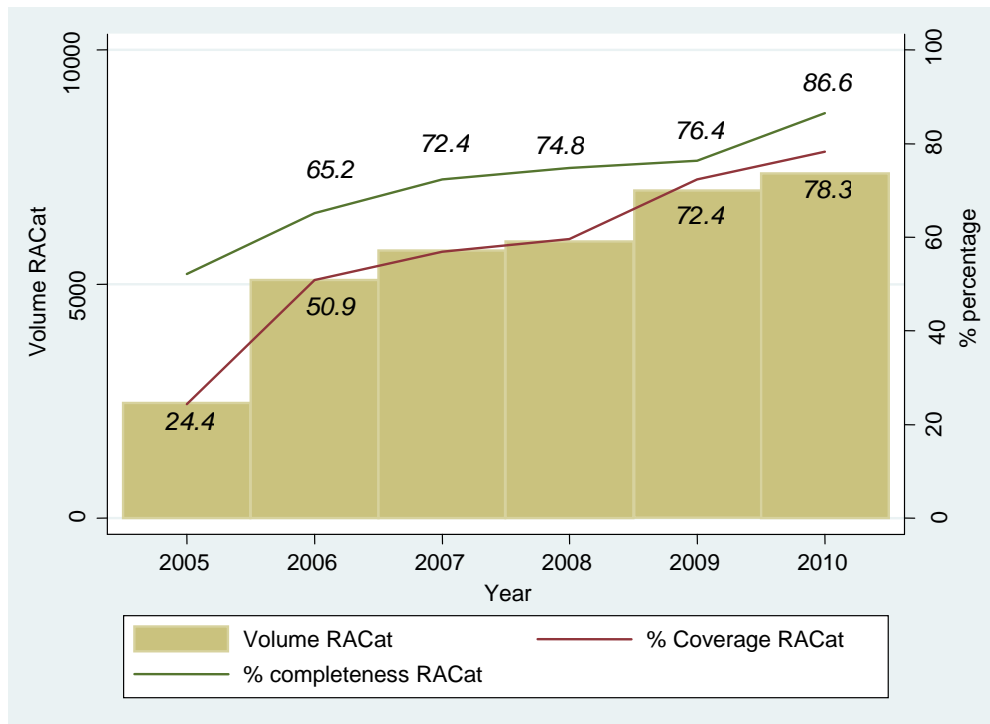
Table 4. Number of knee arthroplasties by health care region, centre, period and whether they are primary or revision arthroplasties. (Source: RACat) Continued.

Health care region	Centre*	2005-2008		2009-2010		Total	% Revision
		Primary	Revision	Primary	Revision		
Camp de Tarragona	Hospital Universitari Tarragona J. XXIII	132	17	247	22	418	9.3
	Hospital Universitari Sant Joan Reus	93	0	183	0	276	0.0
	Hospital i Sant Pau i Santa Tecla	239	6	220	13	478	4.0
	Hospital del Vendrell	239	4	250	6	499	2.0
	Pius Hospital de Valls	240	6	119	4	369	2.7
Catalunya Central	Centre Hospitalari –ALTHAIA	1,129	97	670	113	2,009	10.5
	Fundació Sanitària d'Igualada	269	28	195	35	527	12.0
	Hospital General de Vic	277	5	224	7	513	2.3
	Hospital Sant Bernabé	51	4	120	8	183	6.6
Girona	Hospital Comarcal de Blanes	255	50	126	21	452	15.7
	Clínica Girona	0	0	199	11	210	5.2
	Hospital de Campdevàrol	97	0	54	0	151	0.0
	Hospital de Figueres	518	39	348	25	930	6.9
	Hospital de Palamós	547	32	276	18	873	5.7
	Hospital Provincial Santa Caterina	372	12	233	16	633	4.4
	Hospital Sant Jaume d'Olot	272	23	149	17	461	8.7
	Hospital Universitari Girona Dr.J.Trueta	240	39	169	50	498	17.9
Lleida	Hospital Universitari Arnau de Vilanova	0	2	106	12	120	11.7
	Clínica de Ponent	256	14	169	14	453	6.2
	Hospital de Santa Maria	453	29	316	21	819	6.1
Terres de l'Ebre	Hospital de Tortosa Verge de la Cinta	0	0	307	57	364	15.7
Total		19,373	1,659	14,266	1,653	36,951	9.0

Figure 3 shows the volume of data recorded and the results of completeness and coverage over the years. Completeness increased from 52% in 2005 to 86.6% in 2010. As for coverage, it increased from 24.4% in 2005 to 78.3% in 2010. With the data collected in the last 2 years, Figure 4 shows the percentage of completeness of each center (blue points) compared to the overall completeness (green line) and a confidence interval based on the overall completeness. The centers that are below the range of the confidence interval exhibit lower completeness compared to overall completeness, and the ones that are above exhibit higher completeness than overall completeness. As can be seen, almost all of the healthcare centers that participate in RACat had sent approximately 80% or more of their knee arthroplasty data reported to the MBDSHD⁵ during the 2009-2010 time period. Only 8 out of the 52 centers sent data that fell below the confidence interval based on the overall reference value of 80%.

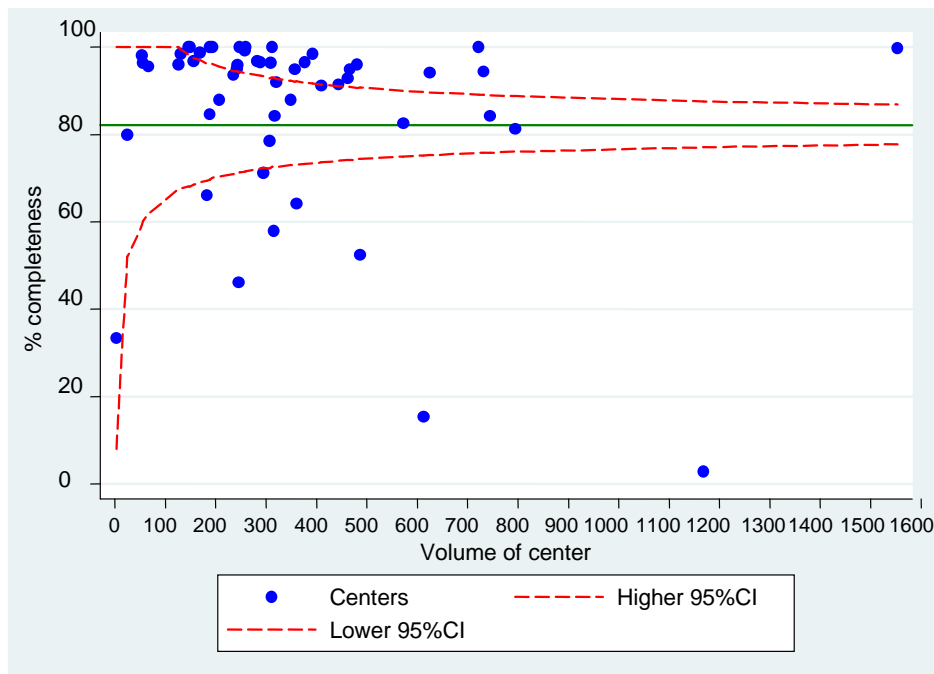
⁵ Hospital Discharge Basic Minimum Data Set

Figure 3. Volume, completeness and coverage of the data on knee arthroplasties per year. (Source: RACat-MBDSHD)



RACat: Catalan Arthroplasty Register; MBDSHD: Minimum Basic Data Set at Hospital Discharge

Figure 4. Percentage of completeness of knee arthroplasties per center during the 2009-2010 period. (Source: RACat-MBDSHD)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register; MBDSHD: Minimum Basic Data Set at Hospital Discharge

Another quality indicator of data is the percentage of arthroplasties that had been classified following the RACat classification, which in the 2009-2010 time period reached 89.9% (Table

5). At a global level, 19.2% of the primary knee arthroplasties have not been classified and therefore cannot be included in further analyses (n=6,468).

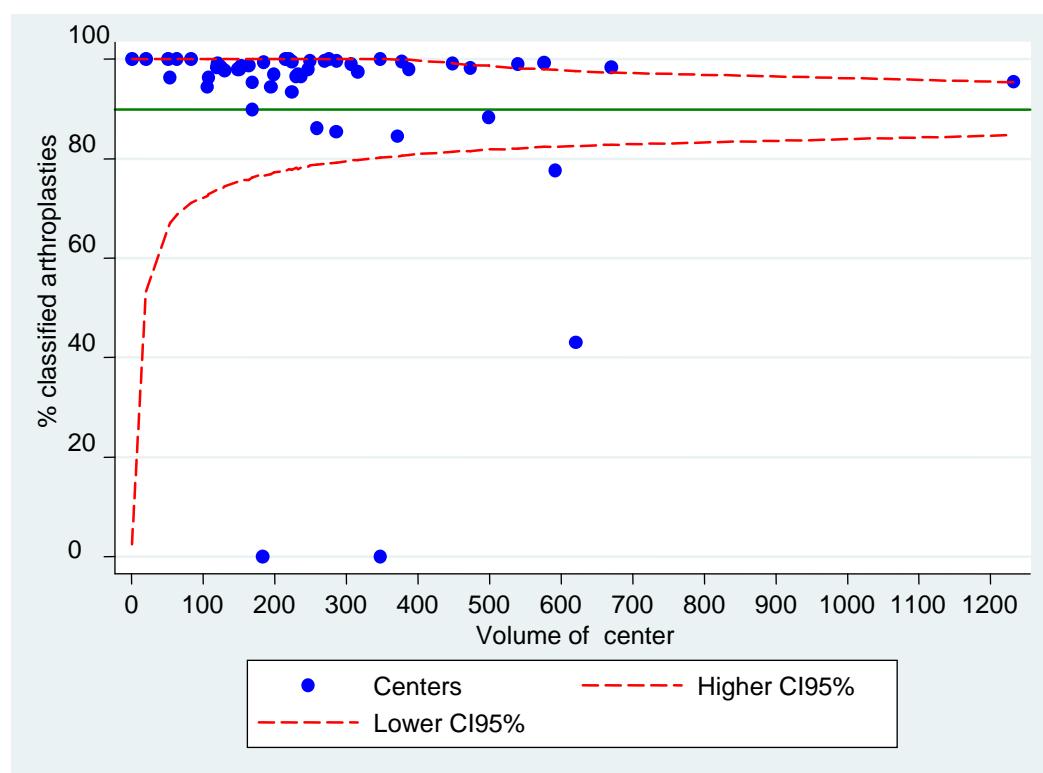
Table 5. Percentages of classified primary knee arthroplasties per center in relation to the volume of data sent in 2009-2010. (Source: RACat)

Classified	2005-2006		2007-2008		2009-2010		Total	
	N	%	N	%	N	%	N	%
Yes	4,604	58.8	9,742	84.3	12,825	89.9	27,171	80.8
No	3,220	41.2	1,806	15.6	1,441	10.1	6,468	19.2
Total	7,824	100	11,548	100	14,266	100	33,639	100

RACat: Catalan Arthroplasty Register

Figure 5 shows how this classification percentage, over the last two years, is sufficiently homogenous between centers and only four centers are identified as being below the lower limit of the confidence interval in 95% of the overall percentage of classified primary arthroplasties.

Figure 5. Percentages of classified primary knee arthroplasties per center in relation to the volume of data sent in 2009-2010. (Source: RACat)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register.

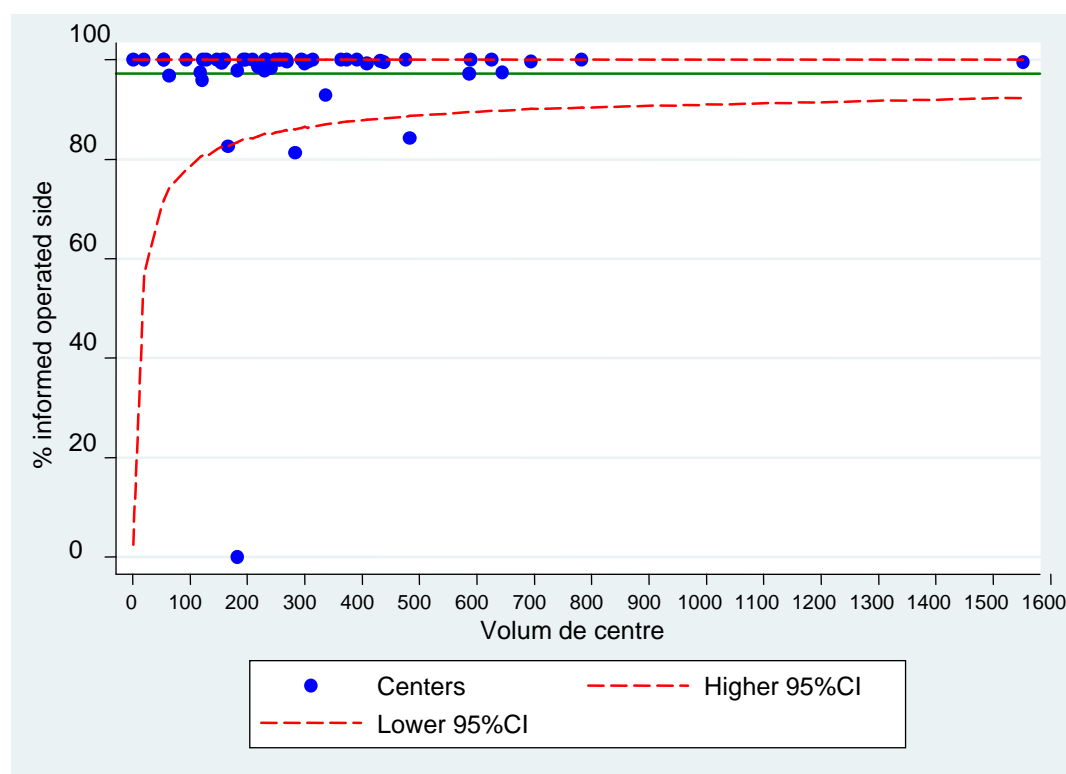
The percentage of arthroplasties with reported laterality received in 2005-2006 was 58.7%; in 2009-2010, this percentage increased to 97.2% (Table 6). With the data of the past 2 years, by center, only 3 centers presented a percentage below the lower limit of the confidence interval of 95% of the overall percentage of arthroplasties with reported laterality (Figure 6).

Table 6. Number of knee arthroplasties with the operated side (left and right) reported by period (source RACat)*

Reported	2005-2006		2007-2008		2009-2010		Total	
	N	%	N	%	N	%	N	%
Yes	4,956	58.7	10,818	85.9	15,475	97.2	31,249	84.6
No	3,490	41.3	1,767	14.0	444	2.8	5,702	15.4
Total	8,446	100	12,585	100	15,919	100	36,950	100

* Overall primary and revision arthroplasties are included. RACat: Catalan Arthroplasty Register

Figure 6. Percentage of primary arthroplasties and knee replacements with reported laterality per center in relation to volume of data sent in the 2009-2010 period. (Source: RACat)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

4.2. Demographic and patient treatment process profile

The average age of the patients that underwent a primary knee arthroplasty has remained constant at approximately 72 years (standard deviation; SD: 7). Overall, the percentage of women is fairly similar between periods and health regions (Table 7).

Table 7. Age and sex of the patients undergoing a primary knee arthroplasty by health care region and period. (Source RACat)

Health care region	2005-2006			2007-2008			2009-2010		
	N	Age	% Women	N	Age	% Women	N	Age	% Women
Alt Pirineu i Aran	97	72.6	61.8	116	73.0	68.1	135	74.6	64.4
Barcelona	5,598	71.9	74.8	7,494	71.9	74.0	9,192	71.9	73.5
Camp de Tarragona	127	72.6	71.6	816	72.1	67.8	1,019	72.2	70.6
Catalunya central	607	72.2	70.5	1,119	71.5	69.7	1,209	71.5	68.4
Girona	1,186	72.3	69.3	1,503	71.8	68.8	1,813	72.0	67.5
Lleida	209	73.1	69.3	500	74.1	68.0	591	73.0	67.0
Terres de l'Ebre	--	--	--	1	0	0	307	72.8	57.3

RACat: Catalan Arthroplasty Register

In the time period spanning between 2009-2010, 78% of patients with a primary arthroplasty were between 65 and 85 years of age. It must be noted that the percentage of patients under the age of 65 with a primary arthroplasty increased from 16.9% in 2005-2006 to 18.6% in 2009-2010. The same happened with patients over the age 85, where it went from 1.4% in 2005-2006 to 2.1% in 2009-2010 (Table 8). No significant differences were observed in terms of demographic profile, which included factors such as age and sex, in patients with a primary or replacement arthroplasty. However, the group of patients over the age of 85 had a higher percentage of replacement arthroplasty than primary arthroplasty.

Table 8. Age and sex of the patients undergoing knee arthroplasty by period and whether they are primary or revision arthroplasty (Source: RACat)

	2005-2006		2007-2008		2009-2010	
	Primary	Revision	Primary	Revision	Primary	Revision
Volume (n)	7,824	622	11,549	1,037	14,266	1,653
Women (%)	73.3	72.9	72.1	73.0	71.4	72.0
Mean age (anys)	72.0	72.4	72.0	72.4	72.0	72.3
Age (%)						
<65 years	16.9	15.9	18.3	18.4	18.5	18.6
65-75 years	45.1	41.5	43.1	39.7	42.6	39.1
75-85 years	36.6	40.3	37.1	38.4	36.8	38.3
>85 years	1.4	2.2	1.5	3.5	2.1	3.9

RACat: Catalan Arthroplasty Register

As far as patients are linked (RACat-MBDSHD), 98% of patients who underwent primary knee arthroplasty presented osteoarthritis and other related disorders as the main reason for intervention. This percentage did not vary over the years. In the case of replacement arthroplasties the main reason for intervention during the whole period (2005-2010) was the presence of some complications such as mechanic, infections or others (90.6% in 2009-2010). With regards to comorbidities (secondary diagnoses reported to MBDSHD) the percentage of patients with one or more comorbidities both in the primary and the replacement arthroplasties groups increased to 67.3% and 68.9% respectively in 2009-2010. The average hospital stay remained fairly constant. For primary arthroplasties length of stay was 7 days and in the case of replacement arthroplasties it was 9 days over the 2009-2010

period. Lastly, the referral for admission to a healthcare center also remained constant in 6-7% of cases (Table 9).

Table 9. Demographic and patient treatment profile of patients with primary and replacement knee arthroplasty by period. (Source: RACat-MBDSHD)

	2005-2006		2007-2008		2009-2010	
	Primary	Revision	Primary	Revision	Primary	Revision
Volume (n)	7,063	492	10,757	869	13,017	1,335
Women	73.3%	67.5%	72.1%	73.2%	71.3%	73.2%
Mean age (years)	72.0	72.3	72.0	72.4	71.9	72.2
Reason for procedure						
Arthrosis	98.2%	--	98.5%	--	98.5%	--
Complications†	--	89.0%	--	90.2%	--	90.6%
- mechanic complication		43.1%		49.7%		57.6%
- infection		20.5 %		13.3%		14.7%
- other complications		36.4 %		36.9%		27.6%
Comorbidity‡						
1 o more	62.5%	61.6%	65.1%	62.5%	67.3%	68.9%
Average stay	8 days	9 days	8 days	8 days	7 days	9 days
p25-p75 (days)	6-10	7-15	7-9	7-13	6-9	7-13
Healthcare discharge	6.6%	6.7%	5.9%	6.7%	6.6%	7.6%

p: percentile; †Specific complications of certain specified procedures (knee arthroplasties); ‡ Comorbidities calculated using the Elixhauser index. RACat: Catalan Arthroplasty Register; MBDSHD: Minimum Basic Data Set at Hospital Discharge

4.3. Characteristics of primary arthroplasties

The 97% of primary knee arthroplasties that could be classified were TKA, and just over 2% were unicompartmental knee arthroplasties (UKA). Within the TKA, the most common arthroplasties were the ones that preserve the posterior cruciate retaining (TKA-CR) and the posterior stabilized ones (TKA-PS), representing 46.8% and 48.4%, respectively. Throughout the duration of the studied periods, it appears that the TKA-CR gradually decreased while the TKA-PS gradually increased (Table 10), with CR decreasing from 51.6% to 46.4% between periods.

Table 10. Number of primary knee arthroplasties per type of arthroplasty and period (Source: RACat)

	2005-2006		2007-2008		2009-2010		Total	
	n	%	n	%	n	%	n	%
Arthroplasty not specified	3,220	49.8	1,807	27.9	1,441	22.3	6,468	100
Type of arthroplasty								
Cruciate retaining	2,374	51.6	4,380	45.0	5,955	46.4	12,709	46.8
Posterior stabilised	2,063	44.8	4,884	50.1	6,208	48.4	13,155	48.4
Constrained	59	1.3	229	2.3	257	2.0	545	2.0
Hingue	5	0.1	17	0.2	32	0.2	54	0.2
Tumoral	0	-	2	0.02	2	0.02	4	0.01
Total TKA	4,501	97.8	9,512	97.7	12,454	97.1	26,467	97.4
Femoropatellar	2	0.04	41	0.4	67	0.5	110	0.4
Unicompartmental	101	2.2	185	1.9	293	2.3	579	2.1
Total UKA	103	2.2	226	2.3	360	2.8	689	2.5
Total other*	0	0	4	0.04	11	0.09	15	0.06
TOTAL	4,604	100	9,742	100	12,825	100	27,171	100

TKA: total knee arthroplasty; UKA: unicompartmental knee arthroplasty *Other: type of arthroplasties not included in the RACat classification. RACat: Catalan Arthroplasty Register

The most common prostheses, both for men and women were TKA-PS and TKA-CR. In women, TKA-PS were implanted in 48.1% of cases and in men in 49.2 % of cases. TKA-CR represented 47.0% of prostheses implanted in women and 46.1% in men (Figure 7).

The most frequent primary knee arthroplasties by age group were also TKA-CR and the TKA-PS (Figure 8) and they represented approximately 41-48% and 47-51% of cases respectively, between periods. It appears that the patellofemoral and unicompartmental type of arthroplasties is implanted in younger patients. As age increases, there is a lower percentage of this type of arthroplasties, decreasing to 0.0% and 1.0% in the age group of 85 years and older.

Figure 7. Percentage distribution of type of primary knee arthroplasties by sex. (Source: RACat)

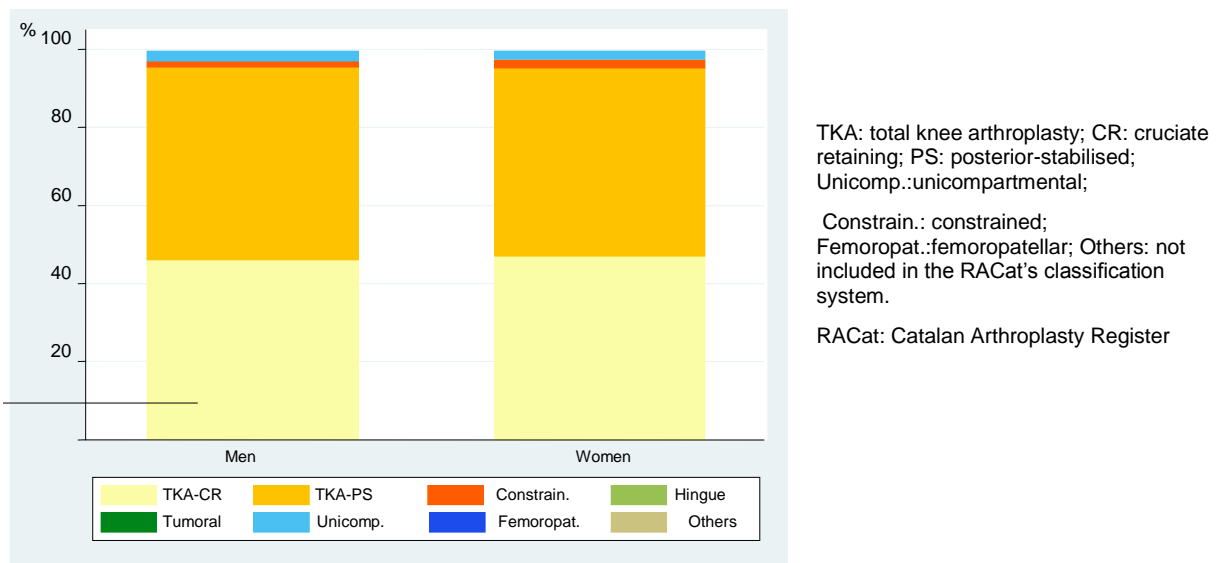
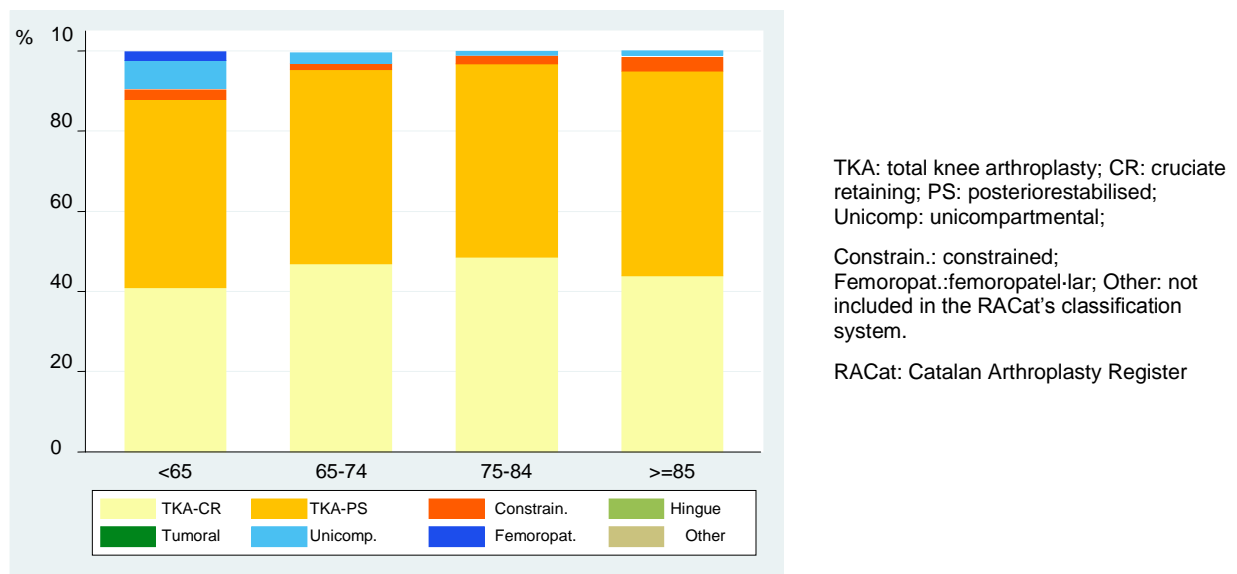


Figure 8. Percentage distribution of primary knee arthroplasties by age group. (Source: RACat)



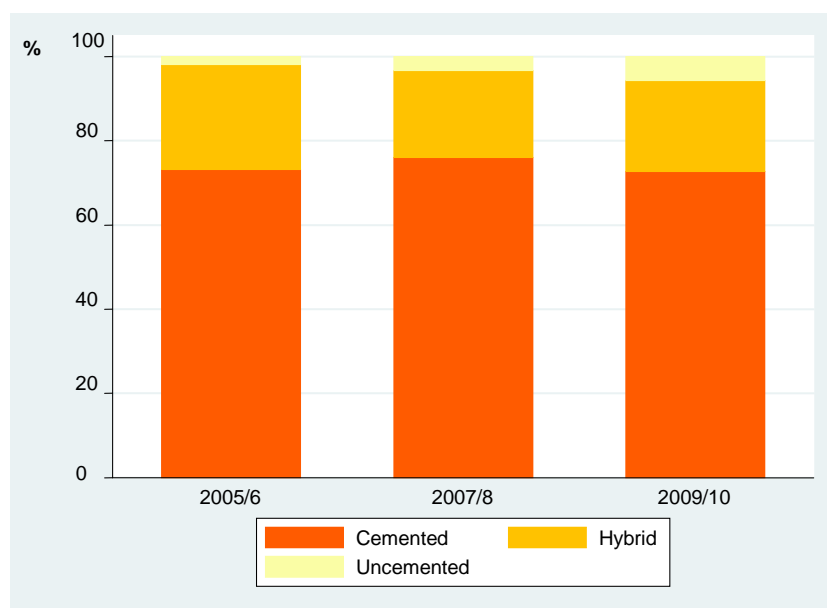
The most common type of fixation in primary knee arthroplasties in all study periods was cemented fixation (73.2% in 2005-2006 and 72.7% in 2009-2010), even though there is a slight change in the percentage of arthroplasties with an uncemented fixation increasing from 1.9% in 2005-2006 to 5.6% in 2009-2010 (Table 11 and Figure 9).

Table 11. Number of primary knee arthroplasties per fixation technique by time period (source RACat)

	2005-2006		2007-2008		2009-2010		Total	
	n	%	n	%	n	%	n	%
Fixation not specified (n)	3,220	49.1	1,848	28.2	1492	22.7	6,550	100
Fixation technique								
Cemented	3,368	73.2	7,369	76.0	9,288	72.7	20,025	74.0
Uncemented	87	1.9	318	3.3	722	5.6	1,127	4.2
Hybrid	1,149	25.0	2,014	20.8	2,764	21.6	5,927	21.9
Total	4,604	100	9,701	100	12,774	100	27,079	100

RACat: Catalan Arthroplasty Register

Figure 9. Percentage distribution of the fixation technique in primary knee arthroplasties by time period. (Source: RACat)



RACat: Catalan Arthroplasty Register

In primary knee arthroplasties, the most common fixation technique in men and women (Table 12) by age group (Table 13) was cemented fixation. There is a slightly lower percentage of cemented arthroplasties in women (3.9%) compared to men (7.9%). By age group, a higher percentage of uncemented primary arthroplasties can be observed in the younger groups.

Table 12. Number of primary knee arthroplasties per fixation technique by sex (Source: RACat)

	Women		Men		Total	
	n	%	n	%	n	%
Fixation not specified (n)	4,793	73.1	1,767	26.9	6,560	19.5
Fixation technique						
Cemented	14,443	74.2	5,581	73.2	20,024	74.0
Uncemented	754	3.9	373	4.9	1,127	4.2
Hybrid	4,259	21.9	1,668	21.9	5,927	21.9
Total	19,456	100	7,622	100	27,079	100

RACat: Catalan Arthroplasty Register

Table 13. Number of primary knee arthroplasties per fixation technique by age groups (Source: RACat)

	< 65 years		65-74 years		75-84 years		>85 years	
	n	%	n	%	n	%	n	%
Fixation not specified (n)	594	9.1	1,917	29.2	3,255	49.6	794	12.1
Fixation technique								
Cemented	1,978	71.0	6,347	72.5	9,984	75.2	1,716	75.4
Uncemented	178	6.4	371	4.2	492	3.7	86	3.8
Hybrid	629	22.6	2,032	23.2	2,792	21.0	474	20.8
Total	2,785	100	8,750	100	13,268	100	2,276	100

RACat: Catalan Arthroplasty Register

In relation to the type of arthroplasty, the cemented fixation technique was the most used overall. TKA-PS and TKA-CR were cemented in 85.6% and 59.5% of cases, respectively. The uncemented and hybrid fixation were used in this last type of prosthesis (Table 14).

Table 14. Number of primary total knee arthroplasties by fixation technique (Source: RACat)

	CR-TKA		PS-TKA		Constrained		Hingue		Tumoral	
	n	%	n	%	n	%	n	%	n	%
Fixation technique*										
Cemented	7,565	59.5	11,223	85.6	528	96.9	54	100	1	25.0
Uncemented	760	6.0	340	2.6	16	2.9	-	-	2	50.0
Hybrid	4,380	34.5	1,545	11.8	1	0.2	-	-	1	25.0
Total	12,705	100	13,108	100	545	100	54	100	4	100

TKA: total knee replacement; CR: cruciate retaining; PS: posterior stabilised; *fixation technique not specified (n=51); RACat: Catalan Arthroplasty Register

Table 15. Number of primary partial knee arthroplasties by fixation technique (Source: RACat)

	Femoropatellar		Unicompartmental	
	n	%	n	%
Fixation technique*				
Cemented	84	100	570	98.4
Uncemented	-	-	9	1.6
Hybrid	-	-	-	-
Total	84	100	579	100

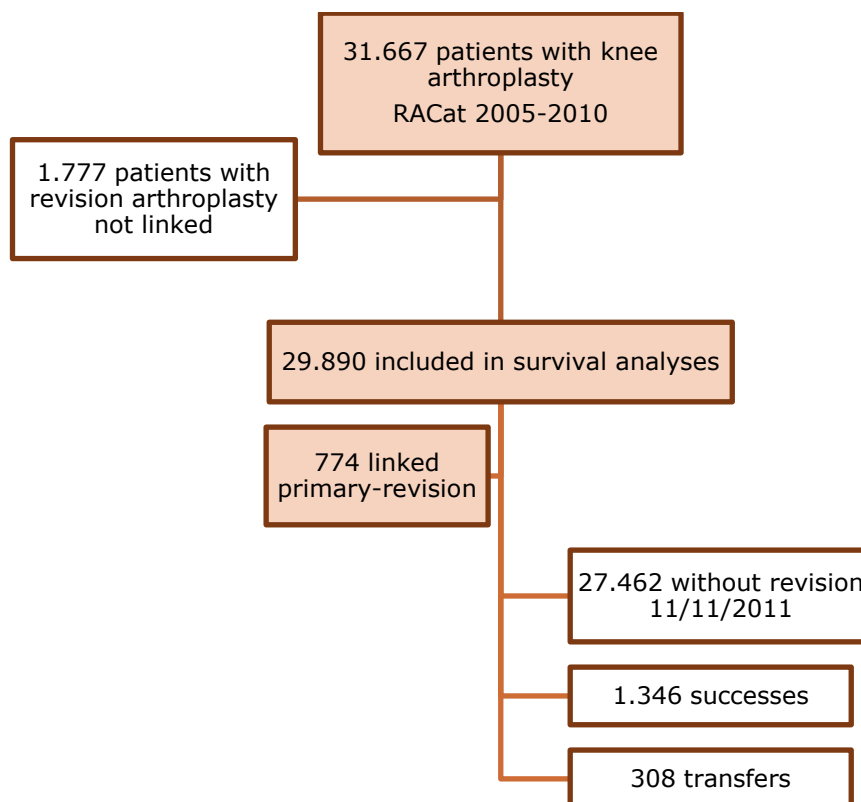
TKA: total knee arthroplasty; Fixation technique not specified (n=26). RACat: Catalan Arthroplasty Register

4.4. Implant survival in knee arthroplasties

Data link and followup description

In the 2005-2010 periods, there was a total of 36,951 primary and revision knee arthroplasties. A total of 31,667 records corresponded to single patients (Figure 10). 1,777 patients were excluded because the only data available corresponded to revision arthroplasty but not to the original primary arthroplasty, which had either been performed before 2005 or had not been reported to the RACat. A total of 29,890 reports with good quality information on knee arthroplasties were included in the survival analyses (Figure 10). Of these reports, 774 arthroplasties had related information linked to primary and revision arthroplasties. The rest of reports were censored for the following reasons: 27,462 patients with primary knee arthroplasty did not present a revision surgery in the study period (2005-2010); 1,346 patients died after the primary surgery; and 308 patients were discharged from CatSalut and transferred to other Spanish autonomous communities or foreign country.

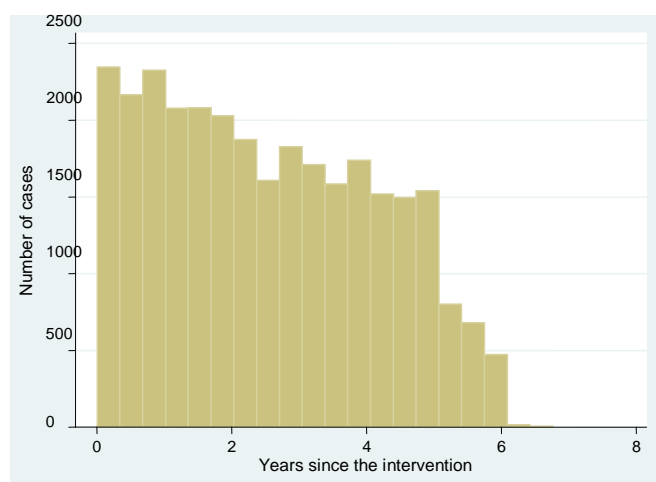
Figure 10. Patient inclusion diagram from 2005 to 2010 for implant survival analyses in primary knee arthroplasties. (Source: RACat)



RACat: Catalan Arthroplasty Register

The median length of followup from the date of the primary arthroplasty until the revision surgery or censorship was of 2.4 years. 25% of the patients, were followed beyond 3.9 years and in a further 25% of cases there was less than 1.1 years followup. Figure 11 shows the distribution of the followup time of these patients from the time they underwent a primary arthroplasty procedure until the revision intervention.

Figure 11. Distribution of the followup time of the patients with a total primary knee arthroplasty. (Source: RACat)



RACat: Catalan Arthroplasty Register

Cumulative probability of revision

The estimated overall cumulative revision rate after a primary knee arthroplasty (with no adjustment) is shown on Table 16. Ninety days after primary surgery, 0.5% (95% CI: 0.4-0.6%), prostheses were revised, increasing to 1.1% at one year (95% CI: 1.0-1.3%). Three years later the estimated cumulative revision rate was 3.3% (3.1-3.6%). After 4 years, the number of censored data is quite high and therefore the results on survival are not robust enough to describe effectiveness beyond 4 years after the primary arthroplasty. It should be taken into consideration that 75% of patients with TKA present a followup of less than 3.9 years.

Table 16. Estimated cumulative revision rate after a primary knee arthroplasty. Results with no adjustment. (Source: RACat)

	Primary Knee Arthroplasty			
	Total	Revision	Revision rate	95%CI
[0 Days-30 days)	29,890	64	0.2%	0.1% 0.3%
[30 days- 90 days)	29,522	78	0.5%	0.4% 0.6%
[90 days-1 year)	28,172	169	1.1%	1.0% 1.3%
[1 any- 2 years)	23,067	267	2.5%	2.3% 2.7%
[2 years-3 years)	16,905	128	3.3%	3.1% 3.6%
[3 years- 4 years)	11,673	43	3.8%	3.5% 4.1%
[4 years- 5 years)	6,710	19	4.2%	3.9% 4.5%
[=>5 years)	2,109	6	4.7%	4.2% 5.3%

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

No significant statistical differences were found in relation to the risk of revision, according to sex and adjusting by age of the patients. A higher risk of revision was observed in groups of younger patients. Still, only a significant statistical relation was found in patients under 65 years of age compared to those aged 85 years or over (HR:4.3; 95% CI:1.6-11.5; data not shown).

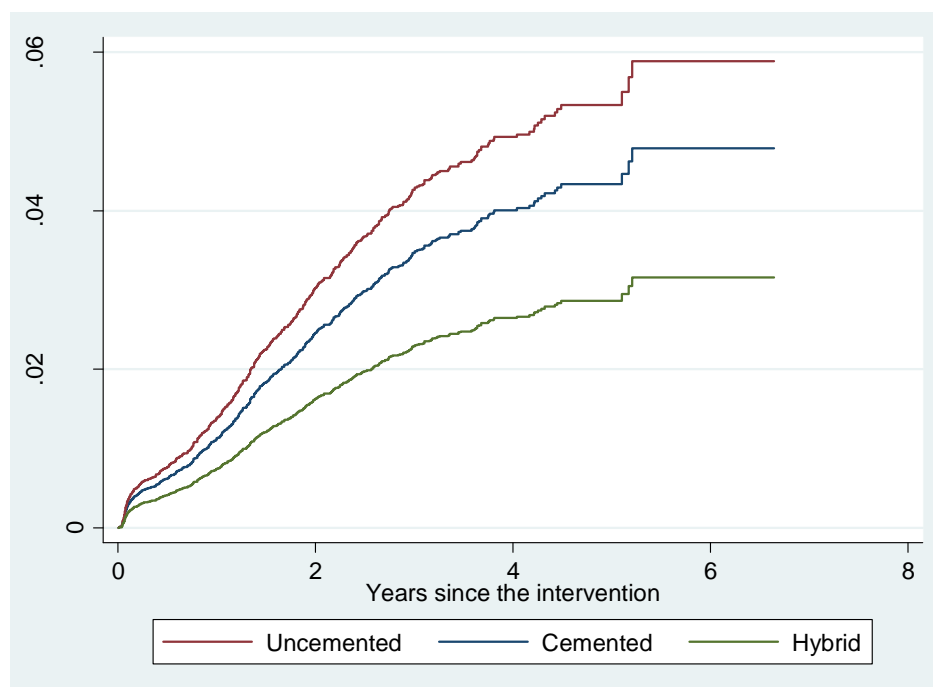
As far as fixation technique, it is noticeable that the cumulative rate of revision (without adjustment) is higher for cemented arthroplasties compared to uncemented and the hybrid arthroplasties, even if these differences are not statistically significant (Table 17). Estimating the risk of revision per fixation technique using a Cox model (adjusted by age and sex of the patients), arthroplasties without a cemented fixation did not present a risk for revision different from the cemented ones (HR: 1.2 95% CI 0.8-1.8). However, the risk of revision with cemented arthroplasties was higher than with hybrid ones (HR 0.7 95% CI 0.5-0.8; Figure 12).

Table 17. Estimated cumulative revision rate after a primary knee arthroplasty per fixation technique. Results with no adjustment. (Source: RACat)

	Cemented			Uncemented			Hybrid		
	Revision	95%CI	95%CI	Revision	95%CI	95%CI	Revision	95%CI	95%CI
[0 Days-30 days)	0.3%	0.2%	0.3%	0.3%	0.1%	0.9%	0.1%	0.0%	0.2%
[30 days- 90 days)	0.5%	0.4%	0.7%	0.6%	0.3%	1.4%	0.3%	0.2%	0.5%
[90 days-1 year)	1.2%	1.0%	1.3%	2.1%	1.3%	3.4%	0.9%	0.6%	1.2%
[1 any- 2 years)	2.5%	2.3%	2.8%	3.7%	2.5%	5.4%	2.0%	1.6%	2.5%
[2 years- 3 years)	3.7%	3.4%	4.1%	4.0%	2.7%	6.0%	2.5%	2.0%	3.1%
[3 years-4 years)	4.4%	4.0%	4.8%	4.0%	2.7%	6.0%	2.7%	2.2%	3.3%
[4 years-5 years)	4.8%	4.3%	5.3%	4.0%	2.7%	6.0%	3.1%	2.4%	3.9%
[=>5 years)	5.4%	4.5%	6.6%	4.0%	2.7%	6.0%	3.6%	2.6%	5.1%

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

Figure 12. Cumulative risk of revision rate after a primary knee arthroplasties according to fixation technique, adjusted according to sex and age. (Source: RACat)



RACat: Catalan Arthroplasty Register

Table 18 shows the cumulative revision rates for the TKA-CR and TKA-PS, the two most common arthroplasties. At bivariate level, one can observe that after one year the cumulated probability of revision was similar in all groups, whereas after 3 years the cumulative

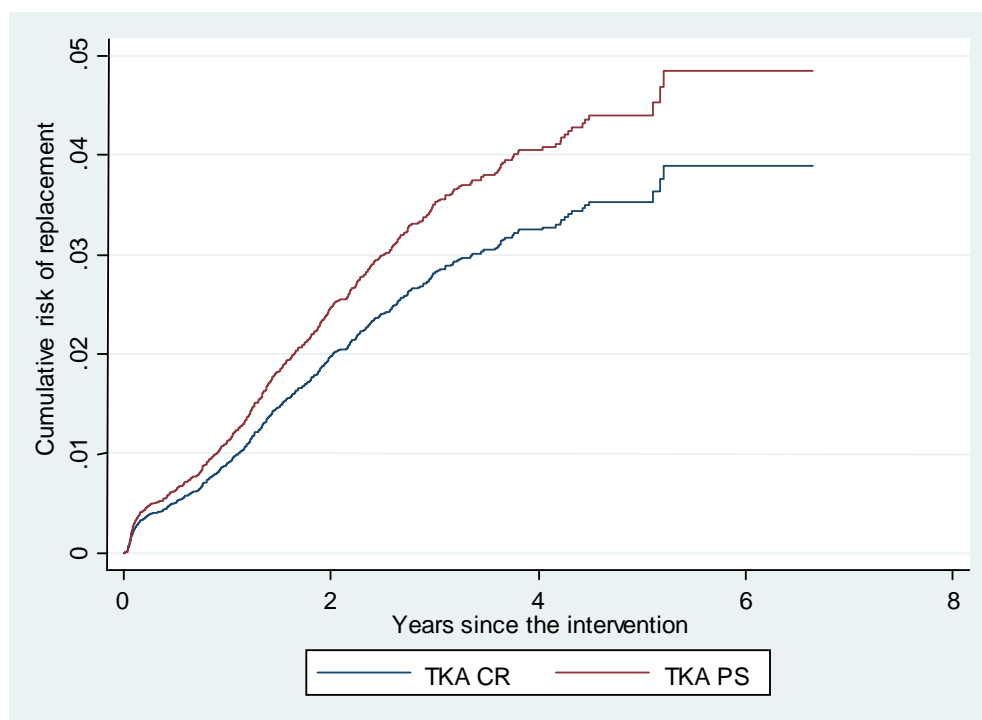
probability was slightly higher in the TKA-PS than in the TKA-CR. When estimating the revision risk with a Cox model (adjusted by age and sex of the patients), the TKA-PS presented a revision risk 25% higher compared to the TKA-CR (HR 1.2 CI 95%: 1.0-1.5; Figure13).

Table 18. Estimated cumulative rate of revision after a primary knee arthroplasties for CR and PS. Results not adjusted. (Source: RACat)

	CR TKA			PS TKA		
	Revision	95%CI	95%CI	Revision	95%CI	95%CI
[0 Days-30 days)	0.2%	0.1%	0.3%	0.2%	0.2%	0.3%
[30 days- 90 days)	0.4%	0.3%	0.6%	0.5%	0.4%	0.7%
[90 days- 1 year)	1.0%	0.8%	1.2%	1.2%	1.0%	1.4%
[1 year- 2 years)	2.1%	1.8%	2.4%	2.7%	2.3%	3.0%
[2 years- 3 years)	3.0%	2.7%	3.5%	3.7%	3.3%	4.2%
[3 years- 4 years)	3.5%	3.0%	4.0%	4.4%	3.9%	4.9%
[4 years- 5 years)	3.8%	3.3%	4.4%	4.8%	4.2%	5.5%
[=>5 years)	4.6%	3.5%	5.9%	5.3%	4.3%	6.5%

TKA: total knee arthroplasty; CR: cruciate retaining; PS: posterior stabilised. RACat:: Catalan Arthroplasty Register; 95% CI: 95% confidence interval

Figure 13. Cumulative risk of revision after a primary knee arthroplasty by type of arthroplasty adjusted by sex and age. (Source: RACat)



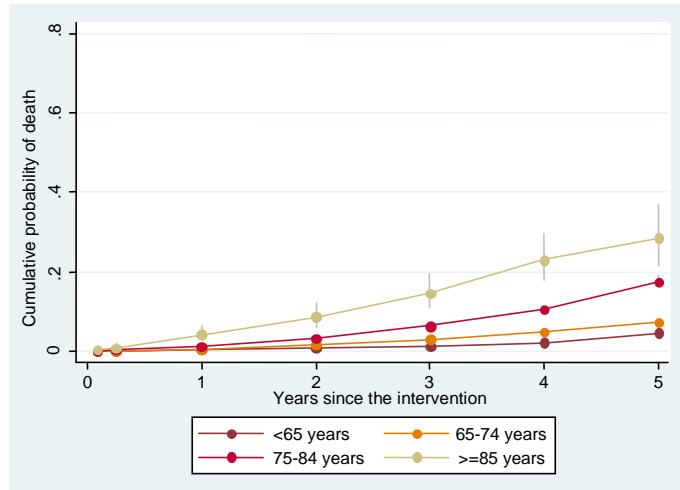
RACat: Catalan Arthroplasty Register

Cumulative probability of death

The cumulative probability of death at 30 days from knee primary surgery was of 0.04% and by age groups this rate was of 0.1%, 0.01%, 0.05% and 0.1%, respectively, for patients under 65, from 65 to 74, from 75 to 84, and older than 85. The cumulative mortality rate one

year after a primary knee arthroplasty was 0.8% and after three years it was 4.1%. By age groups (Figure 14), an expectable gradient is observed where older patients present higher mortality cumulative rates, especially three years after the arthroplasty.

Figure 14. Cumulative probability of death after a primary knee arthroplasty according to age groups. Non-adjusted results. (Source: RACat)



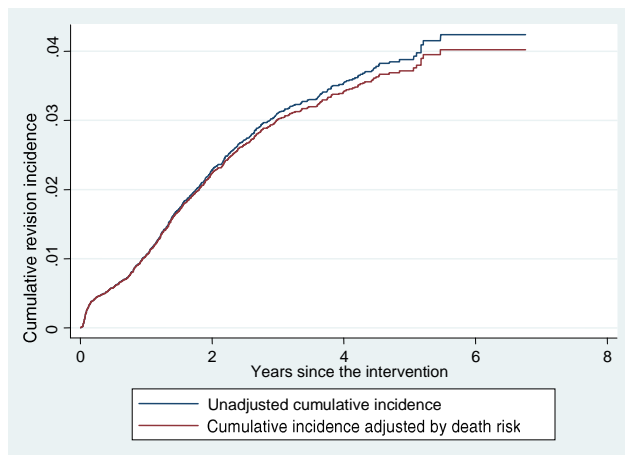
RACat: Catalan Arthroplasty Register

These results present death as a competitive event of the revision of the prostheses. The death occurs before the revision is performed, especially in patients over the age of 75. For analytical purposes, ignoring this fact could bias prostheses survival estimations, as well as the magnitude of the different risk factors associated with the revision arthroplasty.

Prostheses survival in knee arthroplasties adjusted by competitive risk of death

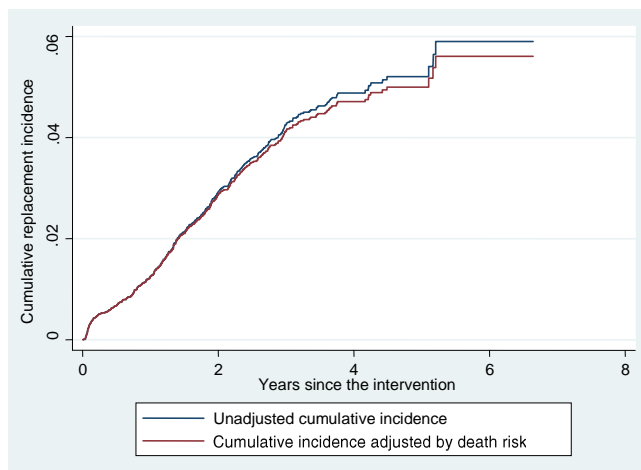
Figures 15 and 16 show the cumulative incidence of revision adjusted by age, sex, and patient death probability and without adjustment for this competitive risk. As shown, the cumulative incidence function without adjustment draws a curve that slowly grows apart from the cumulative incidence function adjusted by death risk over the years since the intervention. Even though the difference is not major, it increases over time and after 3-4 years from the intervention the difference becomes evident. Hence, the cumulative incidence adjusted by age and sex after 4 years was 3.5% and the one adjusted by age, sex, and death risk was 3.4%. Taking into consideration only the 75 year old patient group, the revision incidence adjusted only by age and sex was 4.9%. This percentage drops to 4.7% when the incidence is adjusted in addition by the death probability. Ultimately, failure to take into account the death rate in the followup of the effectiveness of the arthroplasties could overestimate the revision risk by almost 3% in the case of primary knee arthroplasties.

Figure 15. Cumulative incidence of revision after a primary knee arthroplasty adjusted by competitive death risk, sex, and age of the patients.



RACat: Catalan Arthroplasty Register

Figure 16. Cumulative incidence of revision after a primary knee arthroplasty adjusted by competitive death risk, sex, and patients over the age of 75.

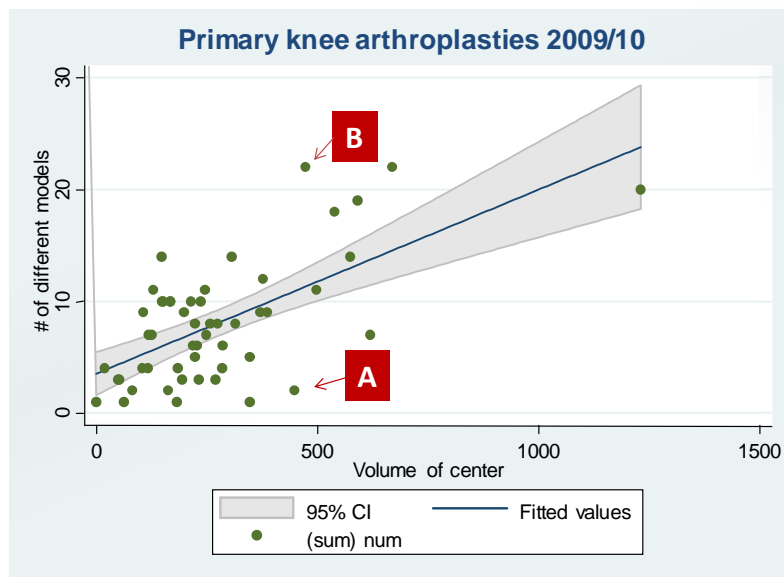


RACat: Catalan Arthroplasty Register

4.5. Characteristics of implant models

In the period of 2005-2010, from all the prostheses correctly classified, a total of 107 different prosthesis models (counting separately the cemented and uncemented models, p.e. Evoris cim and Evoris) were identified. The median of different models used in each center was 10.6 models ranging from 1 to 22 different models. Taking into account the data from 2009 and 2010, it appears that the number of implanted different models grows according to the volume of arthroplasties of the center. Nevertheless, as shown in Figure 17, center “A” with an activity volume close to 500 arthroplasties presents a number of different models of prostheses relatively low in comparison with center “B” with a similar volume of activity.

Figure 17. Number of different prosthesis models in relation to the volume of primary knee arthroplasties for each center in the 2009-2010 period. (Source: RACat)



#: number; sum: sum of the number of different models per center. RACat: Catalan Arthroplasty Register; 95% CI: 95% confidence interval

It is important to note that even if there were a different number of models, the percentages can vary between the models in each center. That is, in addition to describing the number of different prostheses that were used, the weight of these models must also be taken into consideration. Figure 18 shows what percentage represents the 15 most frequently used models from the total number of prostheses used in each center. In center “A”, the NEXGEN cim model represents 98%. In contrast, in the center “B” the same model only represents 60%, where up to 23 different models were used.

Figure 18. Percentile distribution of different prosthetic models for primary knee arthroplasties in the 2009-2010 period per center. (Source: RACat)

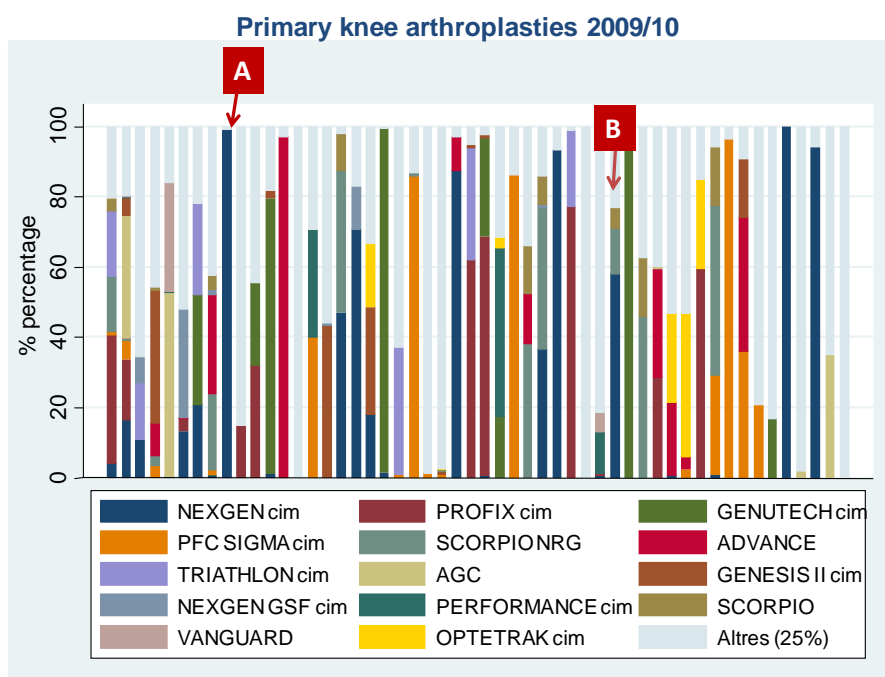


Table 19. Five most frequent models in primary knee arthroplasty per fixation technique and period.
(Source: RACat)

Fixation technique	2005-2006			2007-2008			2009-2010		
	Model	n	%	Model	n	%	Model	n	%
Cemented	Nexgen	851	25.3	Nexgen	2.022	27.4	Nexgen	1,923	20.7
	Profix	390	11.6	Pfc Sigma	843	11.5	Profix	1,319	14.2
	Advance	320	9.5	Profix	822	11.2	Genutech	1,082	11.6
	Optetrak	247	7.3	Scorpio PS	488	6.6	Pfc Sigma	829	8.9
	Pfc Sigma	243	7.2	Genutech	436	5.9	Triathlon	666	7.2
Uncemented	Performance	23	26.4	Performance	108	34.0	Vanguard	159	22.0
	Tri CCC	18	20.7	Scorpio NRG	62	19.5	Performance	119	16.5
	SKS	13	14.9	Gemini Link	35	11.0	Scorpio NRG	116	16.1
	Natural Knee II	11	12.6	Sks	26	8.2	Alpina	98	13.6
	Uknee	8	9.2	Tri CCC	23	7.2	Gemini Link	56	7.8
Hybrid	Advance	696	60.6	Advance	605	30.0	Advance	690	25.0
	913	140	12.2	Agc	450	22.3	Scorpio NRG	629	22.4
	Genutech	89	7.7	Genutech	286	14.3	AGC	542	19.2
	Pfc Sigma	76	6.6	Scorpio NRG	156	7.7	Pfc Sigma	258	9.1
	Uknee	25	2.2	Pfc Sigma	104	5.2	Scorpio	168	6.0

RACat: Catalan Arthroplasty Register

Table 20. Five most frequent primary knee arthroplasty models per type of arthroplasty and period.
(Source: RACat)

Type	2005-2006		2007-2008		2009-2010	
	Model	n %	Model	n %	Model	n %
Cruciate retaining	Advance	696 29.3	Profix cim	806 18.4	Profix cim	1,272 21.4
	Profix cim	383 16.1	Pfc Sigma cim	611 13.9	Advance	706 11.9
	Pfc Sigma cim	165 7.0	Advance	609 13.9	Pfc Sigma cim	595 10.0
	Advance cim	158 6.7	Genutech	290 6.6	Genutech cim	335 5.6
	913	140 5.9	AGC	267 6.1	AGC	278 4.7
Posterior stabilised	Nexgen cim	766 37.1	Nexgen cim	1,865 38.2	Nexgen cim	1,760 28.4
	Scorpio PS cim	215 10.4	Scorpio PS cim	489 10.0	Scorpio NRG	745 12.0
	Alpina cim	181 8.8	Genutech cim	385 7.9	Genutech cim	712 11.5
	Optetrak cim	162 7.9	Genesis II cim	239 4.9	Genesis II cim	390 6.3
	Advance cim	147 7.1	PFC sigma cim	235 4.8	Triathlon cim	362 5.8
Constrained	Endomodel cim	24 40.7	Endomodel cim	116 51.3	Endomodel cim	128 49.8
	Nexgen cim	12 20.3	Nexgen cim	59 26.1	Genutech cim	35 13.6
	Scorpio TS cim	8 13.6	Scorpio ts cim	13 5.7	Nexgen cim	31 12.1
	TC3 cim	6 10.2	TC3 cim	9 3.9	Scorpio TS cim	20 7.8
	Advance cim	5 8.5	913 cim	9 3.9	Legion cim	13 5.1
Hingue	Noiles cim	3 60.0	Rotax cim	11 64.7	RHK cim	10 31.3
	Endomodel cim	1 10.0	Noiles cim	2 11.8	Nexgen cim	8 25.0
	Rotax cim	1 10.0	Nexgen cim	1 5.9	Rotax cim	7 21.9
			RHK cim	1 5.9	MRH cim	4 12.5
			MRH cim	1 5.9	Noiles cim	2 6.3
Femoro-patellar	Spherocentric cim	1 50.0	Competitor cim	31 75.6	Competitor cim	40 59.7
	Mis Avon cim	1 50.0	Mis Avon cim	5 12.2	FPV cim	12 17.9
			Spherocentric cim	4 9.8	Mis Aon cim	4 6.0
			Vanguard PFC cim	1 2.4	Spherocentric cim	3 4.5
Unicompar-mental	Zimmer Uniknee cim	27 26.7	Zimmer Uniknee cim	64 34.6	Accuris cim	120 41.0
	Accuris cim	25 24.8	Accuris cim	51 27.6	Oxford III cim	76 25.9
	Oxford III cim	16 15.8	Oxford III cim	40 21.2	Zimmer Uniknee cim	53 18.1
	Miller/Gallante cim	12 11.9	Endomodel cim	14 7.6	Endo Model cim	15 5.1
	Advance cim	10 9.9	Eius cim	7 3.8	Eius cim	9 3.1

RACat: Catalan Arthroplasty Register

5. HIP ARTHROPLASTIES RESULTS

5.1. Scope and quality of data

Depending on the type of surgery, over the 2005-2010 period, 23,762 primary hip arthroplasties and 2,715 revision arthroplasties were sent to the RACat. The volume of the latter was lower than knee arthroplasties (Table 21). The volume of data on hip arthroplasties sent in the last two years increased in comparison with the ones sent in the 2005-2006 period. It is in the health care region of Barcelona where the highest numbers of primary and revision arthroplasties were registered, a total of 43.8% and 38.2%, which corresponded to the Barcelona city area, respectively. As far as volume of data goes, the health care regions that followed were Girona and Catalunya Central.

Table 22 shows the data volume of primary and revision arthroplasties sent to RACat per region and center. The global burden of revision, understood as the percentage of revision arthroplasties sent compared to the total of events of arthroplasty (primary and revision arthroplasties) was 10.2%, being the load slightly higher than the total knee load. Remarkable differences can be noticed per centers with a minimum load of 0% and a maximum of 22.8%. Furthermore, a 25% of the centers showed a load beneath 6.3% and a further 25% of the centers showed a load above 13.1%.

Table 21. Number of hip arthroplasties by health care region, period and whether they are primary or revision arthroplasties. (Source: RACat)

Health care region	2005-2006		2007-2008		2009-2010		% increase 1st/ 3rd period*	Total 2005-2010		
	Primary	Revision	Primary	Revision	Primary	Revision		Total	Revision	Primary
Alt Pirineu i Aran	115	5	105	7	109	8	-3%	329		20
Barcelona	3,496	382	5,098	580	6,913	909	102%	15,507		1,871
Barcelona Ciutat	1,578	159	2,042	132	3,177	424	107%	6,797		715
B. Nord i Maresme	366	69	594	75	908	114	135%	1,868		258
Garraf i Alt Penedès	193	33	333	82	369	50	85%	895		165
Llobregat	792	50	813	79	1,041	100	36%	2,646		229
Vallès	567	71	1,316	212	1,418	221	157%	3,301		504
Camp Tarragona	84	1	453	25	633	50	704%	1,170		76
Catalunya Central	440	59	870	90	966	127	119%	2,276		276
Girona	922	77	1,209	131	1,418	165	58%	3,549		373
Lleida	90	19	242	25	330	31	231%	662		75
Terres de l'Ebre	-	1	1	-	268	23	--	269		24
Total	5,147	544	7,978	858	10,637	1,313	110%	23,762		2,715

*The percentage of volume increase of hip data sent to RACat in the 1st period (2005-2006) in relation to the 3rd period (2009-2010) was calculated: $[\text{data volume 2005-2006 primary and revisions} / \text{data volume 2005-2006+2009-2010 primary and revision}] * 100$; RACat: Catalan Arthroplasty Register

Table 22. Number of hip arthroplasties by health care region, centre, period and whether they are primary or revision arthroplasties. (Source: RACat)

Health care region	Centre	2005-2008		2009-2010		% revision	
		Primary	Revision	Primary	Revision	Total	revision
Alt Pirineu i Aran	Fundació Sant Hospital –S. Urgell	68	2	43	1	114	2.6
	Hospital Comarcal del Pallars	88	2	40	4	134	4.5
	Hospital de Puigcerdà	64	8	26	3	101	10.9
Barcelona	Clínica Plató. Fundació Privada	86	6	97	11	200	8.5
	Corporació Sanitària Parc Taulí	611	131	447	87	1,276	17.1
	Hospital Santa Creu i Sant Pau	1	-	363	44	408	10.8
	Hospital Sant Joan Déu Martorell	231	65	197	20	513	16.6
	Fundació Privada Hospital de Mollet	227	10	100	7	344	4.9
	Hospital Clínic i Provincial Barcelona	1,342	178	778	134	2,432	12.8
	Hospital Comarcal de l'Alt Penedès	148	30	162	20	360	13.9
	Hospital de l'Esperança i Mar	95	12	510	57	674	10.2
	Hospital de l'Esperit Sant	196	52	230	20	498	14.5
	Hospital de l'Hospitalet	504	52	211	38	805	11.2
	Hospital de Mataró	428	66	364	44	902	12.2
	Hospital de Sant Boi	226	12	144	13	395	6.3
	Hospital de Sant Celoni	179	8	93	5	285	4.6
	Hospital de Sant Jaume de Calella	397	34	178	13	622	7.6
	Hospital de Terrassa	184	37	224	39	484	15.7
	Hospital de Viladecans	-	-	75	21	96	21.9
	Hospital Dos de Maig de Barcelona	139	20	149	18	326	11.7
	Hospital General de Granollers	428	49	68	6	551	10.0
	Hospital Municipal de Badalona	325	23	132	14	494	7.5
	Hospital Mútua de Terrassa	254	48	361	72	735	16.3
	Hospital Residència Sant Camil	378	85	207	30	700	16.4
	Hospital Sant Rafael	-	-	179	53	232	22.8
	Hospital Sant Joan Despí	-	-	125	5	130	3.8
	Hospital Universitari de Bellvitge	644	-	414	8	1,066	0.8
	Hospital Universitari G. Trias Pujol	11	3	182	36	232	16.8
	Hospital Universitari Sagrat Cor	632	75	369	39	1,115	10.2
Hospital Universitari Vall d'Hebron	1,325	-	732	68	2,125	3.2	

RACat: Catalan Arthroplasty Register

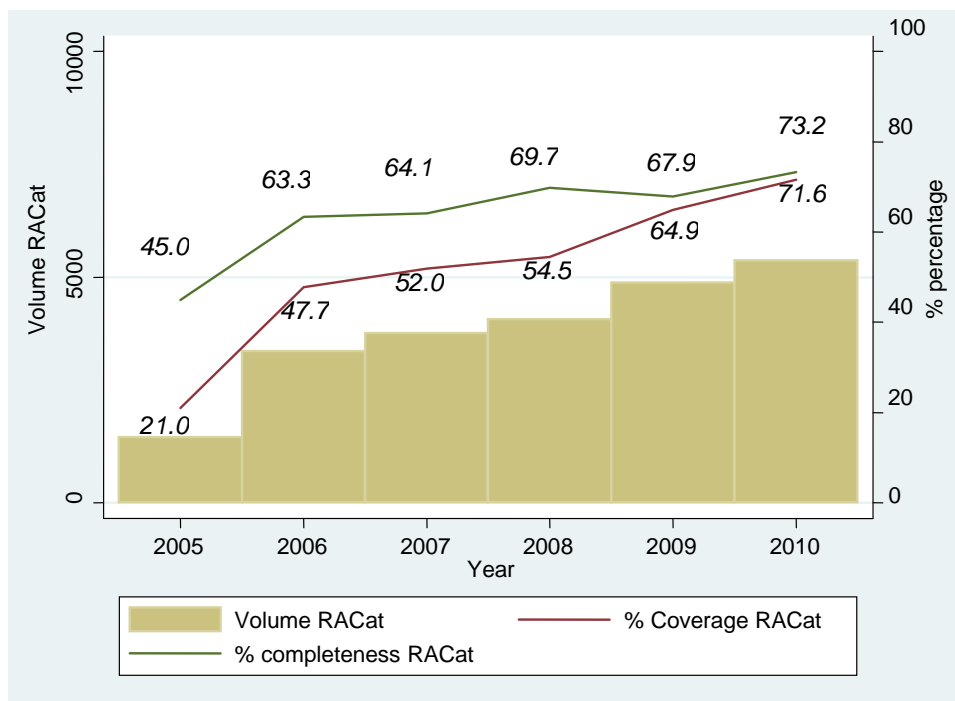
Table 22. Number of hip arthroplasties by health care region, centre, period and whether they are primary or revision arthroplasties (Source: RACat) Continued

Health care region	Centres	2005-2008		2009-2010		Total	% revision
		Primary	Revision	Primary	Revision		
Camp de Tarragona	Hospital Universitari Tarragona J. XXIII	145	11	211	25	392	9.2
	Hospital Universitari Sant Joan Reus	71	-	164	-	235	0.0
	Hospital de Sant Pau i Santa Tecla	83	3	79	16	181	10.5
	Hospital del Vendrell	90	8	79	3	180	6.1
	Pius Hospital de Valls	148	4	100	6	258	3.9
Catalunya Central	Centre Hospitalari -ALTHAIA	648	102	447	95	1,292	15.2
	Fundació Sanitària d'Igualada	329	41	207	22	599	10.5
	Hospital General de Vic	291	3	239	1	534	0.7
	Hospital Sant Bernabé	42	3	73	9	127	9.4
Girona	Hospital Comarcal de Blanes	203	26	120	11	360	10.3
	Clínica Girona	-	-	39	4	43	9.3
	Hospital de Campdevàno	80	3	42	-	125	2.4
	Hospital de Figueres	365	23	273	31	692	7.8
	Hospital de Palamós	427	36	193	21	677	8.4
	Hospital Provincial Santa Caterina	246	24	178	21	469	9.6
	Hospital Sant Jaume d'Olot	177	16	132	13	338	8.6
	Hospital U. Girona Dr. Josep Trueta	236	46	263	51	596	16.3
Lleida	Hospital Universitari Arnau de Vilanova	-	-	78	14	92	15.2
	Clínica de Ponent	98	15	104	4	221	8.6
	Hospital de Santa Maria	234	29	148	13	424	9.9
Terres de l'Ebre	Hospital Comarcal d'Amposta	1	-	-	-	1	0.0
	Hospital de Tortosa Verge de la Cinta	-	1	268	23	292	8.2
Total		13,125	1,402	10,637	1,313	26,477	10.2

RACat: Catalan Arthroplasty Register

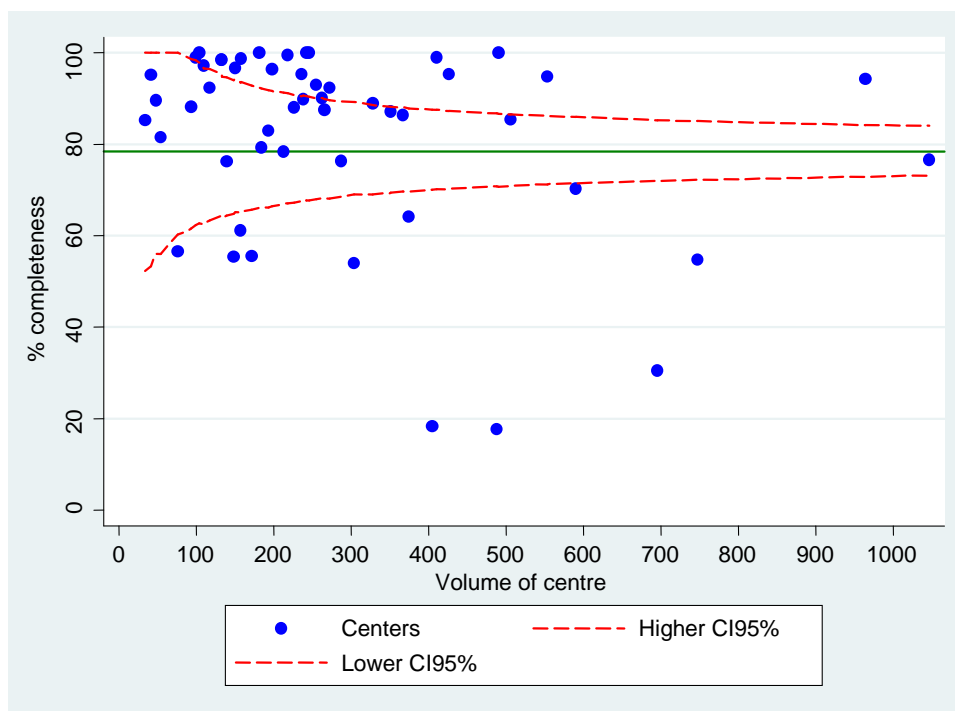
Figure 19 shows the volume of data submitted for registration during the studied period. The completeness went from 45.0% in 2005 to 73.2% in 2010. As far as the coverage, it went from 21.0% in 2005 to 71.6% in 2010. As shown, most of the centers that participate in RACat sent almost all their reported arthroplasties data to the MBDSHD, same as in the case of the knee arthroplasties during the 2009-2010 period. Even so, 11 centers are below the inferior limit of the confidence interval of 80% of completeness.

Figure 19. Volume, Coverage, and completeness of hip arthroplasty data according to year. (Source: RACat-MBDSHD)



RACat: Catalan Arthroplasty Register; MBDSHD; Minimum Basic Data Set at Hospital Discharge

Figure 20. Completeness percentage of hip arthroplasty data per center according to arthroplasty volume sent in the 2009/2010 period. (Source: RACat-MBDSHD)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register; MBDSHD; Minimum Basic Data Set at Hospital Discharge

As shown in Table 23, in the 2005-2006 period, 56.6% of the arthroplasties were classified. This percentage reached 83.4% in the 2009-2010 period.

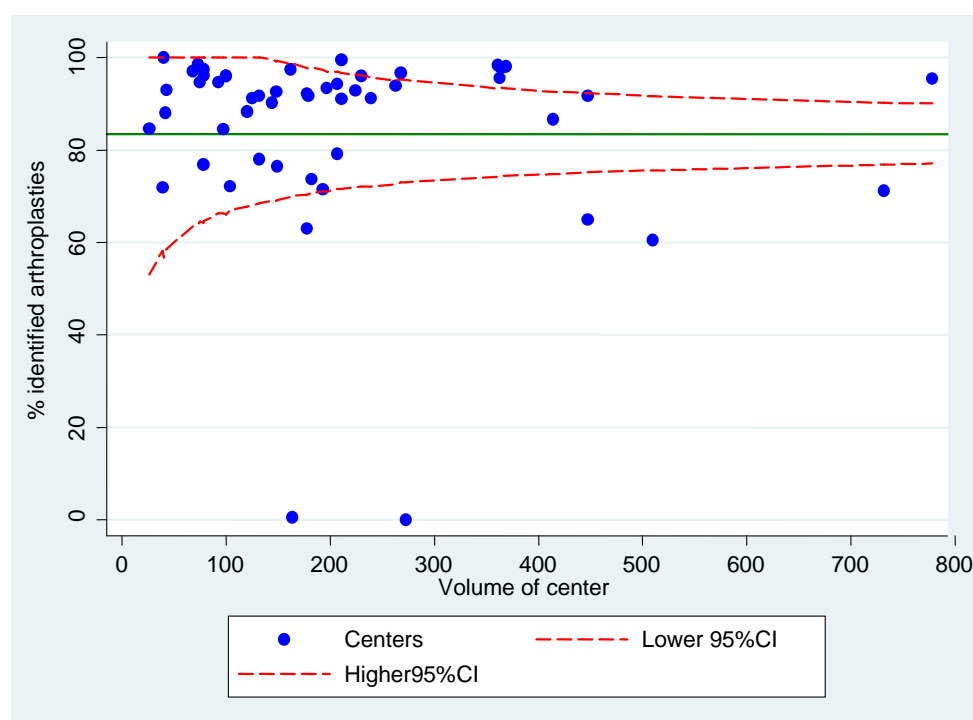
Table 23. Number of primary classified hip arthroplasties by period (source RACat)

Classified	2005-2006		2007-2008		2009-2010		Total	
	N	%	N	%	N	%	N	%
Yes	2,915	56.6	5,987	75.0	8,871	83.4	17,519	74.8
No	2,232	43.4	1,991	25.0	1,766	16.6	5,967	25.2
Total	5,147	100	7,978	100	10,637	100	23,762	100

RACat: Catalan Arthroplasty Register

On the other hand, Figure 21 shows how this percentage of classification, as far as the last two years go, is fairly even between centers and only six centers are identified with a percentage of classification below the inferior limit of the confidence interval of the median of all the centers.

Figure 21. Percentage of primary hip arthroplasties classified per center according to sent data volume in the 2009/2010 period. (Source: RACat)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

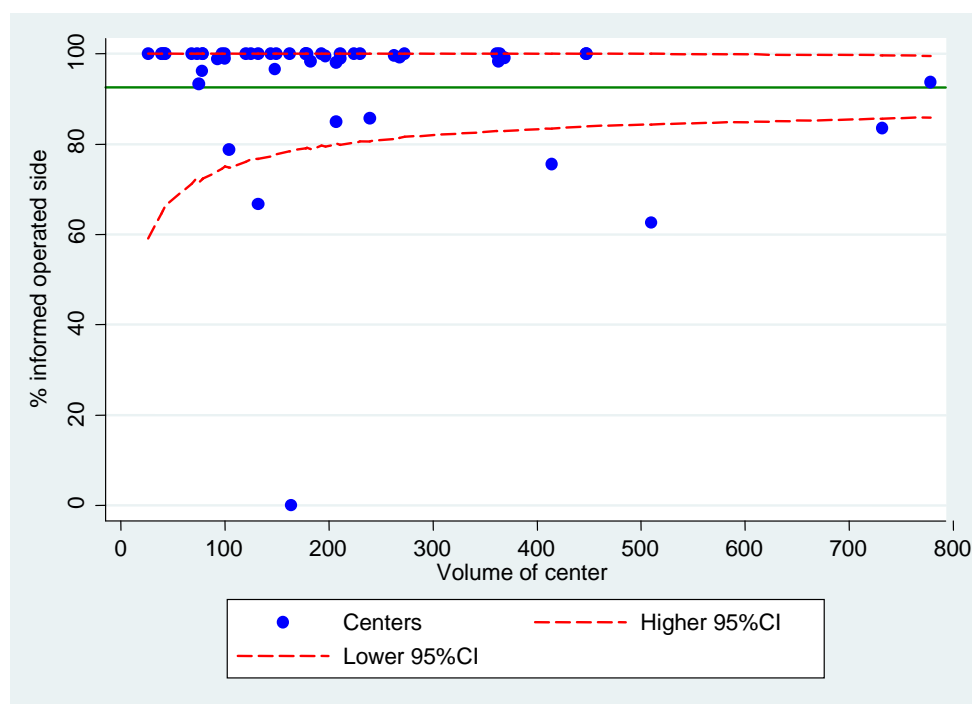
The percentage of arthroplasties received with the operated side (left and right) informed in 2005-2006 grew from 55.6% up to 93.1% in the 2009-2010 period (Table 24). With the data of the last two years, and per center, this percentage was rather homogenous. The majority of centers were below 90% and only 5 centers were identified under the median value of all the centers (Figure 22).

Table 24. Number of primary and revision hip arthroplasties with the operated side (left and right) informed by period (Source: RACat)

Informed	2005-2006		2007-2008		2009-2010		Total	
	N	%	N	%	N	%	N	%
Yes	3,166	55.6	6,788	76.8	11,123	93.1	21,077	79.6
No	2,525	44.4	2,048	23.2	827	6.9	5,400	20.4
Total	5,691	100	8,836	100	11,950	100	26,477	100

RACat: Catalan Arthroplasty Register

Figure 22. Percentage of primary and revision hip arthroplasty with operated side left and right) informed, per center and in relation to data volume sent in 2009/2010. (Source: RACat)



95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

5.2. Demographic and patient treatment process profile

The mean age of the patients that underwent a THA has remained constant at about 69 years (SD 12) and the ones who underwent a PHA (Partial Hip Arthroplasty) remained constant at about 89 years (SD 13). The percentage of women decreased from 77.2% to 75.5% for the PHA and from 54.3% to 52.2% for the THA in the last period (Table 25).

Table 25. Age and sex of the patients undergoing a primary hip arthroplasty by health care region and period (Source: RACat)

Health care regions		2005-2006			2007-2008			2009-2010		
		N	Age	Women	N	Age	Women	N	Age	Women
Alt Pirineu i Aran	THA	49	73.1	53.1%	68	70.8	55.9%	72	75.0	62.5%
	PHA	17	82.7	64.7%	23	86.8	87.0%	30	86.9	66.7%
Barcelona	THA	1.178	68.2	55.1%	2.550	68.5	54.2%	3.646	68.3	53.3%
	PHA	588	84.0	76.9%	1.378	84.2	78.2%	2.333	84.6	75.4%
Camp de Tarragona	THA	45	71.1	51.1%	240	67.2	50.0%	342	67.8	45.6%
	PHA	34	85.0	79.4%	95	83.6	73.7%	100	83.8	69.0%
Catalunya entral	THA	164	70.0	48.2%	446	69.5	49.1%	513	68.7	48.5%
	PHA	116	83.4	76.7%	290	83.8	75.9%	351	84.0	76.9%
Girona	THA	494	70.8	56.3%	618	70.3	55.7%	718	70.2	55.0%
	PHA	143	85.9	78.3%	93	86.1	81.7%	235	85.0	75.7%
Lleida	THA	83	70.3	41.0%	176	68.0	40.3%	257	67.3	46.3%
	PHA	4	86.6	100%	9	86.5	100%	15	84.9	86.7%
Terres de l'Ebre	THA	--	--	--	--	--	--	174	67.2	47.1%
	PHA	--	--	--	--	--	--	85	84.4	83.5%

THA: total hip arthroplasty; PHA: partial hip arthroplasty. RACat: Catalan Arthroplasty Register

Table 26 shows how THA are mainly performed in patients under the age of 85, on men and women indistinctly. On the other hand, PHAs were performed mainly on patients older than 75 and more frequently on women. Between periods, it appears that for THA, the percentage of patients older than 85 increases and the percentage of patients between 65 and 75 decreases. As for partial arthroplasties, the percentage of patients aged between 65 and 75 also decreases between periods.

Table 26. Age and sex of the patients undergoing a primary and revision hip arthroplasty by period (Source: RACat)

	2005-2006			2007-2008			2009-2010		
	THA	PHA	Revision	THA	PHA	Revision	THA	PHA	Revision
Volume (n)	2.133	907	544	4.319	1.908	858	6.039	3.198	1.313
Women (%)	54.3	77.2	57.2	53.1	78.0	58.2	52.2	75.4	56.3
Mean age (years)	69.2	84.3	71.0	68.8	84.3	71.7	68.5	84.5	72.2
Age (%)									
<65 years	29.4	1.2	26.5	32.2	1.2	27.0	32.7	1.8	22.5
65-75 years	35.3	7.9	27.6	30.9	7.1	23.0	30.8	5.6	27.6
75-85 years	32.7	40.8	39.1	33.1	42.6	39.3	32.4	42.1	39.2
>85 years	2.6	50.1	6.8	3.8	49.2	10.7	4.1	50.4	10.6

THA: total hip arthroplasty; PHA: partial hip arthroplasty.

Table 27 shows the characteristics of the patients with their healthcare process whose data were jointly added to both the RACat and CMBDH combined. Even though 11.9% of the patients (Figure 19) of RACat could not be linked to the data of the CMBDH, the distribution by sex and age were not affected (Table 27); meaning, it can be observed how there is a similar percentage of women in the data of patients incorporated to the RACat compared to the data of patients incorporated to the RACat and CMBDH combined.

Regarding the reason for the surgery, the percentage of patients with a THA operated for arthritis or other related disorders, increased from 6.9% in 2005-2006 up to 80.1% in 2009-

2010. The main reason for surgery when it came to PHA was a femoral neck fracture (95%). On the other hand, between 88.3% and 90.8% of patients with a revision arthroplasty were operated on because they developed complications with the primary hip arthroplasty (90.8% in 2009-2010).

In relation to the comorbidities, 52% of the operated patients of a THA in 2005-2006 presented one or more comorbidities, and in 2009-2010 the same percentage was 59.2% (Table 27). For PHA, this percentage ranged from 70.6% to 78.0% and for the revision arthroplasties the percentage of patients with some kind of comorbidity between periods was 50.4% and 63.8%, respectively. The median stay decreased between periods for the THA and in all the periods for the PHA. For the revision hip arthroplasties, the median stay also decreased going from 14 to 11 between 2005-2006 and 2009-2010. Lastly, around 10% of patients with a HTA were referred for admission in a healthcare center. This percentage was higher for PHA, reaching 31.5% in the last period, and for the revision arthroplasties, it was of 14.6%, also in the last period.

Taula 27. Demographic and patient treatment profile of patients with primary and revision hip arthroplasty by period. (Source: RACat-CMBDAH)

	2005-2006			2007-2008			2009-2010		
	THA	Partial	Revision	THA	Partial	Revision	THA	Partial	Revision
Volume (n)	2.811	1.596	409	4790	2.394	650	6.208	3.053	986
Women	55.1%	77.3%	59.2%	53.8%	77.9%	58.9%	52.8%	76.5%	57.8%
Median age (years)	69.2	83.9	71.9	69.0	84.2	72.5	69.0	85.0	72.0
Reason for surgery									
Arthritis and other	76.9%	2.0%	--	78.7%	2.0%	--	80.1%	1.8%	--
Femoral neck fracture	14.0%	95.4%	--	13.1%	95.7%	--	12.0%	95.3%	--
Complications†	--	--	89.0%	--	--	88.3%	--	--	90.8%
Mechanical complication			58.4%			72.0%			75.5%
Infection	-	-	12.7%	-	-	8.8%	-	-	9.2%
Other diagnosis			28.8%			19.2%			15.3%
Comorbidities‡									
1 or more	52.8%	70.6%	50.4%	52.0%	75.3%	56.8%	59.2%	78.0%	63.8%
Median stay	9 dies	12 dies	14 dies	9 dies	12 dies	13 dies	8 dies	11 dies	11 dies
p25-p50 (days)	8-12	9-16	9-21	7-11	9-17	8-20	7-10	8-15	8-18
Healthcare discharge	9.5%	27.3%	13.2	8.9%	28.5%	14.0	10.4%	31.5%	14.6

p:percentile †Specific complication of certain specified procedures (hip arthroplasties). ‡ Comorbidities calculated from the Elixhauser index

5.3. Characteristics of primary arthroplasties

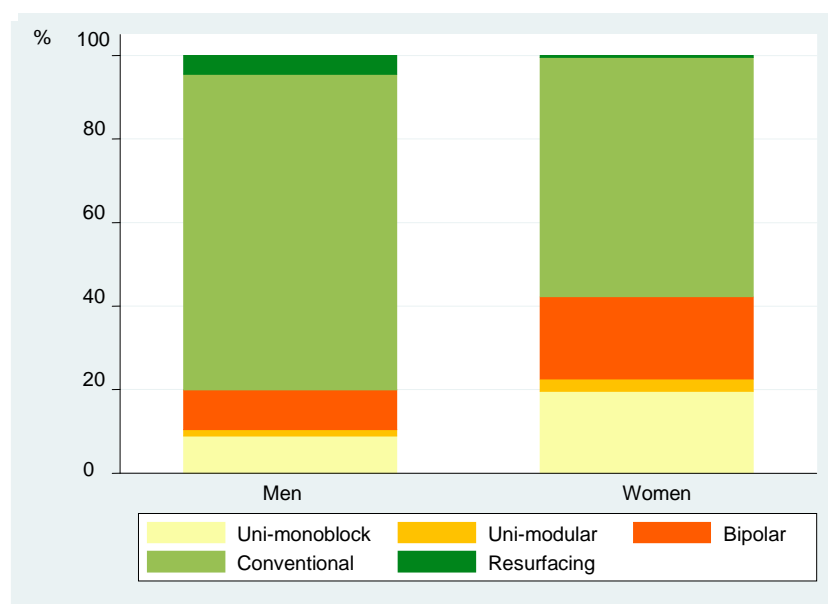
The most frequent THA in all the periods was the conventional total one (64.5% of the classified arthroplasties) and for PHA, it was the bipolar and unipolar monobloc (15.7% and 15.4%. respectively (Table28). Between periods, the bipolar partial arthroplasties increased from 1.6% to 18.3% as also did the superficial THA (0.8% in 2005-2006 and 2.5% in 2009-2010).

Table 28. Number of primary hip arthroplasties per type of arthroplasty and period. (Source: RACat)

	2005-2006		2007-2008		2009-2010		Total	
	n	%	n	%	n	%	n	%
Not specified (n)	2,232	43.4	1,991	25.0	1,766	16.6	5,989	25.2
Type of arthroplasty								
Unipolar monoblock	468	16.1	934	15.6	1,332	15.0	2,734	15.4
Unipolar modular	95	3.3	135	2.2	188	2.1	418	2.3
Bipolar	339	11.6	819	13.7	1,629	18.3	2,787	15.7
Total PHA	902	31.0	1,888	31.5	3,149	35.5	5,939	33.4
Conventional	1,990	68.3	3,969	66.3	5,501	62.0	11,460	64.5
Resurfacing	23	0.8	130	2.2	221	2.5	374	2.1
Total THA	2,013	69.0	4,099	68.5	5,722	64.5	11,834	66.6

PHA: partial hip arthroplasty; THA: total hip arthroplasty

The most frequent type of primary hip arthroplasty, both in men and women, was the total conventional and the partial bipolar (Figure 23). At a global level, it is important to emphasize that 80% of the arthroplasties performed on men were THA and in women this kind of arthroplasty represented a total of 57.9%. In men, the total conventional type was more common than in women (75.4% versus 57.4% of the total hip arthroplasties). On the other hand, PHAs were less frequent in men than in women, representing 19.9% compared to 42.1% performed in women. Superficial arthroplasties were more frequent in men (2.5%) compared to women (0.8%).

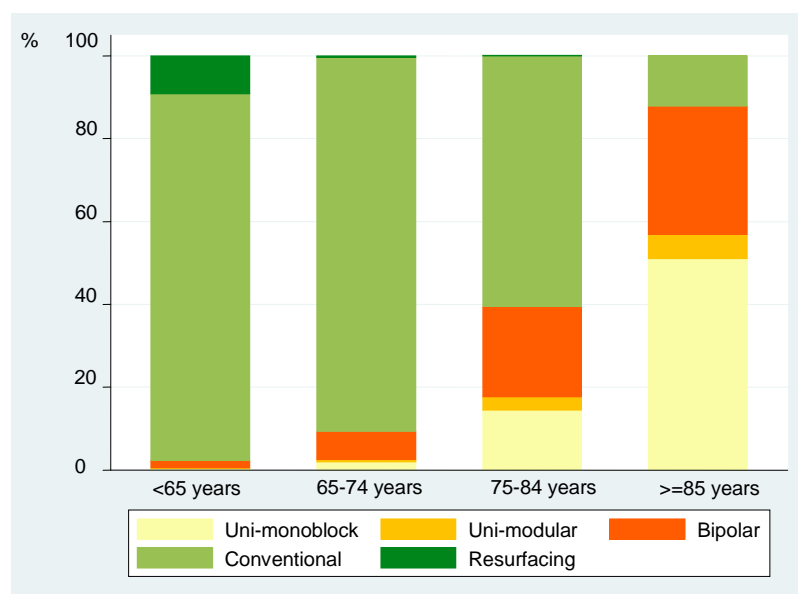
Figure 23. Type of primary hip arthroplasties by sex. (Source: RACat)

Uni-monoblock: unipolar monoblock; uni-modular: unipolar modular

The most common type of primary hip arthroplasty was the total conventional arthroplasty (97.8% in patients younger than 65, 93.8% in patients aged between 65 and 74, and 73.5% for patients aged 75 to 84 (Figure 24). Partial monobloc unipolar hip arthroplasties were

more frequent in the older age group compared to the rest of age groups (29.6% bipolars and 42.1% monobloc - unipolars).

Figure 24. Type of primary hip arthroplasties by age groups. (Source: RACat)



Uni-monoblock: unipolar monoblock; uni-modular: unipolar modular

The most frequent fixation technique in THA in all periods was the uncemented technique (range: 53.4-66.6%. Table 29 and Figure 25). Cemented arthroplasties decreased between the first and last period from 16.1% to a 8.5% for the THA. As far as PHA, the fixation technique distribution was more homogenous throughout the entire period (Table 29 and Figure 26).

Table 29. Number of primary hip arthroplasties per fixation technique according to the period. (Source: RACat)

	2005-2006		2007-2008		2009-2010		Total	
	n	%	n	%	n	%	n	%
Arthroplasty not especificed (n)	2,232	37.2	1,991	33.2	1,766	29.5	5,989	100
Fixation technique not especificed	-	-	1	11.1	8	88.9	9	100
Total Hip Arthroplasty								
Fixation technique								
Cemented	324	16.1	458	11.2	485	8.5	1,267	10.7
Uncemented	1,074	53.3	2,487	60.7	3,806	66.6	7,367	62.3
Hybrid	615	30.5	1,153	28.1	1,423	24.9	3,191	27.0
Partial Hip Arthroplasty								
Fixation technique								
Cemented	480	53.2	992	52.5	1,723	54.7	3,195	53.8
Uncemented	422	46.8	896	47.6	1,426	45.3	2,744	46.2

Figure 25. Percentage distribution of the fixation technique of primary total hip arthroplasties according to period. (Source: RACat)

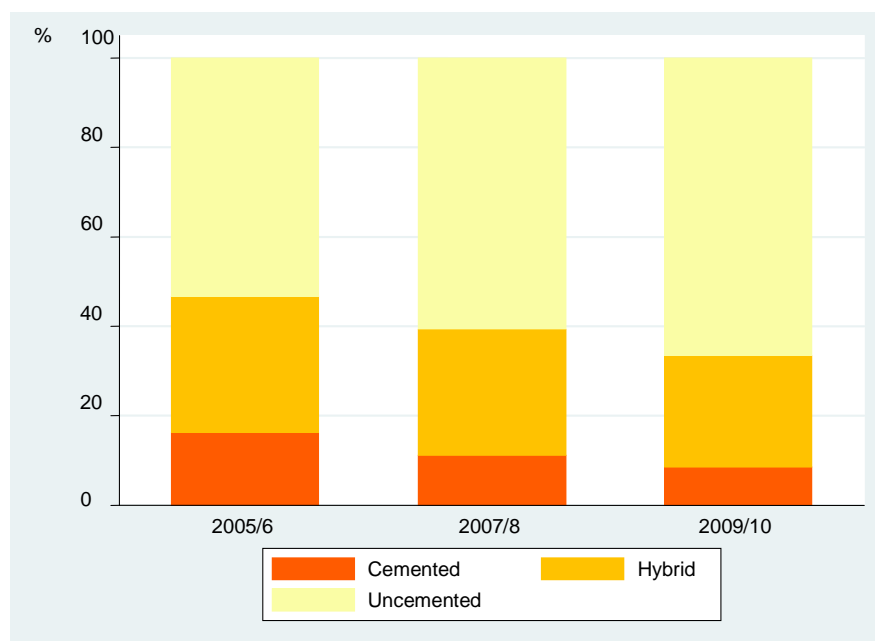
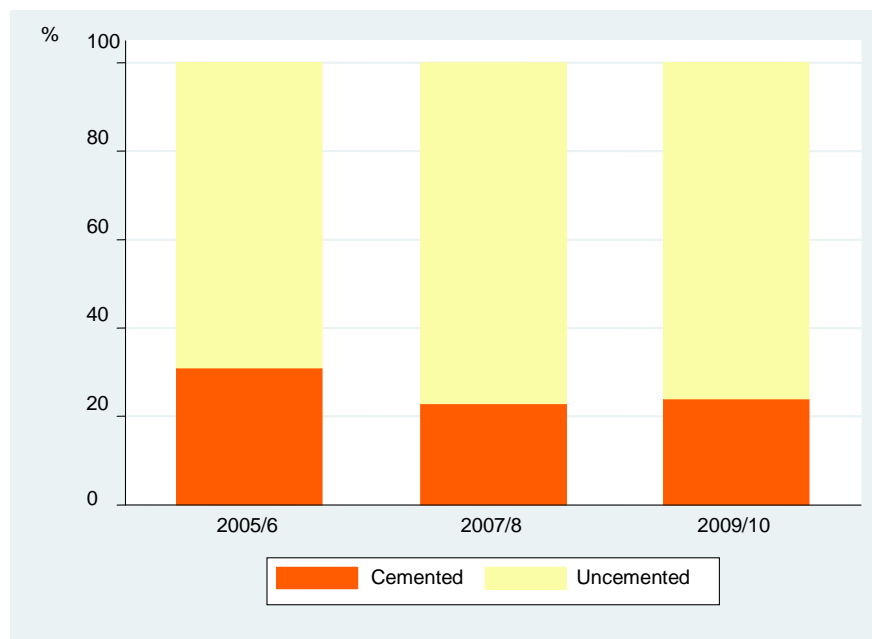


Figure 26. Percentage distribution of the fixation technique of primary partial hip arthroplasties according to period. (Source: RACat)



When taking into consideration the type of fixation according to type of arthroplasty, in conventional arthroplasties, the uncemented technique appears to be the most common one (63.7%), while for resurfacing arthroplasties, the most common was the hybrid fixation technique (79.9%) (Table 30a). In the case of partial hip arthroplasties, specifically unipolar-monobloc arthroplasties, the most common fixation was the uncemented one (86.6%), while in unipolar-modular and bipolar orthoplasties, the cemented technique was the most common (99.5% and 86.6%. respectively. Table 30b).

Table 30a. Number of primary total hip arthroplasties by fixation technique (Source: RACat)

Fixation technique	Conventional		Resurfacing		Total	
	n	%	n	%	n	%
Cemented	1,267	11.1	0	-	1,267	10.7
Uncemented	7,292	63.7	75	20.0	7,367	62.3
Hybrid	2,892	25.2	299	79.9	3,191	27.0
Total THA	11,451	100	374	100	11,825	100

In 5,989 cases it was not possible to classify the type of arthroplasty; and in 9 cases of THA it was not possible to obtain on the friction devices.

Table 30b. Number of primary partial hip arthroplasties by fixation technique. (Source: RACat)

Fixation technique	Uni-monoblock		Uni-modular		Bipolar		Total	
	n	%	n	%	n	%	n	%
Cemented	365	13.3	416	99.5	2,414	86.6	3,195	53.8
Uncemented	2,369	86.6	2	0.5	373	13.4	2,744	46.2
Total PHA	2,734	100	418	100	2,787	100	5,939	100

Unimonoblock: unipolar monoblock; unimodular: unipolar modular. In 5,989 cases it was not possible to classify the type of arthroplasty.

The most frequent fixation technique for THA, both for women and men, was the uncemented technique (55.9% and 69.5%). The percentage of cemented THA was higher in women when it came to THA (14.6% for women and 6.4% for men), even though this type of fixation was similar in partial arthroplasties (53.2% for women and 55.6% for men)(Table 31).

Table 31. Number of primary hip arthroplasties per type of fixation technique according to sex. (Source: RACat)

Fixation technique	Women		Men		Total	
	n	%	n	%	n	%
Total arthroplasty						
Cemented	913	14.6	354	6.4	1,267	10.7
Uncemented	3,492	55.9	3,875	69.5	7,367	62.3
Hybrid	1,846	29.5	1,345	24.1	3,191	27.0
Partial arthroplasty						
Cemented	2,421	53.2	774	55.6	3,195	53.8
Uncemented	2,127	46.8	617	44.4	2,744	46.2

In 5,989 cases it was not possible to classify the type of arthroplasty.

The most frequent fixation technique for THA in patients under the age of 65 and in those aged between 65 and 74 was the uncemented type (Table 32). The hybrid fixation technique was more frequent in the group of patients aged between 75 and 85 and in those aged 85 or more there was more variability in the chosen technique. In PHA, the cemented fixation technique was the most frequent in patients under 65 (78.1%) compared to the age group older than 85 (44.5%) where the uncemented type was the most frequent (55.5%).

Table 32. Number of primary hip arthroplasties per type of fixation technique according to age groups. (Source: RACat)

	< 65 years		65-74 years		75-85 years		>85 years	
	n	%	n	%	n	%	n	%
Total arthroplasty								
Fixation technique								
Cemented	42	1.1	216	5.7	884	23.1	125	30.4
Uncemented	3,165	83.3	2,443	64.6	1,626	42.4	133	32.4
Hybrid	594	15.6	1,123	29.7	1,321	34.5	153	37.2
Partial arthroplasty								
Fixation technique								
Cemented	73	78.5	285	74.2	1,519	60.8	1,318	44.5
Uncemented	20	21.5	99	25.8	981	39.2	1,644	55.5

In 5.989 cases it was not possible to classify the type of arthroplasty; and in 9 cases of THA it was not possible to obtain information on the friction devices.

In conventional THA the most commonly used friction device was metal-polyethylene (76.3%) and ceramic-polyethylene (13.0%) (Table 33). These types of friction devices were the most common in all the age groups, even though there was more variability in the friction device used in the patients under 65 (Table 34).

Table 33. Number of primary conventional hip arthroplasties according to the friction device. (Source: RACat)

Type of arthroplasty	Metal-metal		Metal-polyethylene		Ceramic-ceramic		Ceramic- polyethylene	
	n	%	n	%	n	%	n	%
Conventional	398	3.9	7,787	76.3	699	6.8	1,325	13.0

In 1.251 cases it was not possible to obtain information on the friction device.

Table 34. Number of primary conventional hip arthroplasties per type of friction device according to age groups. (Source: RACat)

Friction device	< 65 years		65-74 years		75-84 years		>85 years		Total	
	n	%	n	%	n	%	n	%	n	%
Metal-metal	305	13.3	66	2.4	22	0.5	5	0.5	398	3.9
Metal-polyethylene	1,022	44.5	2,059	76.0	3,723	89.0	983	96.5	7,787	76.3
Ceramic-ceramic	471	20.5	152	5.6	70	1.7	6	0.6	699	6.8
Ceramic- polyethylene	499	21.7	435	16.0	366	8.8	24	2.4	1,324	13.0
Total	2,296	100	2,712	100	4,176	100	1,018	100	10,202	100

In 1.251 cases it was not possible to obtain information on the friction device.

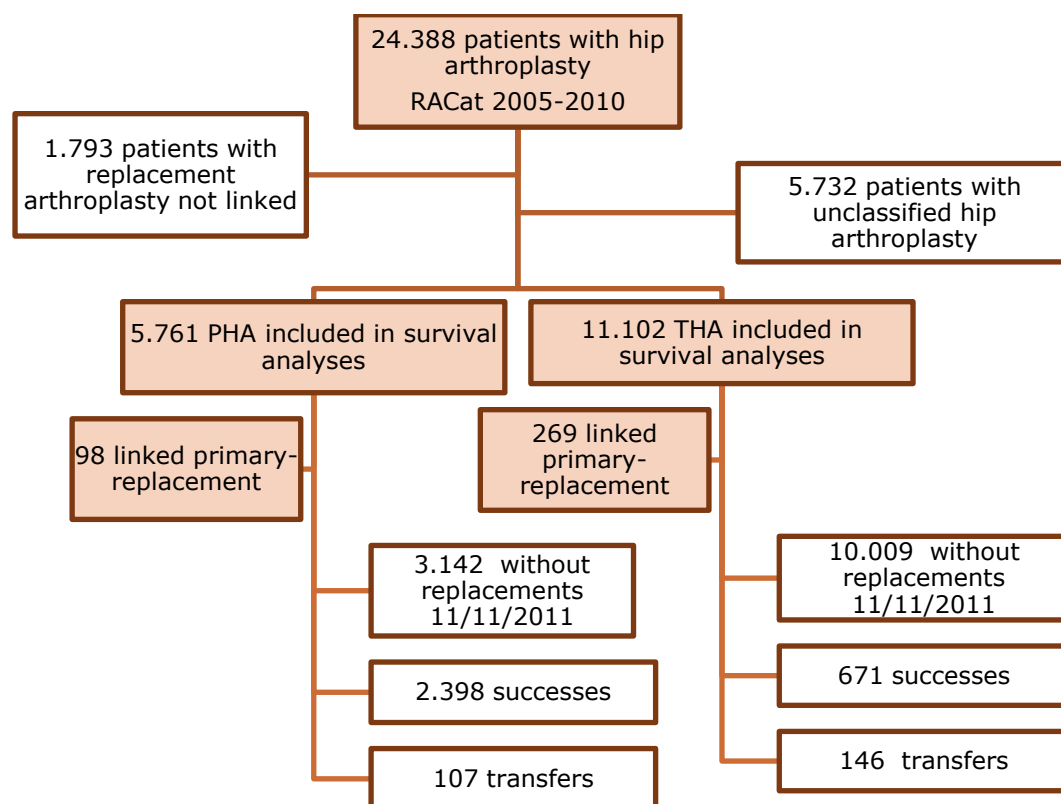
5.4. Implant survival in hip arthroplasties

Link description and data followup

In the 2005-2010 periods, there were a total of 26.477 primary and revision hip arthroplasties. A total of 24.388 records corresponded to single patients. Up to 1.787 patients were discarded; patients on whom there was information on revision arthroplasty but

not on the original primary arthroplasty that had either been performed before 2005 or had not reported to the RACat. On the other hand, 5.761 patients with hip arthroplasties on whom there was not enough information to be classified were discarded (Figure 27). A total of 5.745 and 11.095 reports with quality information on PHA and THA, respectively, were included in the survival analyses. Of the total of reports included in the analyses, 367 arthroplasties had related information linked to the primary or revision arthroplasty (98 for PHA and 269 for THA). The rest of reports were censored for the following reasons: 13.151 patients with primary hip arthroplasties did not have a revision arthroplasty in the study period (93% up to date 31/12/2010. 93%), 3.069 patients died after the primary surgery (6%) and 253 patients (1%) were withdrawn from CatSalut do to relocation of the patient to other Spanish autonomous communities or abroad.

Figure 27. Patient inclusion diagram in survival analyses of primary hip arthroplasties.

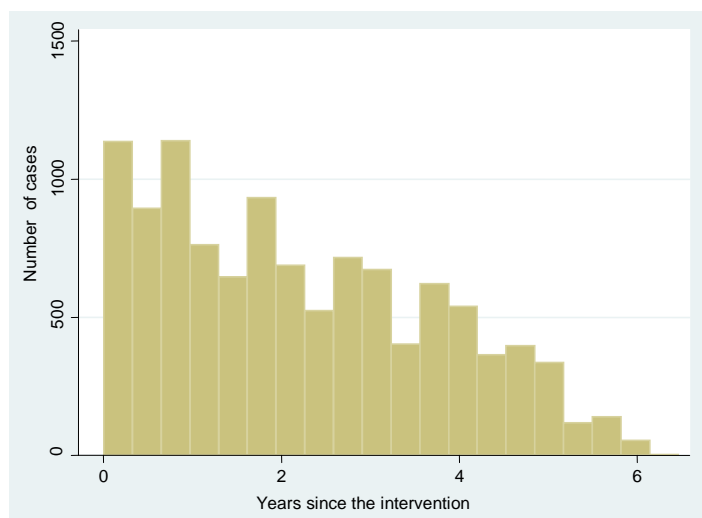


THA: total hip arthroplasty; PHA: partial hip arthroplasty.

5.4.1. Primary total hip arthroplasties

The median followup from the date of the primary arthroplasty until the revision or censorship of the 11.095 patients with a total hip arthroplasty was 2.0 years. In 25% of the patients the followup was sustained beyond 3.4 years and in another 25% the followup was less than 0.9 years. Figure 28 shows the distribution of the followup time of these patients from the time of surgery of a primary total hip arthroplasty until the revision arthroplasty.

Figure 28. Distribution of the followup time of the patients with a primary total hip arthroplasty. (Source: RACat)



Cumulative probability of revision

Table 35 shows results of the prostheses survival in primary total hip arthroplasties (data without adjustment, estimated cumulative revision rate). After 90 days from surgery, 1.3% of the prostheses of primary arthroplasties were changed; after one year the rate increased to 1.9%; and after three years the estimated cumulative revision rate was 2.9%. As in knee arthroplasties, after 4 years, the number of censored data is quite high and therefore the results on survival are not robust enough to describe the effectiveness beyond the 4 years after the THA. It should be taken in to consideration that 75% of patients with TKA present a followup of less than 4.2 years and therefore caution should be used when since the data is not robust enough from this followup period onwards.

Table 35. Estimated cumulative revision rate after a total hip arthroplasty. Unadjusted results. (Source: RACat)

	Primary Total Hip Arthroplasty			
	Total	Revision	Revision rate	95%CI
[0.30 days)	11,095	82	0.7%	0.6% 0.9%
[30. 90 days)	10,841	61	1.3%	1.1% 1.6%
[90 d. 1 year)	10,206	53	1.9%	1.7% 2.2%
[1 year. 2 years)	7,889	41	2.5%	2.2% 2.8%
[2 years. 3 years)	5,444	17	2.9%	2.5% 3.3%
[3 years. 4 years)	3,464	13	3.4%	2.9% 3.8%
[4 years. 5 years)	1,766	2	3.5%	3.1% 4.1%
[=>5 years)	401	0	3.5%	3.1% 4.1%

95%CI: 95% confidence interval.

In bivariate analysis of revision rate in THA according to the type of fixation, there are no big differences between the different rates (Table 36). Consequently, before one year from surgery, cemented arthroplasties show a higher revision rate than the rest of groups. After 3 years, this rate distribution remained stable, being 3.3% for cemented, 2.8% for uncemented

and 2.9 for hybrid arthroplasties; even though the differences observed were not statistically relevant. A tendency was observed in the risk of revision according to age groups that showed that the younger patients were at more risk than the older ones. Nevertheless, it appeared that there were no significant statistical differences for risk of revision according to age or between men and women in patients with THA (data not shown).

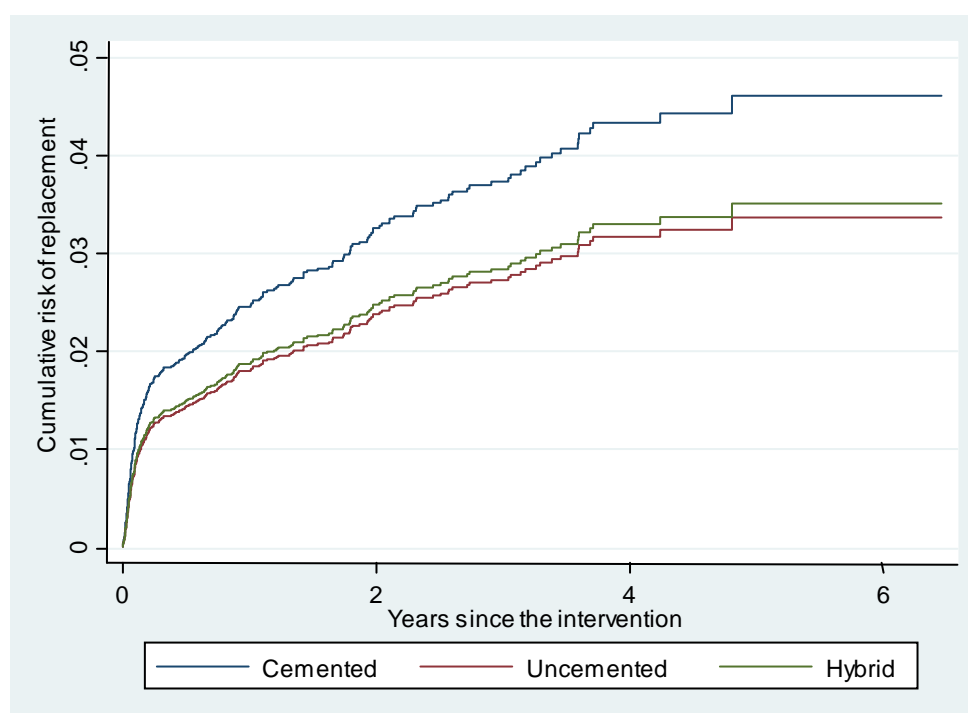
In relation to the revision per type of fixation (adjusted by patient, age and sex), arthroplasties with an uncemented fixation did not present a different revision risk compared to cemented arthroplasties (HR 0.73 CI 95% 0.49-1.09), nor did the hybrid ones compared to the cemented arthroplasties (HR 0.76 IC95% 0.50-1.15; Figure 29).

Table 36. Estimated revision cumulative rate after a total hip arthroplasty according to fixation type. Unadjusted results. (Source: RACat)

	Cemented			Uncemented			Hybrid		
	Revision	95%CI		Revision	95%CI		Revision	95%CI	
[0.30 days)	0.9%	0.5%	1.7%	0.7%	0.6%	1.0%	0.7%	0.5%	1.1%
[30. 90 days)	1.9%	1.2%	2.8%	1.3%	1.1%	1.6%	1.2%	0.8%	1.6%
[90 d. 1 year)	2.4%	1.6%	3.4%	1.9%	1.6%	2.2%	1.8%	1.4%	2.3%
[1 year. 2 years)	3.0%	2.2%	4.4%	2.4%	2.0%	2.8%	2.5%	1.9%	3.1%
[2 years. 3 years)	3.3%	2.3%	4.6%	2.8%	2.4%	3.3%	2.9%	2.3%	3.7%
[3 years. 4 years)	3.8%	2.7%	5.4%	3.4%	2.9%	4.1%	3.0%	2.4%	3.9%
[4 years. 5 years)	3.8%	2.7%	5.4%	3.4%	2.9%	4.1%	3.6%	2.7%	4.9%
[=>5 years)	3.8%	2.7%	5.4%	3.4%	2.9%	4.1%	3.6%	2.7%	4.9%

95%CI: 95% confidence interval. RACat: Catalan Arthroplasty Register

Figure 29. Cumulative risk of revision after a total hip arthroplasty according to fixation technique adjusted according to age and sex. (Source RACat)



It is important to bear in mind that 11% of the reports did not provide information on the friction device and that metal-polyethylene devices represent a 66% of the total number of cases. On the other hand, it is important to highlight that because of the controversy surrounding the differences in THA survival according to the friction device, especially between metal-metal and the rest of groups, the RACat still does not have a high enough number of revision cases in the subgroups and there is not enough followup time to have robust estimates for these compararisons. Therefore, the estimates for the revision rate are given only at a bivariate level without adjustment.

Table 37 shows the unadjusted cumulative revision rate according to friction device. Even though the differences are not statistically significant, it appears that up to 3 years, the THA with the highest cumulative rate were the metal-polyethylene ones (2.9% at 3 years) compared to the rest of groups (2.7% metal-metal; 2.8% ceramic-ceramic; 2.4% ceramic-polyethylene). After 4 years, the friction device with more probability of revision was THA with metal-metal (4.0%) compared to the rest of groups but also with no statistical significance.

Table 37. Estimated cumulative revision rate after a total hip arthroplasty according to friction device. Unadjusted results. (Source: RACat)

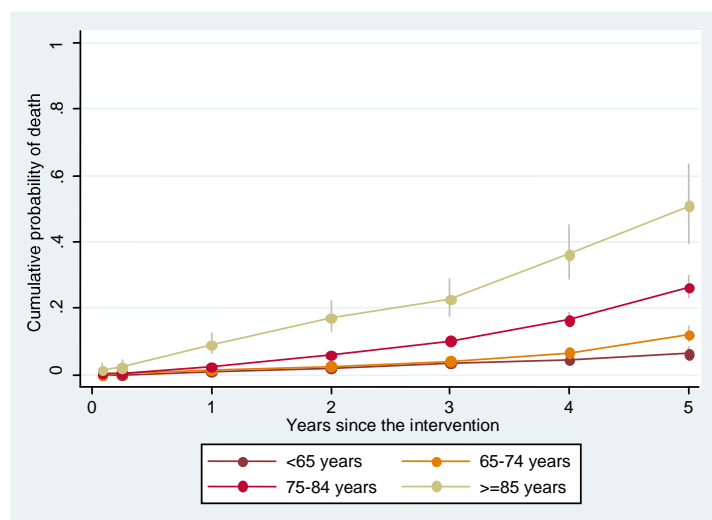
	Metal-metal		Metal-Polyethylene		Ceramic-Ceramic		Ceramic- Polyethylene	
	Revision	95%CI	Revision	95%CI	Revision	95%CI	Revision	95%CI
[0.30 days)	0.1%	0-1.0	0.8%	0.6-1.0	0.5%	0.2-1.5	0.6%	0.3-1.2
[30. 90 days)	0.3%	0.1-1.2	1.5%	1.2-1.8	0.5%	0.2-1.5	0.7%	0.3-1.3
[90 d. 1 year)	1.2%	0.6-2.4	2.0%	1.7-2.3	1.5%	0.8-3.1	1.4%	0.9-2.3
[1 year. 2 years)	1.7%	0.9-3.2	2.6%	2.2-3.0	2.2%	1.2-4.2	1.8%	1.2-2.9
[2 years. 3 years)	2.7%	1.4-5.2	2.9%	2.5-3.3	2.8%	1.5-5.3	2.4%	1.5-3.7
[3 years. 4 years)	4.0%	1.8-8.7	3.4%	2.9-4.0	2.8%	1.5-5.3	2.4%	1.5-3.7
[4 years. 5 years)	4.0%	1.8-8.7	3.6%	3.1-4.3	2.8%	1.5-5.3	2.4%	1.5-3.7
[=>5 years)	4.0%	1.8-8.7	3.6%	3.1-4.3	2.8%	1.5-5.3	2.4%	1.5-3.7

95CI%: 95% confidence interval.

Cumulative probability of death

The cumulative probability of death after one year from the THA was 1.8% and after three years it was 6.6%. By age groups (Figure 30), an expectable gradient is expected where older patients present higher mortality cumulative rates, especially after three years from the arthroplasty.

Figure 30. Cumulative probability of death after a total hip arthroplasties according to age groups. Unadjusted results. (Source: RACat)

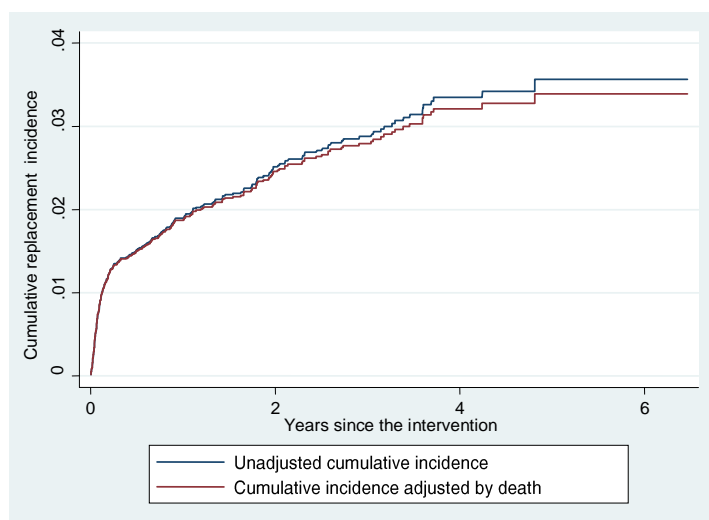


These results present death as a competitive event with the revision of the prosthesis. The death takes place before the revision is performed, especially in patients over the age of 75. For analytical purposes, ignoring this fact could bias prostheses survival estimations as well as the magnitude of the different risk factors associated with the revision.

Prostheses survival in total hip arthroplasties adjusted by competitive risk of death, age and sex

Figure 31 shows the effect of competitive risk of death on the cumulative incidence of revision. As shown, the cumulative incidence function without adjustment draws a curve that slowly grows apart from the cumulative incidence function adjusted by death risk with the passing of the years since the procedure. Even though the difference is not major, it increases over time and after 3-4 years from the intervention the difference becomes evident. Hence, the cumulative incidence in THA after 4 years for the whole group adjusted by age, sex and risk of death was 3.2%. Taking into consideration only the 75 year old patients, the revision incidence adjusted by age and sex was 2.9%. When it is adjusted in addition to age and sex also by success probability, the incidence was 2.7%. Ultimately, not taking into account the death rate in the followup of the effectiveness of the arthroplasties could overestimate the revision risk in almost by 5% in the case of total hip arthroplasties.

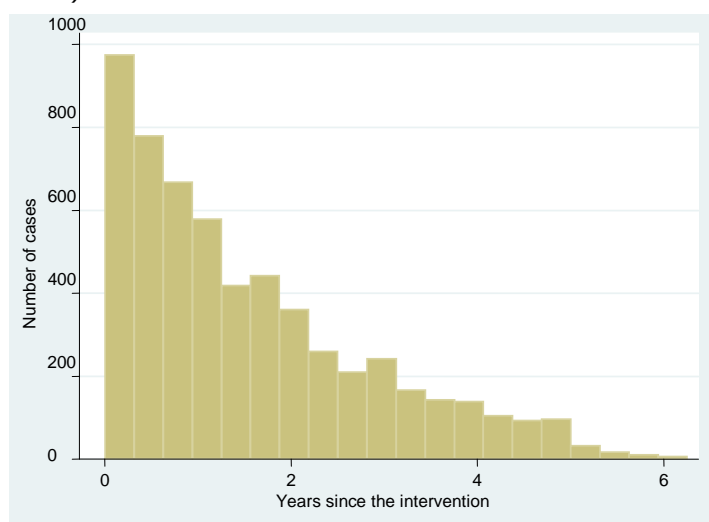
Figure 31. Cumulative incidence of revision after a total primary hip arthroplasty adjusted by competitive death risk, sex, and age of the patients. (Source: RACat)



Primary partial hip arthroplasties

The median followup of data for partial hip arthroplasty until revision or censorship on the 5,745 patients with a PHA was 1.2 years. For 25% of the patients, the followup was longer than 2.3 years and for another 25% the followup was less than 0.5 years. Figure 32 shows the time distribution of the followup of these patients.

Figure 32. Distribution of the followup time of the patients with a primary partial hip arthroplasty. (Source: RACat)



Cumulative probability of revision

Table 38 shows the crude prostheses survival results for primary partial hip arthroplasties (cumulative revision rate). After 90 days from surgery, 1.1% of the primary arthroplasties were revised; one year later 1.6%, and three years later 2.5%. After 3 years, the number of censored data is quite high and therefore it is better to be cautious when interpreting the

effectiveness after 3 years. It should be taken into consideration that 75% of patients with TKA present a followup of less than 2.3 years.

Table 38. Estimated cumulative revision rate after a partial hip arthroplasty. Unadjusted results. (Source: RACat)

Primary Partial Hip Arthroplasty					
	Total	Revision	Revision rate	95%CI	
[0-30 days)	5,745	32	0.6%	0.4%	0.8%
[30- 90 days)	5,456	29	1.1%	0.9%	1.4%
[90 days- 1 year)	4,960	20	1.6%	1.3%	2.0%
[1 year- 2 years)	3,185	12	2.1%	1.7%	2.6%
[2 years- 3 years)	1,709	5	2.5%	2.0%	3.1%
[3 years- 4 years)	909	0	2.5%	2.0%	3.1%
[4 years- 5 years)	389	0	2.5%	2.0%	3.1%
[=>5 years)	68	0	2.5%	2.0%	3.1%

95CI%: 95% confidence interval. RACat: Catalan Arthroplasty Register.

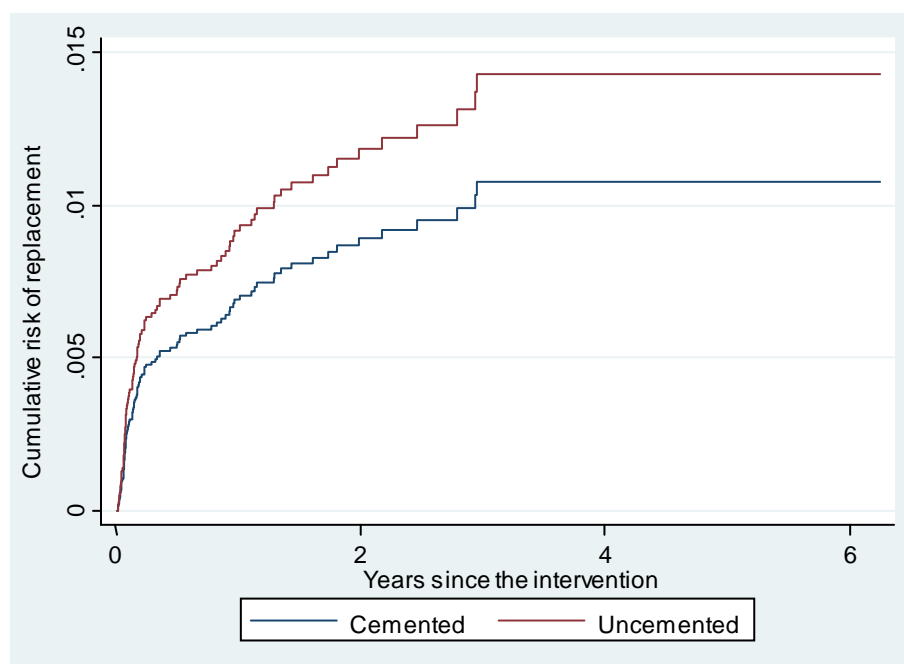
A tendency in the revision risk according to age group was observed, being the younger age groups at a higher risk than the older ones. As with THA, the differences shown in the replacement risk were not significant according to age or sex for patients with a PHA (data not shown). As far as fixation type is concerned, it is observed that the cumulative replacement rates are higher for uncemented arthroplasties compared to cemented ones (Table 39 and Figure 33). Estimating the risk of revision per fixation type through a Cox model (adjusted by patient age and sex), the arthroplasties without an uncemented fixation presented a non-statistically significantly higher risk of revision compared to the cemented ones (HR 1.32 CI95% 0.88-1.98; Figure 34).

Table 39. Revision estimated cumulative rate after a partial hip arthroplasties according to fixation technique. Results without adjustment. (Source: RACat)

	Cemented			Uncemented		
	Revision	95%CI		Revision	95%CI	
[0-30 days)	0.5%	0.3%	0.8%	0.7%	0.4%	1.1%
[30-90 days)	1.0%	0.7%	1.4%	1.3%	0.9%	1.8%
[90 days- 1 year)	1.4%	1.0%	1.9%	1.9%	1.4%	2.5%
[1 year- 2 years)	2.0%	1.5%	2.7%	2.2%	1.6%	3.0%
[2 years- 3 years)	2.2%	1.6%	3.1%	2.7%	2.0%	3.8%
[3 years-4 years)	2.2%	1.6%	3.1%	2.7%	2.0%	3.8%
[4 years-5 years)	2.2%	1.6%	3.1%	2.7%	2.0%	3.8%
[=>5 years)	2.2%	1.6%	3.1%	2.7%	2.0%	3.8%

95CI%: 95% confidence interval. RACat: Catalan Arthroplasty Register.

Figure 33. Cumulative risk of revision after a partial hip arthroplasties according to fixation technique, adjusted according to sex and age. (Source: RACat)

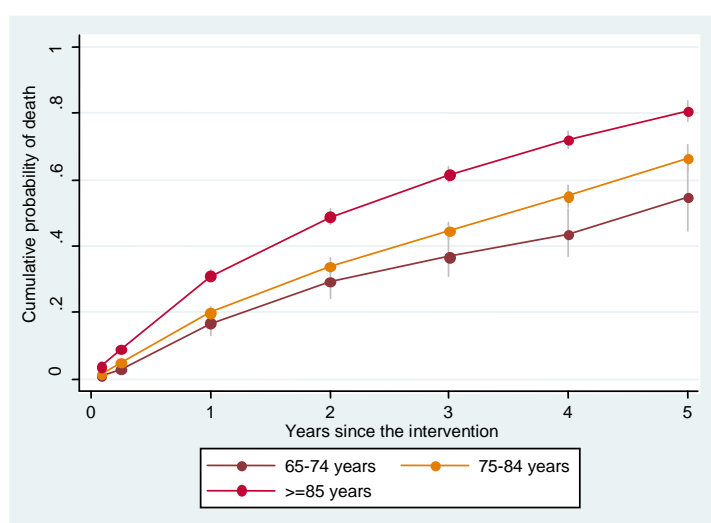


RACat: Catalan Arthroplasty Register

Cumulative probability of death

The cumulative probability of death after one year from a PHA was 25%, and after three years, it was 53%. Per age groups, Figure 34 shows an expectable gradient in older patients who present higher cumulative mortality rates, especially after three years from the arthroplasty.

Figure 34. Cumulative probability of death after a partial hip arthroplasty according to age groups. Unadjusted results. (Source: RACat)



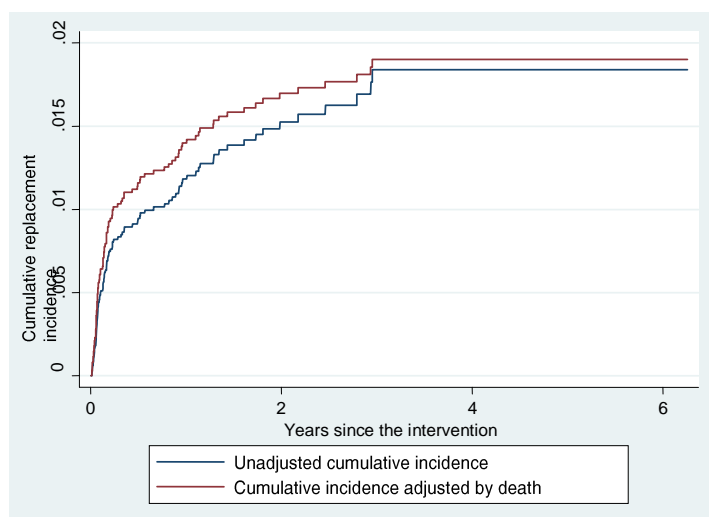
These results present death as a competitive event with the revision of the prosthesis. The death takes place before the revision is performed, especially in patients over the age of 75.

For analytical purposes, ignoring this fact could bias prosthesis survival estimations as well as the magnitude of the different risk factors associated with the revision.

Prostheses survival in partial hip arthroplasties adjusted by competitive risk of death, age and sex

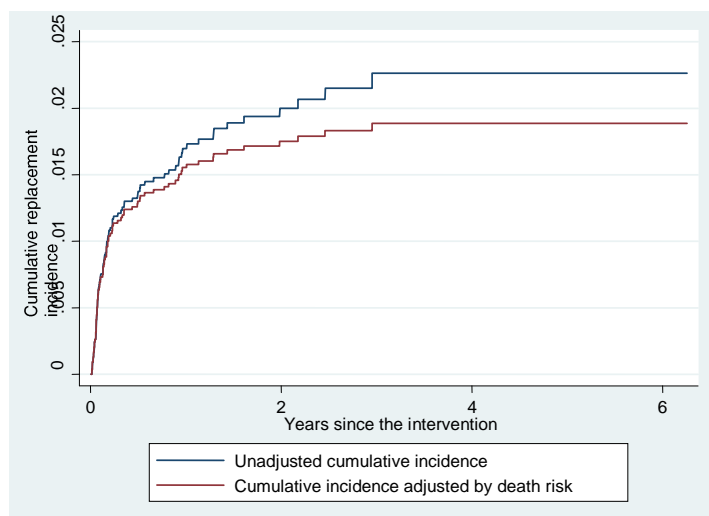
Figure 35 show the effect of this analysis on the cumulative incidence of revision. As can be seen, the curve drawn by the cumulative incidence function without adjustment slowly grows apart from the cumulative incidence function adjusted by death risk over the years since the operation. Even though the difference is not major, it increases over time and after 2-3 years from the operation the difference becomes evident. Hence, the cumulative revision incidence after 2 years in PHA for the entire group adjusted by age and sex was 1.5% and the one adjusted by age, sex and also death risk was 1.7%. Taking into consideration only the 75 year old patients (Figure 36), the adjusted incidence by age and sex was of 2.0% and when it was also adjusted by the death risk it was 1.7%. Ultimately, not taking into account the morbidity in the followup of the effectiveness of the arthroplasties could overestimate the revision risk by more than 15% in the case of partial hip arthroplasties.

Figure 35. Cumulative incidence of revision after a partial hip arthroplasty adjusted by competitive death risk, age and sex. (Source: RACat)



RACat: Catalan Arthroplasty Register

Figure 36. Cumulative incidence of revision after a partial hip arthroplasty adjusted by competitive death risk, age, and sex in patients over the age of 75 (Source: RACat)



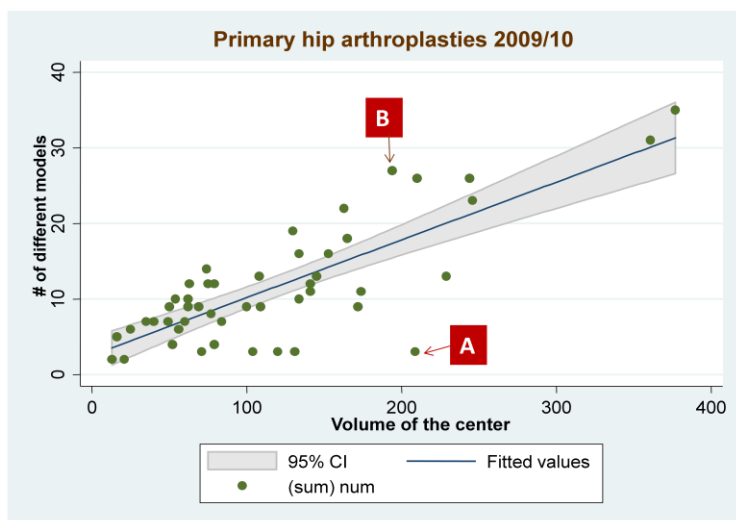
RACat: Catalan Arthroplasty Register

5.5. Characteristics of the implant models

In the 2005-2010 period, a total of 366 different models of stem-socket combinations (counting separately the cemented and uncemented models. ex. Evoris cim and Evoris) were identified. The median of different models used in each center was 15.6 models, ranging from 3 to 35 different models. Taking into account the data from 2009 and 2010, it appears that the number of implanted different models grows according to the volume of arthroplasties of the center. Nevertheless, as shown in Figure 37, center “A” with an activity volume close to 200 arthroplasties presents a relatively low number of different models of prostheses in comparison with another or center “B” with a similar volume of activity. As described in the case of knee arthroplasties (Figures 17 and 18), the distribution that these different prostheses can have in relation to the total of implants or the most frequently used one in a center (see Figure 38) has to be taken into consideration.

In the case of THA, the model is presented as the combination of stem and socket component, and in the PHA the stem model and the manufacturer are specified (Table 40).

Figure 37. Number of different prostheses models in relation to the volume of primary hip arthroplasties for each center sent to RACat in the 2009-2010 period. (Source: RACat)



#: number; sum: sum of the number of different models per center.

Figure 38. Percentile distribution of different prosthetic models for primary total hip arthroplasties in 2009-2010 according to the center. (Source: RACat)

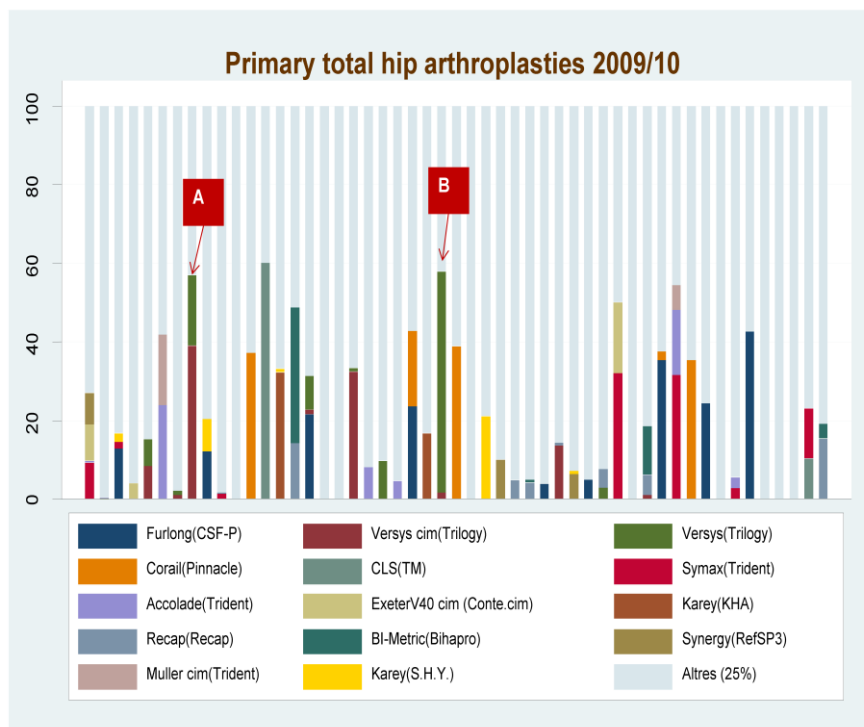


Table 40. Five most frequent primary arthroplasty stem-acetabulum (cotyle) models per type of arthroplasty and period. (Source: RACat)

Tipus	2005-2006				2007-2008			2009-2010		
	Model	n	%	Model	n	%	Model	n	%	
Unipolar monoblock	Austin Moore -Surgival	205	43.8	Austin Moore -Surgival	386	41.3	Austin Moore -Surgival	599	45.0	
	Austin Moore -Stryker	114	24.4	Austin Moore -Stryker	365	39.1	Austin Moore -Stryker	552	41.4	
	Thompson cim -Surgival	79	16.9	Thompson cim -Surgival	81	8.7	Thompson cim -Stryker	96	7.2	
	Austin Moore -Biomet	46	9.8	Austin Moore -Traiber	37	4.0	Thompson cim -Surgival	76	5.7	
	Austin Moore -Traiber	24	5.1	Austin Moore -Biomet	35	3.7	Austin moore -Biomet	4	0.3	
Unipolar modular	Eco cim (Biomet)	60	63.2	Eco cim (Biomet)	90	66.7	CCM cim (Mathys)	57	30.3	
	Eco cim (Biomet)	35	36.8	Fullfix cim (Mathys)	43	31.8	Fullfix cim (Mathys)	45	23.9	
				Eco cim (Mathys)	1	0.7	Autobloqueante cim (Surgival)	36	19.1	
				Wagner SL(Zimmer)	1	0.7	Cemira cim (Mathys)	27	14.4	
							Eco cim (Biomet)	18	9.6	
Bipolar	Mainstream M. cim (Biomet)	45	13.3	Selfblocking cem (Biarticular)	150	18.4	Selfblockking cem (Biarticular)	191	11.7	
	Muller cim* (Zimmer)	40	11.8	Selfblocking cem (Surgival)	120	14.7	Selfblocking cem (Surgival)	162	10.0	
	Autobloqueante cim (Surgival)	37	10.9	Mainstream M. cim (Biomet)	120	14.7	Karey cim (Surgival)	80	4.9	
	Eco cim (Biomet)	36	10.6	Eco cim (Biomet)	61	7.5	Versys cim (Zimmer)	79	4.9	
	Versys cim (Zimmer)	23	6.8	Versys cim (Zimmer)	48	5.9	Furlong cim (J.R.I.)	73	4.5	
Conventional	Versys (Trilogy)	211	10.6	Versys (Trilogy)	356	9.0	Versys cim (Trilogy)	276	5.2	
	Versys cim (Trilogy)	162	8.1	Versys cim (Trilogy)	355	8.9	Versys (Trilogy)	243	4.6	
	Furlong (Furlong)	139	7.1	United U2 (United U2)	183	4.6	Corail (Pinnacle)	234	4.4	
	United u2 (United u2)	133	6.7	Symax (Trident)	150	3.8	Furlong (CSF Plus)	232	4.4	
	Eco cim (Expansys)	91	4.6	Furlong (Furlong)	138	3.5	United U2 (United U2)	229	4.3	
Resurfacing	Asr (Asr)	13	56.5	ASR (ASR)	37	28.5	Recap (Recap)	63	29.4	
	Conserve plus (Conserve)	5	21.7	Recap (Recap)	33	25.4	Cormet (Cormet)	45	21.0	
	BHR (BHR)	4	17.4	Icon TM (Icon TM)	16	12.3	Conserve plus (Conserve)	28	13.1	
	Recap (Recap)	1	4.3	Conserve Plus (Conserve)	12	9.2	Conserve plus (Conserve Plus)	19	8.9	
				Cormet (Cormet)	9	6.9	Adept (Adept)	17	7.9	

DISCUSSION

The results that are shown in this second report offer a description of the arthroplasties and implants used in Catalonia in the 2005-2010 periods. It was possible to link the data from RACat to the available clinical-administrative data from the MBDSHD. This enabled to analyze the progression of the completeness and the coverage of RACat data in the last years, supporting the significant improvement of the participation of the centers. This improvement has also appeared in the indicators linked to the quality of the data, such as for example: the informed operated side or the classification of the prostheses. This improvement can be attributed to different factors, including the interest of the centers for the project giving back the results to each hospital and the different strategies of dissemination of the obtained results at RACat^{16,17,f}. It could also be attributed to the implementation in 2008 of the assessment from CatSalut of the specialized care in the area of OST by means of 4 indicators related to the participation with the RACat¹⁸. Even with this improvement of the coverage and the quality of the data, the defining of strategies that allows even more improvement must continue. The participation of private centers would be essential in the project in order to have a complete picture of the healthcare assistance activity in the area of OST in Catalonia.

The results of this report allowed describing some aspects of the variability per centers and healthcare regions, in relation to the volume of activity sent to RACat, as well as the burden of revision. Hence, for knee arthroplasties as well as for hip arthroplasties, it can be observed how there are centers with a 0% burden of revision and others with a value above the joint revision median. This fact can be related with the level of completeness of the revision data sent from the centers to the RACat or also the fact that some centers are not performing revision arthroplasties because they are sent to reference or more experienced centers. Revision surgery is more complex, more risky, and calls for more material and experience resources than the primary surgery.

It was possible to describe the demographic characteristics, the health condition, and some data of the healthcare provision process by linking the information available at MBDSHD with RACat information. The MBDSHD registers includes information on the reason for the surgery, the comorbidities, the length of the stay, or whether the patient was referred to another healthcare center after being discharged⁸. It also enabled us to validate the distribution of the patients included in RACat by age and sex, since the MBDSHD includes all the admissions to acute patients hospitals of the XHUP network. Hence, in the same period of time, the percentage of women and the percentage of patients with arthritis due to the primary surgery or the median stay, are fairly consistent between both information sources. For example, in the 2005-2006 period, the percentage of women with primary knee arthroplasty and primary total hip arthroplasty at the RACat was 73.3% and 54.3%, respectively. In the case of a study published with the data from the MBDSHD in 2005, this percentage was 73.7% and 53.1%, respectively.¹⁹ On the other hand, the data included in

f More information on available products of RACat at the website: l'Agència d'Informació, Avaluació i Qualitat en Salut

this report, both in the RACat or the MBDSHD in the 2005-2006 period, shows that a 98.2% of the patients with a primary knee arthroplasty and a 76.9% of the patients with a primary total hip revision had a surgery because of osteoarthritis. These figures are very similar to those published in other studies (98.5% for knee and 79.3% for hip) for the Catalonia territory with data from the MBDSH²⁰. This fact could be indicating that the existence of information bias is unlikely (due to possible loss of data that were not sent to RACat) because no differences were observed between the different information sources in some relevant characteristics of the patients. Future studies will be aimed at analyzing other characteristics of the process or essential structure that could influence the variability per center or the prostheses survival such as complexity or the admission circumstance (planned or emergency).

Even taking into consideration the limitations derived from comparing the results of the RACat with other international registries, given that they incorporate different followup periods, population groups, as well as different implants and techniques, it can be observed that the principal reason for the procedure in primary knee arthroplasties in the RACat was osteoarthritis, as in the majority of registries: a 98.5% at RACat; a 97.0% at the National Joint Registry for England and Wales (NJR); and 92.0% at Swedish Knee Arthroplasty Register (SKAR), possibly reflecting the application of similar indication criteria when it comes to knee surgery^{11,12}. In primary knee and hip arthroplasties, the percentage of patients with recommended surgery because of osteoarthritis was similar at RACat and the Swedish Knee Arthroplasty Register (SKAR) for THA (80.1% and 83.0%, respectively) and for partial arthroplasties, the main reason for the intervention was the fracture of the femoral neck (95.3% and 93.4%, respectively)²¹. In the case of the NJR of England and Wales, the percentage of osteoarthritis as the main reason for THA was 93%. This register did not account for partial hip arthroplasties.

As for the type of primary knee arthroplasties at RACat, the same pattern appears throughout the studied years, being the most commonly performed procedures total arthroplasties and the least frequently performed unicompartmental arthroplasties. In the case of primary hip arthroplasties, it can be observed that in the last years the volume of partial arthroplasties has increased (particularly with regard to bipolar arthroplasties), the femoral neck fracture being the main reason at RACat, as well as the total hip resurfacing arthroplasties that were performed mostly on younger patients (under 65 years of age). This fact may be due to the improvement of the quality of the data on informed prostheses that enabled their classification in these mutually exclusive groups, varying the percentages of the different types of arthroplasties.

When data obtained by RACat are compared against data from other international registries, the percentage of unicompartmental arthroplasties is observed to be less common at RACat (2.5%) than that of the *Registro Implantología Protésica Ortopédica* (RIPO) – Emilia Romagna's Registry of Orthopedic Prosthesis Implantology (12.0%), NJR (9.2%) or the Swedish registry (5.3%)^{11,12,22}. A lower percentage of THA is observed at RACat than compared to other registries. On the other hand, the percentage represented by partial hip arthroplasties included at RACat was 33.4%. This percentage was similar to that described at RIPO (28.0%)^{22,21,23}. In the case of SHAR, in the publication analysed in this report, THAs are accounted for in the 1992 - 2009 period, whereas PHAs are only accounted for in the

2005-2010 period, being the percentage of PHA 9.9% in relation to the total number of primary hip arthroplasties.

In regards to the type of fixation in the studied period, RACat records an increase in the volume of primary uncemented knee arthroplasties. For the THA, the percentage of cemented ones decreases and the uncemented ones increases between periods (2005-2006 compared to 2009-2010). This fact may indicate changes in the profiles of the operated patients or the epidemiology of the arthroplasties, even though it could be due to improvements in the classification of the prostheses or to changes linked to the impact that the results of the arthroplasty registries had on the clinical decision-making process of the health care professionals at COT. Even with these trends, in the case of RACat, a lower percentage of cemented TKA (74%) than in other registries can be observed: 89.2% at RIPO, 85% at the NJR, and 97% at SKAR^{22,11,12}. THA showed more variability between registries, the distribution of the cemented ones, in the case of partial arthroplasties, being similar to that recorded by RACat (53.8%) and at SHAR (52%)²¹.

Published studies consider that appropriate survival of the arthroplasties after 10 years is 90%; in other words, there is a 10% risk probability of revision after a 10 year followup²⁴. Standards of effectiveness should be defined at short-term and mid-term for the survival results of the arthroplasties at RACat. The strategy used at RACat up to the present time to interpret the degree of coherency and adequacy of clinical effectiveness has been a comparison of the results with those from other international arthroplasty registries. For hip arthroplasties, the risk of revision was higher for total arthroplasties compared to partial arthroplasties at the RACat. This fact could probably be due to the effect that in the first type the patients are younger and in better health condition which allows reoperation (2nd arthroplasty or revision) if a complication or failed protheses occurred. For primary knee arthroplasties, the early revision rate was 1.1% (CI95%:1.0-1.3%) at RACat compared to 0.7% (CI95%:0.67-0.73) at NJR. This early cumulative revision rate is considered early failure (NJR), mostly related with prostheses and surgery problems, and can therefore be considered more as an arthroplasty clinical security indicator than an indicator of effectiveness^{11,25}. In total hip arthroplasties at RACat, also after a year, the cumulative revision rate was 1.9% (CI95%:1.7%-2.2%) compared to a 1.1% (CI95%:1.03-1.1) at NJR. These differences could be linked to the characteristics of the type of patients seen, to the type of surgery, to the techniques, and to the models used. It is important to bear in mind that the RACat has not compiled all the information on primary and revision arthroplasties performed in Catalonia and, therefore, the risk of revision could be either overestimated or even underestimated (coverage 78.3% and 71.6% in 2010). Summarizing, as discussed before, it is necessary to further define what is considered an appropriate outcome of early failure, at an overall level, adjusted by risk factors of the patients of the assisted healthcare process and of the organizational structure in order to be able to compare the performance by healthcare regions or centers.

As far as the factors related with a better or worst prognosis of the arthroplasty in terms of its survival, this report reveals results or tendencies consistent with those of the literature, even though not always statistically significant. The lack of volume of revision surgery cases and a median with a relatively short followup (3 years), both for knee and hip, make it difficult to analyse certain subgroups. For example, associations between fixation types and risk of

revision adjusted by different factors after 5 or 10 years can be found in the literature. As shown in the international literature, the RACat has found no differences in prostheses survival according to the sex of the patients. There seems to be a tendency of higher risk of revision in the younger group of patients compared to the group of patients over the age of 85. This can be explained by the fact that older patients die or that their surgical risk increases over time due to a deteriorated health status or higher presence of comorbidity, which makes the healthcare professionals decide not to perform a second surgery to replace the primary arthroplasty.

At RACat no statistically significant differences were found between cemented and uncemented arthroplasties. However, a higher probability of revision in the hybrid rather than in the cemented type was found. At the Finish Arthroplasty Register (FAR), cemented primary knee arthroplasties showed a higher probability of replacement compared to the uncemented in followups of less than 3.6 years, but from this period on, the differences were not statistically significant²⁶. At the NJR and SKAR, cemented primary knee arthroplasties were found to have more likelihood of revision than the uncemented ones after 7 or 8 years, respectively^{11,27}. In the case primary total or partial hip arthroplasties results, RACat found no significant differences according to fixation type in contrast to the NJR and a publication of the NARA group with results from the registries of Sweden, Norway and Denmark. These registries have recorded survival differences, with more likely revision risk for uncemented vs cemented^{11,28,27}. Further years of followup, a higher replacement volume, and a better quality and completeness of the available data, are essential to achieve more reliable and robust results in order to confirm, if needed, the findings of other European registries.

In the current literature there is some controversy on the long-term adverse effects of total hip arthroplasties with a metal-metal friction device. There have been allegations that this friction device shows a lower survival rate than other types of friction devices and that it is potentially associated with a risk of carcinogenic side effects^{11,29}. RACat data do not allow carrying out this analysis because of the low volume of available cases and the lack of long-term survival data. Lastly, this second report explores the impact that death has as a competitive risk factor on the assessment of the cumulative revision rate^{14,15}. The findings at three and four years suggest that not taking into consideration death could overestimate the revision risk. In the near future, when longer followup becomes available, this overestimation is expected to be more evident, as shown in the 10 year analyses presented in the last annual report of the United Kingdom registry¹¹.

Some inherent limitations and weaknesses of all clinical effectiveness registers should be taken into consideration. In future studies, other types of analyses should be taken into account to study tendency changes in the characteristics of the population with arthroplasty surgery. In this report, a crude comparative analysis was carried out based on percentages to show the characteristics of each of the periods studied, for example, activity volume or percentage of women and mean patient age. It would be necessary to incorporate a comparison of rates to describe changes in knee and hip arthroplasty epidemiology based on RACat data, as it is done in other studies in Catalonia with the information available at MBDSHD²⁰. In relation to RACat data, it is adequate for the assessment of results, but it needs to be complemented with other sources of information to be able to comply with the international recommendations. The use of Registre Central d'Assegurats (Central Registry

of Insurance Holders) and its application portal facilitated the fast implementation of the RACat. Even though the communication between the CAHTA and the centers is smooth, other mechanisms must be set up in order to increase the participation, quality and impact of the results in the centers.

These strategies should be supported by the CatSalut as well as by regular meetings with the hospitals to find out their problems and clear doubts related to the data that must be sent to RACat as well as the presentation and discussion of their results.

In future studies it will be important to analyze other issues like the variability of arthroplasty type per center and region, the fixation technique, or other characteristics of the patient's healthcare process. It will be necessary to gather information such as weight and size, surgical risk or other characteristics of the surgical technique that could affect negatively or positively the arthroplasty's prognosis; always bearing in mind that in order to compare centers it would be necessary to adjust the result according to factors such as the level of complexity of the centers, the surgical risk of the patients, or other aspects that could account for significant differences ²⁹. This benchmarking exercise will be of special interest for the implementation and the clinical management of the patients. As for the survival analyses of the arthroplasties, not only the characteristics of the patients and the process should be considered, but also the structural elements of the centers.

In conclusion, in the completeness study period, the RACat has improved the coverage and the quality of the data. The results of RACat showed that it could be a useful tool for the followup of knee and hip arthroplasties trends, to describe and identify elements related with the failure of the surgery as well as to analyze the variations of the characteristics of the patients and prostheses between the hospitals and Catalonia's healthcare regions. Therefore, it is a tool to evaluate OST that can be extremely useful for decision making. The main limitation is the short followup period of the patients that dose not allow to obtain robust long-term results, as can be found in the nordic registries. Lastly, the strengths of this project include the ongoing interest of the people responsible for the decision-making and the actors related to knee and hip orthopedic surgery, as well as the availability of computerized data from the CatSalut hospitals. The available data for this report enabled to analyze the clinical effectiveness of primary knee arthroplasties and total and partial hip arthroplasties on a case-by-case basis up to 4 years of followup, adjusted by age and sex of the patients, showing results that are consistent with the international literature. The RACat is a leading initiative at the National Health Service as a population registry of the public healthcare system, and with over 5 years in place, in line with other arthroplasty registries of other countries (England and Wales, Denmark, Finland, Italy, Norway or Sweden, among others). The involvement of the main actors of the RACat, especially the Catalan Association of Orthopedic Surgery and Trauma, for the dissemination and implementation of the results, and the research that has stemmed out of it, can benefit the improvement of healthcare services, just as it has happened in other countries. Finally, the RACat offers a post-market monitoring system of the implants.

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