High tibial osteotomy in Sweden, 1998-2007 A population-based study of the use and rate of revision to knee arthroplasty

W-Dahl, Annette; Robertsson, Otto; Lohmander, Stefan

Published in:
Acta Orthopaedica

DOI:
10.3109/17453674.2012.688725

2012

High tibial osteotomy in Sweden 1998-2007

A population-based study of the use and rate of revision to knee arthroplasty

Annette W-Dahl[1,2], Otto Robertsson[1,2], L. Stefan Lohmander[1,3,4,]

[1] Department of Orthopedics, Clinical Sciences Lund, Lund University, Lund, Sweden

[2] Department of Orthopedics, Skåne University Hospital Lund, Lund, Sweden

[3] Research Unit for Musculoskeletal Function and Physiotherapy, University of Southern Denmark, Odense, Denmark

[4] Department of Orthopedics and Traumatology, University of Southern Denmark, Odense, Denmark

Correspondence: annette.w-dahl@med.lu.se

Abstract

Background and purpose

Most studies on high tibial osteotomies (HTO) are hospital-based and based on a limited number of patients. Expressed as rate of revision to knee arthroplasty we evaluated the use and outcome of HTO performed in Sweden (9 million inhabitants) 1998-2007.

Patients and methods

3 161 HTO procedures on patients 30 years or older (69% men) operated on for knee osteoarthritis in Sweden 1998-2007 were identified through the in- and out-patient care registers of the Swedish National Board of Health and Welfare. Pertinent data were verified through surgical records. Conversions of HTO to knee arthroplasty before 2010 were identified through the Swedish Knee Arthroplasty Register (SKAR). The 10-year survival was analysed using revision to an arthroplasty as the end point.

Results

The number of HTO's decreased by one third between 1998 and 2007, from 388 operations to 257 per year. Most of the HTO's were performed by open wedge osteotomy using external fixation. The cumulative revision rate at 10 years was 30 % (95% CI 28-32). The risk of revision increased with increasing age and was higher in women than men, RR 1.3 (CI 1.1-1.5).

Interpretation

If being without an artificial joint implant is considered beneficial, then HTO is an excellent alternative to knee arthroplasty in the younger and/or physically active patients suffering from knee osteoarthritis.

Introduction

Among the surgical options for treatment of knee osteoarthritis (OA), high tibial osteotomy (HTO) is a joint preserving alternative which most commonly is used in the younger and/or physically active patients.

HTO can be performed with different methods, such as closed wedge osteotomy, open wedge osteotomy and dome-shaped osteotomy. It has been used as a surgical treatment for OA since the 1950's and has served as a standard treatment for uni-compartmental knee OA. However, the use of HTO has decreased during the last decades, concomitant with an increasing use of knee arthroplasty.

In the beginning of the 1980's HTO was estimated to constitute about 30% of the primary knee reconstruction surgery in Sweden (Tjörnstrand et al. 1981), decreasing to about 20 % during 1989 – 1991 (Knutson et al. 1994). Information from the national database on in-patient procedures on the number of patients operated on by angle, rotation or correction osteotomy in the knee or tibia from 1998-2007 showed a further decline to about 40 % (W-Dahl et al. 2010).

Many follow-up studies on HTO's report the majority of patients being good to excellent with declining results over time and an increasing risk of revision after 10-15 years (Odenbring et al. 1990, Coventry et al. 1993, Naudie et al. 1999, Sprenger and Doerzbacher 2003, Aglietti er al. 2003, Koshino et al. 2004, Flecher et al. 2006, Papachristou et al. 2006, Gstottner et al. 2008, van Raaij et al. 2008, Akizuki et al. 2008, W-Dahl et al. 2010, Schallberger et al. 2010). Publications including more than 100 patients are few and show rates of revision at 10 years of between 5 and 20 % (Odenbring et al. 1990, Flecher et al. 2006, Gstottner et al. 2008, W-Dahl et al. 2010).

In contrast to knee arthroplasties, there is no national registration of HTO´s in Sweden and the knowledge of its use, including methods, techniques, patients and outcome, is incomplete.

We report on the use of HTO in Sweden during 1998-2007 and the outcome expressed as rate of conversion to knee arthroplasty.

Methods

The Swedish National Board of Health and Welfare patient register (PAS) contains information on the personal identification number (including information on date of birth and sex), admission date, discharge date, surgical code, diagnosis code (ICD-10) and operating hospital. Information on patients operated on by the surgical code NGK59 (angle, rotation or correction osteotomy in the knee or tibia) in combination with the ICD-10 code M17 (knee osteoarthritis) during the years 1998-2007 was gathered from the PAS.

For each of the 74 hospitals that were identified as having performed HTO's during 1998-2007, each orthopedic department was asked to deliver medical records of each of the identified patients in order to identify the side of the surgery (left/right), and to verify the indication of surgery, diagnosis and surgical date.

As the PAS registers by admission, simultaneous bilateral surgeries become registered as one admission. Such operations, not included in the PAS but identified through information from the medical records were added. In case of the operating unit disagreeing with the PAS with respect of the diagnosis being OA or the surgery a HTO, the patient was excluded. Further re-osteotomies as well as patients younger than 30 years were excluded.

Information from the Swedish Knee Arthroplasty Register (SKAR) was used to calculate the proportion of HTO’s out of a total including uni-compartmental and total knee arthroplasties (UKA & TKA). Further, it was checked how many of the HTO’s had been converted to knee arthroplasty before 2011. The Swedish Knee Arthroplasty Register (SKAR) was initiated in 1975 and all hospitals performing knee arthroplasties in Sweden report the primary as well as the revision procedures to the

SKAR. The coverage of the SKAR is 100% and the completeness is 97% (SKAR 2010.)

If it was not possible to identify the HTO side (6 procedures) through the medical records and the patient had later been subject to knee arthroplasty, we assumed a worst case scenario of the case being a conversion of the HTO.

The study was approved by the Ethics Committee at the Medical Faculty, Lund University (88/2008) and was performed in accordance with the Declaration of Helsinki.

Statistics

Cumulative revision rate (CRR) curves were produced using the life table method with monthly intervals. The 95 % confidence intervals (CIs) were calculated using the Wilson quadratic equation with Greenwood and Peto effective sample-size estimates (Dorey et al. 1993). When comparing risk of age groups and sex, Cox regression was used and relative risk (RR) estimates CI. Adjustment was made for sex, year of surgery and age category (30–39, 40–49, 50–59, 60–). In common with many other registry-based studies, BMI and OA grade were not included in the adjustments. Bilateral observations were included in the data analyzed but without consideration of subject dependency, as this was found not to be an issue when estimating CRR after knee arthroplasty (Robertsson and Ranstam 2003). Statistical analyses were carried out using Stata 11 (StataCorp College Station, TX, USA, 2010).

Results

3,161 operations in 2,835 patients that met the criteria primary HTO (NGK59) in combination with knee OA (M17) and 30 years and older 1998-2007 were identified through the Swedish National Board of Health and Welfare (Figure 1). The mean age at osteotomy was 52 years (SD 7.5), 69 % were males. 98 % of the patients were 65

years or younger with a majority (71 %) of them younger than 55. The median follow-up time was 8.7 (3-12.9) years. By reviewing the medical records for the patients identified in the PAS, the diagnosis and procedure combined was verified as correct in 93.6 % of the procedures.

In absolute numbers high tibial osteotomies decreased 34% between the years 1998 and 2007, from 388 operations to 257 per year. In 1998 HTO constituted 6.8 % of the primary knee reconstruction surgery in Sweden, compared to 2.5% in 2007 (Figure 2). Less than half of the hospitals (35/74) performed HTO surgery each year during the 10-year period and 36% of the HTO's were performed in only 7 hospitals. In 1998, 60 % of the HTO's were performed in clinics that operated less than 15 HTO's while the corresponding figure in 2007 was 70 %.

The use of open wedge osteotomy with internal fixation started in 2000. Open wedge osteotomy with external fixation was the most common procedure used during 1998-2007, followed by closed wedge osteotomy (Figure 3). The use of closed wedge osteotomy decreased, while the use of open wedge with internal and external fixation increased (Figure 3).

The 10-year risk of an HTO being converted to an arthroplasty was 30 % (CI 28-32) and the 13-year risk 37 % (CI 34-57) (Figure 4). 730 HTOs were later converted to an arthroplasty. An additional 6 cases were considered conversions in a worst case scenario of the HTO side being unknown while the patient had been subject to a later knee arthroplasty.

Most of the conversions were to a TKA (36 to a UKA and 700 to a TKA) (Table 1). Using Cox regression, the risk of revision, after adjusting for age and year of surgery, was found to be higher for women than men (Figure 4), with a risk ratio of (RR) 1.3 (95% CI 1.1-1.5). Further, the risk of revision increased with increasing age. Compared to the youngest age group (30-39 years), the risk of revision increased in the older age groups, with RR 2 (CI 1.3-3.3) 40-49 year, RR 2.7 (CI 1.8 – 4.1) 50-59 year and RR 2.5 (CI 1.6-4) in patients 60 years or older.

Discussion

This population-based retrospective study on HTO's from a whole nation during a 10-year period showed a decrease in the use of HTO in OA patients over the study period. For high tibial osteotomies performed during 1998-2007 in Sweden we found that they were most common in men and almost exclusively used for patients younger than 65 years of age.

Our CRR of 30% implies that 70% of the HTO's had not been converted at 10 years after surgery. To our knowledge, this long-term outcome study after 3,161 HTO is the largest of its kind. Further, it was population-based, covering the whole nation with 96% of the procedures identified through the administrative database verified in medical records by diagnosis and procedure.

We used the surgical and diagnosis code to identify the patients, assuming that the right codes had been registered. It is likely that there are HTO's that were incorrectly coded and thus missed. However, we feel confident that the absolute majority of surgeries were captured and bias due to missing cases or loss to follow-up minimal. There were 137 procedures not identified in the clinics where the HTO had been registered as performed in the administrative PAS register. These procedures may have been misclassified by diagnosis, surgical code or operating hospital. The outpatient care register started in 2002, so out-patient care surgery performed before that year is not available. However, the number of HTO's performed in out-patient care before 2002 was low. Registration in the PAS register is the foundation for payment in the Swedish national health care system, ensuring a low rate of missing information from both public and private care.

On a national level the proportion of surgeries with HTO out of all knee reconstructive surgery including UKA and TKA decreased during 1998-2007, consistent with earlier reports (Tjörnstrand et al. 1981, Knutson et al. 1994, W-Dahl et al. 2010). For 2007, we found that HTO's constituted less than 3 % of the primary knee reconstruction surgeries, suggesting a lower proportion than in Germany (Kock et al. 2011).

During the last decade the numbers of knee arthroplasty procedures more than doubled in Sweden (SKAR 2010) and among patients younger than 55 years, which represent the majority of the osteotomy patients, the incidence of UKA doubled and that of TKA quintupled (W-Dahl et al. 2010). However, in spite of the decreasing use of HTO it was more frequently used than UKA at the end of the observation period (W-Dahl et al. 2010).

The “industrialization” of knee arthroplasty, concentrating the surgery to high volume units (W-Dahl et al. 2010) together with economical incitements for knee replacement may have contributed to the decreasing use of HTO. Most of the osteotomies studied were performed in clinics performing less than 15 operations per year. For UKA, it has been shown that hospitals performing less than 23 UKA’s per year had a 1.6 times higher revision rate than units that operated more (Robertsson et al. 2001). It is probable that similar factors influence outcome in HTO, suggesting a need to concentrate HTO surgery to fewer units.

Our population based study of 3,161 HTO's found that both increasing age and female sex were associated with an increased risk for conversion to knee replacement. Previous reports on smaller cohorts have been inconsistent, showing either an increased revision risk with age (Naudie et al 1999, Fletcher et al 2006, Trieb et al. 2006, Gstottner et al. 2008) or the converse (Odenbring et al. 1990, Sprenger and Doerzbacher 2003, Huang et al. 2005, Spahn et al. 2006, van Raaij et al. 2008, Efe et al. 2011). Reports regarding the influence of sex have been inconsistent as well (Aglietti et al. 2003, Huang et al. 2005, Fletcher et al. 2006, van Raaij et al. 2008). The reasons for these discrepancies may be differences in study sizes, loss to follow-up, patient selection or other factors. In Sweden the risk of revision after knee arthroplasty has been similar for both sexes (SKAR 2010) and we have no clear explanation for the observed difference after HTO.

Our finding of increased revision risk with age for HTO is opposite to what has been found for both UKA (SKAR 2010, W-Dahl et al. 2010) and TKA (SKAR 2010) for which there is a marked inverse relationship. We speculate that the reason for this

difference may depend on the aim of the treatment as well as the expectation of the patients. The aim of a HTO is to delay the progress of a disease already started, with the option of later conversion if needed, while an arthroplasty can be viewed as a "definite" treatment of a damaged joint or a part thereof. For TKA patients not satisfied, the only available offer is "more of the same", thus the bar to revise may be high. Young HTO patients can benefit by delaying arthroplasty surgery as the TKA revision rate is high among the younger.

In patients younger than 65 years the CRR at 10 years after UKA is about 16%, and 6% for TKA (SKAR 2010), so the 29% CRR we found for HTO is considerably higher. Considering the possible causes mentioned above as well as the fact that the HTO patients were considerably younger at surgery (51 years) than the UKA patients (58 years) and TKA patients (59 years), the revision rate for HTO may be regarded as acceptable.

If it is considered beneficial to avoid insertion of artificial joint implants in the younger and/or physically active patients suffering from knee OA, HTO may be considered as a good choice. With 70% survival at 10 years after surgery the HTO managed to markedly delay knee arthroplasty surgery in the majority of patients. However, further studies are needed to monitor still longer term results, the effect on quality of life and the outcome for those converted to knee arthroplasty.

Author contributions:

AWD: study design and data collection.

OR: study design and data analysis.

SL: study design.

All authors prepared the manuscript and read and approved the final manuscript.

This study was supported by The Swedish Research Council (LSL), the Swedish Rheumatism Association (LSL), the King Gustaf V 80-year Birthday Fund (LSL, the

Faculty of Medicine Lund University (LSL), and Region Skåne (LSL). The sponsors had no role in the design, analysis, and interpretation of this study, or in the decision to publish this manuscript.

No competing interests declared.

References

Aglietti P, Buzzi R, Vena L M, Baldini A, Mondaini A. High tibial valgus osteotomy for medial gonarthrosis: a 10- to 21-year study. J Knee Surg 2003; 16 (1): 21-6.

Akizuki S, Shibakawa A, Takizawa T, Yamazaki I, Horiuchi H. The long-term outcome of high tibial osteotomy: a ten- to 20-year follow-up. J Bone Joint Surg Br 2008; 90 (5): 592-6.

Coventry M B, Ilstrup D M, Wallrichs S L. Proximal tibial osteotomy. A critical long-term study of eighty-seven cases. J Bone Joint Surg Am 1993; 75(2): 196-201.

Dorey F, Nasser S, Amstutz H. The need for confidence intervals in the presentation of orthopaedic data—current concepts review. J Bone Joint Surg (Am) 1993; 75: 1844.

Efe T, Ahmed G, Heyse T J, Boudriot U, Timmesfeld N, Fuchs-Winkelmann S, Ishaque B, Lakemeier S, Schofer M D. Closing-wedge high tibial osteotomy: survival and risk factor analysis at long-term follow up. BMC Musculoskelet Disord 2011; 12: 46.

Flecher X, Parratte S, Aubaniac J M, Argenson J N. A 12-28-year followup study of closing wedge high tibial osteotomy. Clin Orthop Relat Res 2006; 452: 91-6.

Gstottner M, Pedross F, Liebensteiner M, Bach C. Long-term outcome after high tibial osteotomy. Arch Orthop Trauma Surg 2008; 128 (1): 111-5.

Kolstad K. Uptilting osteotomy of the lateral tibial plateau for a knee deformity. A case report. Acta Orthop Scand 1992; 63 (1):100-1.

Knutson K, Lewold S, Robertsson O, Lidgren L. The Swedish knee arthroplasty register. A nation-wide study of 30,003 knees 1976-1992. Acta Orthop Scand 1994; 65 (4): 375-86.

Kock F X, Weingartner D, Beckmann J, Anders S, Schaumburger J, Grifka J, Luring C. Operative Treatment of the Unicompartmental Knee Arthritis - Results of a Nationwide Survey in 2008. Z Orthop Unfall 2011; 149 (2): 153-159.

Koshino T, Yoshida T, Ara Y, Saito I, Saito T. Fifteen to twenty-eight years' follow-up results of high tibial valgus osteotomy for osteoarthritic knee. Knee 2004; 11 (6): 439-44.

Naudie D, Bourne R B, Rorabeck C H, Bourne T J. The Install Award. Survivorship of the high tibial valgus osteotomy. A 10- to -22-year followup study. Clin Orthop Relat Res 1999; (367): 18-27.

Odenbring S, Egund N, Knutson K, Lindstrand A, Larsen S T. Revision after osteotomy for gonarthrosis. A 10-19-year follow-up of 314 cases. Acta Orthop Scand 1990; 61 (2): 128-30.

Papachristou G, Plessas S, Sourlas J, Levidiotis C, Chronopoulos E, Papachristou C. Deterioration of long-term results following high tibial osteotomy in patients under 60 years of age. Int Orthop 2006; 30 (5): 403-8.

Robertsson O, Ranstam J. No bias of ignored bilaterality when analysing the revision risk of knee prostheses: Analysis of a population based sample of 44,590 patients with 55,298 knee prostheses from the national SwedishKnee Arthroplasty Register. BMC Musculoskeletal Disorders 2003; 4: 1.

Schallberger A, Jacobi M, Wahl P, Maestretti G, Jakob R P. High tibial valgus osteotomy in unicompartmental medial osteoarthritis of the knee: a retrospective follow-up study over 13-21 years. Knee Surg Sports Traumatol Arthrosc 2011; 19 (1):122-7.

Sprenger T R Doerzbacher J F. Tibial osteotomy for the treatment of varus gonarthrosis. Survival and failure analysis to twenty-two years. J Bone Joint Surg Am 2003; 85-A (3): 469-74.

The Swedish Knee Arthroplasty Register annual report 2010 http://www.knee.se

Tjornstrand B, Egund N, Hagstedt B V. Tibial osteotomy in medial gonarthrosis. The importance of over-correction of varus deformity. Arch Orthop Trauma Surg 1981; 99 (2): 83-9.

Trieb K, Grohs J, Hanslik-Schnabel B, Stulnig T, Panotopoulos J, Wanivenhaus A. Age predicts outcome of high-tibial osteotomy. Knee Surg Sports Traumatol Arthrosc 2006; 14 (2): 149-52.

W- Dahl A, Robertsson O, Lidgren L. Surgery for knee osteoarthritis in younger patients. Acta Orthop 2010; 81 (2): 161-4.

W-Dahl A, Robertsson O, Lidgren L, Miller L, Davidson D, Graves S. Unicompartmental knee arthroplasty in patients aged less than 65. Acta Orthop 2010; 81 (1): 90-4.

van Raaij T, Reijman M, Brouwer R W, Jakma T S, Verhaar J N. Survival of closing-wedge high tibial osteotomy: good outcome in men with low-grade osteoarthritis after 10-16 years. Acta Orthop 2008; 79 (2): 230-4.

Table 1. Frequency of type of prosthesis of the HTO's converted to knee arthroplasty

Type	n = 736
TKA without patella	651
TKA with patella	49
UKA medial	35
UKA lateral	1

TKA = total knee arthroplasty
UKA = uni compartmental knee arthroplasty

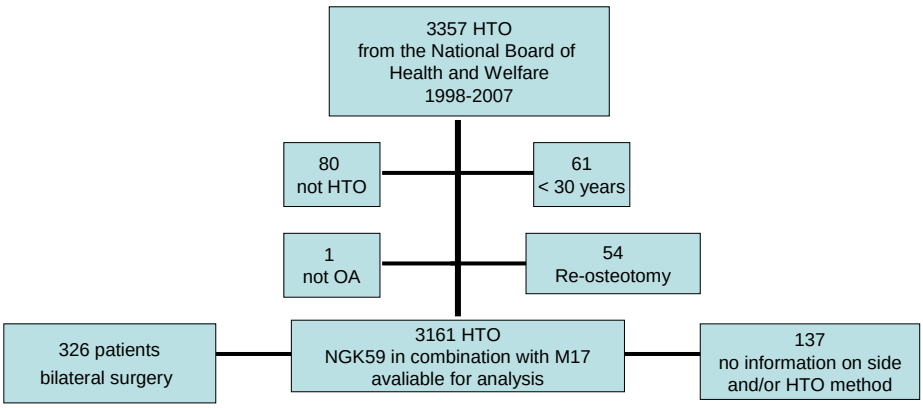

Figure 1. Flow chart of the study

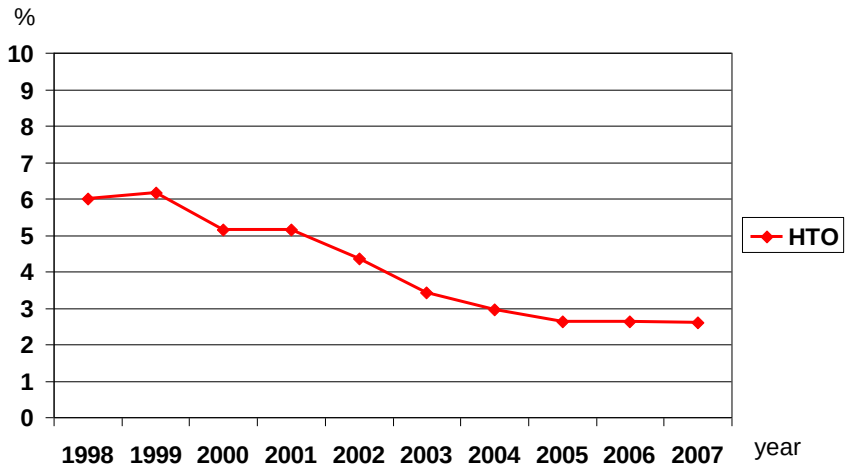

Figure 2. HTO as proportion of primary knee reconstruction surgery in Sweden 1998-2007.

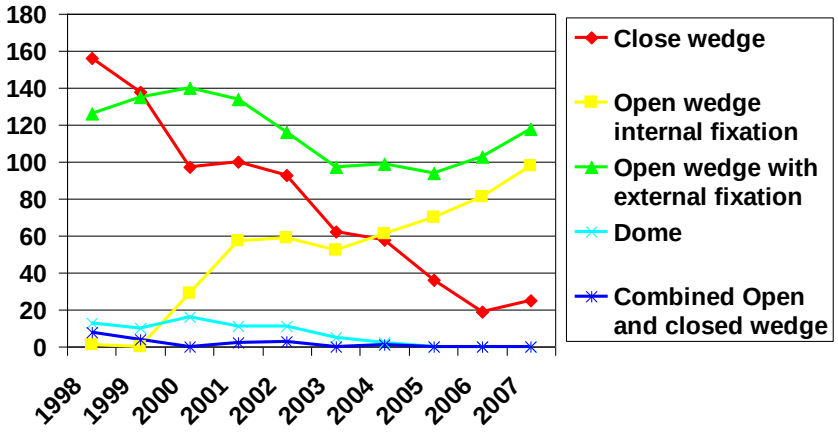

Figure 3. The frequency of the different methods of HTO per year.

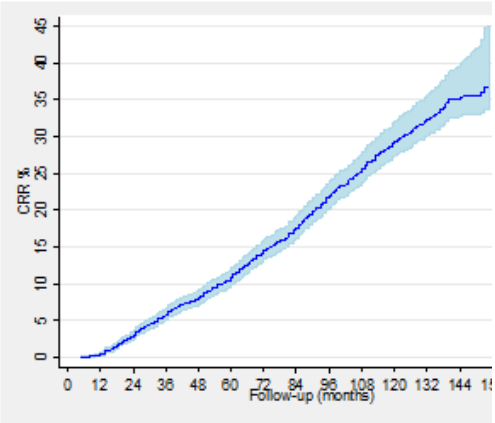

Figure 4. Cumulative Revision Rate (CRR) of HTO with follow-up to 2010

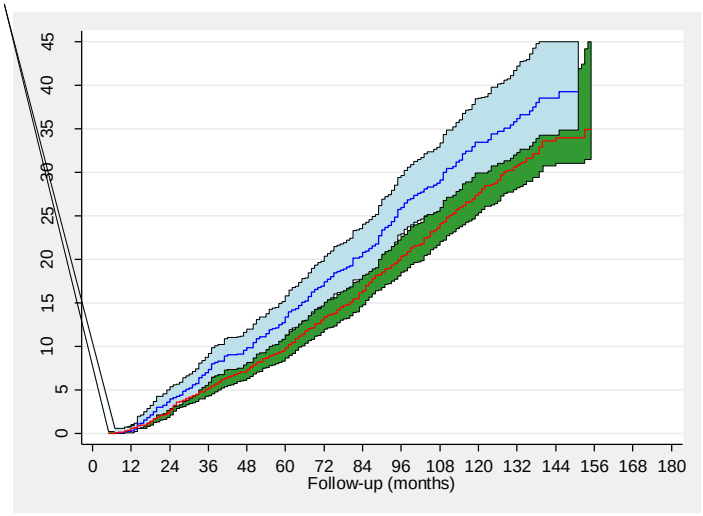

Figure 5. Cumulative revision rate (CRR) in men and women