

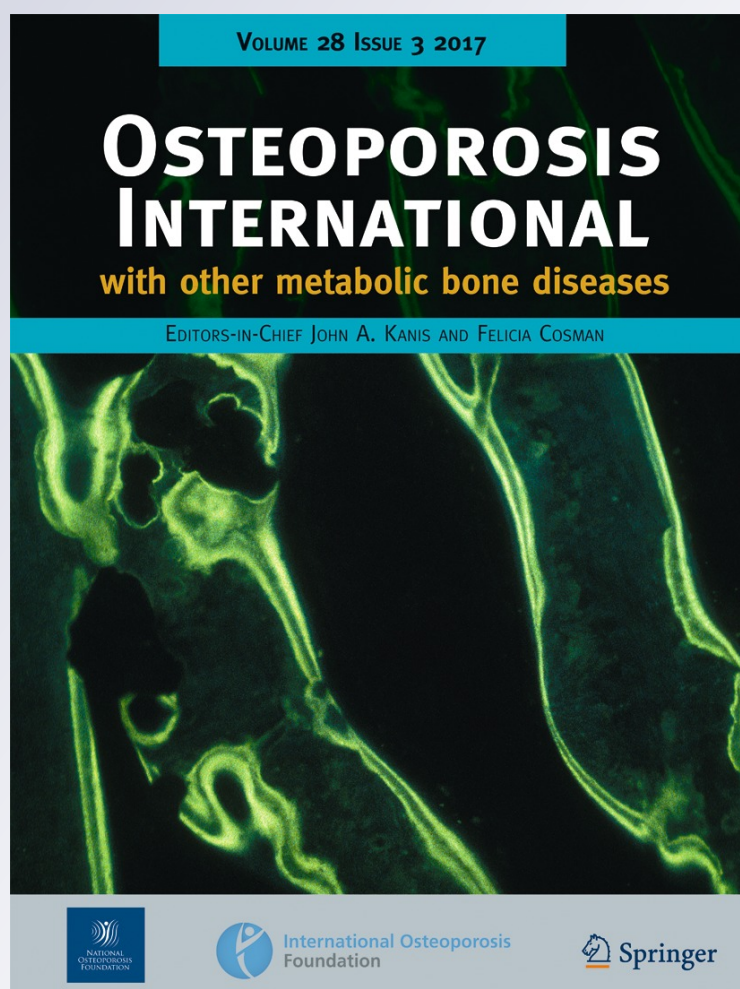
Proximal humeral fractures in Sweden—a registry-based study

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Proximal humeral fractures in Sweden—a registry-based study

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Abstract

Summary Proximal humeral fracture is the third most common osteoporotic fracture. To our knowledge, this is the first nationwide population-based registry study in adults that includes both inpatient and outpatient visits. Thus, we were able to report the true incidence rates and trends in the treatment of proximal humeral fractures.

Introduction Proximal humeral fractures are among the most common osteoporotic fractures. Valid epidemiologic population-based data, including both inpatient and outpatient visits, however, are lacking.

Methods To investigate the Swedish national incidence rates and treatment trends of proximal humeral fractures, we obtained data from the Swedish Hospital Discharge Register between 2001 and 2012. All adult patients (≥ 18 years of age) in the Swedish Hospital Discharge Register were included. Outpatient visits have been included in the register since 2001.

Results We identified 98,770 patients (women $n = 72,063$; 73 %) with proximal humeral fractures between 2001 and

2012. In 2001, the sex-specific incidence of proximal humeral fractures was 134.5 per 100,000 person-years for women and 49.2 for men. In 2012, the corresponding values were 174.6 for women and 68.1 for men, increasing 30 % in women and 39 % in men. A total of 17,013 surgical procedures were conducted between 2001 and 2012. Open reduction and internal fixation with a plate was the most common procedure ($n = 5050$, 30 %), followed by endoprosthetic implantation ($n = 3962$, 23 %) and intramedullary nailing ($n = 3376$, 20 %). The proportion of surgically treated patients increased from 12.1 % in 2001 to 16.8 % in 2012 for women and from 15.1 % in 2001 to 17.1 % in 2012 for men.

Conclusion The Swedish national incidence of proximal humeral fractures has been increasing, although it seems to have peaked in the elderly population during 2008–2010. The rate of surgical treatment has increased substantially, particularly open reduction and internal fixation with a plate. To our knowledge, this is the first nationwide epidemiologic study for Sweden reporting the incidence of proximal humeral fractures and including all inpatient and outpatient visits.

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Keywords Epidemiology · Fracture · Humerus · Proximal

Introduction

Proximal humeral fractures are among the most common osteoporotic fractures [1, 2]. Osteoporosis is one factor affecting the incidence of proximal humeral fractures, and most fractures occur after falling from a standing height [3, 4]. Numerous studies have described the incidence rates of proximal humeral fractures in selected populations, but most include only surgically treated or hospitalized patients [1, 3, 5,

6]. A study by Court-Brown and colleagues of all fractures diagnosed over a period of 1 year revealed an incidence rate of 63 per 100,000 person-years for proximal humeral fractures, representing 5.7 % of all fractures [1]. The mean age of a proximal humeral fracture patient was 65 years with a male to female ratio of 3:7 [1]. The incidence of proximal humeral fractures begins to increase after 50 years of age with a female dominance [7, 8]. The national incidence rate of hospitalized patients with a proximal humeral fracture has increased during the past few decades in Finns aged 60 years or more [9, 10]. One limitation of these previous Finnish studies is that they covered only those patients hospitalized due to proximal humeral fracture and thus did not assess the total incidence of proximal humeral fractures. To our knowledge, the present study is the first nationwide epidemiologic study reporting the national population-based incidence of proximal humeral fractures that includes both inpatient and outpatient cases.

The aims of this nationwide population-based registry study including all inpatient and outpatient visits were to assess the true incidence rates and treatment trends of proximal humeral fractures in Sweden and to determine the possible changes over time in their surgical treatment. We hypothesized that, as suggested by recent studies in Finland, the incidence of proximal humeral fractures has substantially increased [9, 10].

Materials and methods

To investigate the national incidence of proximal humeral fractures, we obtained data from the Swedish Hospital Discharge Register (SHDR) between 2001 and 2012. All adult patients (≥ 18) in the SHDR were included. The Swedish National Board of Health and Welfare established the national register in 1964, and the SHDR has covered national inpatient care since 1987. Outpatient visits have been included in the register since 2001 [11]. The data collected by the SHDR is mandatory for all Swedish hospitals, including private (only inpatient care), public, and other institutions with both inpatient and outpatient settings (surgical day care procedures are reported starting from 1997). However, primary health care data are still not reported on a national level [11]. The registry includes personal identification number, age, sex, domicile of the patient, length of hospital stay, primary and secondary diagnoses, and surgical procedures performed during the hospital stay. Diagnoses in the SHDR were coded with the International Classification of Diseases, Tenth Revision (ICD-10) starting from 1997. The SHDR undergoes routine internal validity checks (missing data, corrupted variables, etc.) by both individual caregivers and by the Swedish National Board of Health and Welfare (Socialstyrelsen), who maintains the database.

Additionally, numerous external validation studies have been conducted on the registry [11].

The main outcome measured in this study was the number of patients hospitalized or treated on an outpatient basis with a diagnosis of proximal humeral fracture on any of the six diagnosis code variables allowed in the SHDR (ICD-10 code S42.2, S42.20, or S42.21) in Sweden between 2001 and 2012.

The secondary outcome measured was the number of surgically treated patients with a diagnosis of proximal humeral fracture. Surgical procedures were assessed using procedural coding according to a Swedish version of the Nomesco (Nordic Medico-Statistical Committee) classification. Procedural codes used were external fixation (NBJ29), fixation with biodegradable implant (NBJ39), wire fixation (NBJ49), intramedullary nail (NBJ59), plate fixation (NBJ69), screw fixation (NBJ79), combination surgery (NBJ89), other fracture surgery (NBJ99), and arthroplasty (NBB09-99). Only de-identified registry data were used in this study. The Regional Ethics Committee of Stockholm approved the study (Dnr 2013/5:6).

Statistical analysis

To compute the incidence rate of proximal humeral fractures and the rate of surgically treated proximal humeral fractures, the annual mid-population data for each calendar year of the study period was obtained from the Official Statistics of Sweden. Official Statistics of Sweden maintains an electronic national registry of the population of Sweden which is subjected to quality control on a yearly basis [12]. The resulting rates (per 100,000 person-years) are based on the results of the entire adult population of Sweden rather than cohort- or sample-based estimates, and thus, 95 % confidence intervals or other statistical estimation methods were not calculated. Statistical analysis was performed using SPSS 22.0.

Results

A total of 98,770 proximal humeral fractures were identified in Sweden between 2001 and 2012. There were 6462 fractures in 2001 and 9298 in 2012. The number of proximal humeral fractures was 26,707 (27 %) in men and 72,063 (73 %) in women. Mean age at the time of injury was 62 years in men and 72 years in women. Mean age at the time of injury decreased from 71 years in 2001 to 69 years in 2012, with a similar change in both sexes.

The overall incidence of proximal humeral fractures increased 31 % from 92.7 per 100,000 person-years in 2001 to 121.9 per 100,000 person-years in 2012. In men, the incidence rate increased 39 % from 49.2 per 100,000 person-years in 2001 to 68.1 per 100,000 person-years in 2012. In women, the incidence increased 30 % from 134.5 per 100,000 person-

years to 174.6 per 100,000 person-years in 2012 (Fig. 1). Although the fracture incidence increased in all age groups, the smallest increase occurred in the 70 years and older population (Table 1).

A total of 17,013 fractures were treated surgically between 2001 and 2012. The number of fractures treated surgically increased from 2001 to 2012. There were 810 fractures that were treated operatively in 2001 and 1552 fractures in 2012. The number of fractures treated operatively was 4892 (29 %) in men and 12,121 (71 %) in women with a male to female ratio of 3:7. Between 2001 and 2012, the mean age at the time of surgery remained constant in men at 60 years of age, while in women, it decreased from 72 years in 2001 to 69 years in 2012.

The overall rate of surgical treatment was 11.6 per 100,000 person-years ($n = 810$) in 2001 and 20.3 per 100,000 person-years ($n = 1552$) in 2012 with an increase of 75 %. In women, the rate increased 82 % from 15.9 per 100,000 person-years ($n = 566$) in 2001 to 29.0 per 100,000 person-years ($n = 1119$) in 2012. In men, the rate increased 61 % from 7.1 per 100,000 person-years ($n = 244$) in 2001 to 11.4 per 100,000 person-years ($n = 431$) in 2012 (Fig. 2). The rate of surgical treatment increased most profoundly in the 50 years and older population (Table 1).

Open reduction and internal fixation (ORIF) with a plate was the most common surgical procedure performed ($n = 5050$, 30 %), followed by arthroplasty ($n = 3962$, 23 %) and intramedullary nailing ($n = 3376$, 20 %). The number and rate of fractures treated with external fixations, screw fixations, or absorbable screw fixations were low during the entire study period; thus, they were excluded from further analysis.

During the entire 12-year study period, there was a clear increase in the number and rate of the two main surgical procedures: rates of ORIF with plate and arthroplasty increased while the rate of intramedullary nailing, the third main surgical procedure, decreased (Fig. 3).

The overall rate of ORIF with plate in 2001 was 0.7 per 100,000 person-years ($n = 47$) and 8.9 per 100,000 person-years ($n = 682$) in 2012, a 12-fold increase. The steepest increase in the rate of ORIF with plate was observed among women aged 60–69 years: from 1.6 per 100,000 person-years ($n = 7$) in 2001 to 30.0 per 100,000 person-years ($n = 178$) in 2012, followed by women aged 70 years and older: from 2.1 per 100,000 person-years ($n = 15$) in 2001 to 28.2 per 100,000 person-years ($n = 197$) in 2012. The increase in the rate of ORIF with plate was profound in women over 50 years of age (Fig. 4).

The overall rate of arthroplasty in 2001 was 2.8 per 100,000 person-years ($n = 198$) and 5.0 per 100,000 person-years ($n = 384$) in 2012, an almost twofold increase. The steepest rise in the rate of arthroplasty was observed among women aged 70 years and older: from 17.1 per 100,000 person-years ($n = 117$) in 2001 to 28.8 per 100,000 person-years ($n = 201$) in 2012, followed by women aged 60–69 years: from 4.7 per 100,000 person-years ($n = 20$) in 2001 to 12.3 per 100,000 person-years ($n = 73$) in 2012. The rate of arthroplasty increased in women over 50 years of age and in men after the age of 60.

The rate of nailing decreased over time, from 3.4 per 100,000 person-years ($n = 236$) in 2001 to 2.8 per 100,000 person-years ($n = 213$) in 2012. In 2012, the proportion of ORIF with plate of all surgical procedures used in the

Fig. 1 Incidence of proximal humeral fractures in Swedish adults per 100,000 person-years between 2001 and 2012

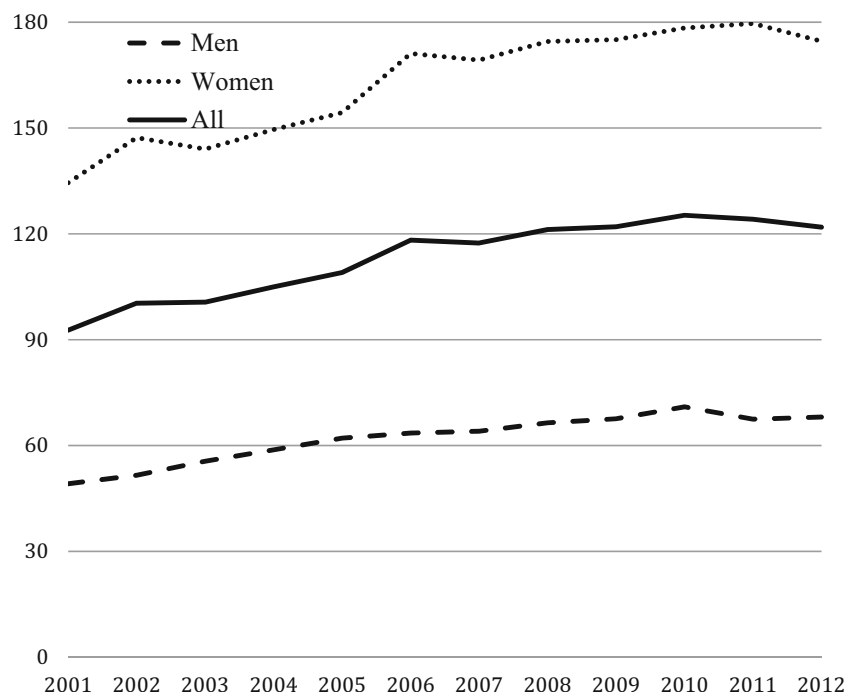


Table 1 Incidence of proximal humeral fractures per 100,000 person-years and rate of surgical treatment per 100,000 person-years in the adult Swedish population in 2001 and 2012

Age groups	Incidence of fracture in 2001 (rate of surgical treatment)	Incidence of fracture in 2012 (rate of surgical treatment)
18–29	9.9 (1.5)	16.4 (1.9)
30–39	15.2 (1.9)	28.1 (3.1)
40–49	31.8 (4.9)	48.9 (7.4)
50–59	61.3 (8.7)	105.6 (18.7)
60–69	118.3 (16.5)	181.9 (39.9)
70 years and older	348.6 (40.3)	380.5 (56.6)

treatment of proximal humeral fractures was 46 % followed by arthroplasty 26 %, intramedullary nailing 14 %, and tension band or pinning 5 %.

Discussion

The principal finding of the present study was that the Swedish national incidence of proximal humeral fractures has been increasing, and no major changes in the trend were observed. The incidence of proximal humeral fractures was 121.9 per 100,000 person-years in 2012, which is significantly greater than the incidence reported in a recent cohort study performed in Tampere, Finland, which demonstrated an incidence of 82 per 100,000 person-years [13] and doubled the rate (61 per 100,000 person-years) reported in a study of all emergency department visits for proximal humeral fractures in the USA [5]. In 2002, the incidence of proximal humeral fractures in Swedes 60 years and older was 266 (per 100,000 persons), more than double the rate (105 per 100,000 person-years) Palvanen et al. reported for Finns

60 years and older in the same year [10]. One possible reason for the difference is that the study by Palvanen et al. did not include proximal humeral fractures treated in the outpatient setting. The present study includes both inpatients and outpatients in Sweden, which may explain why the resulting incidence rates are higher than those in previous studies. In addition, the incidence of proximal humeral fractures appears to vary markedly in Western populations [14].

Proximal humeral fractures are the third most common type of osteoporotic fracture after hip and distal radius fractures [15, 16]. The osteoporotic hip fracture incidence increased over several decades until the late 1990s; after which, the trend shifted and a decrease in the incidence was noted in Finland through the entire first decade of the new millennium [17]. The incidence of osteoporotic hip fractures has plateaued in other Scandinavian countries like Sweden and Norway [18]. Also, Wilcke et al. reported that the rise in the incidence of distal radius fractures in older women has leveled off [19]. In the present study, we found that the incidence of proximal humeral fractures increased in the elderly until it seemingly peaked during 2008–2010; after which, it leveled off. We did

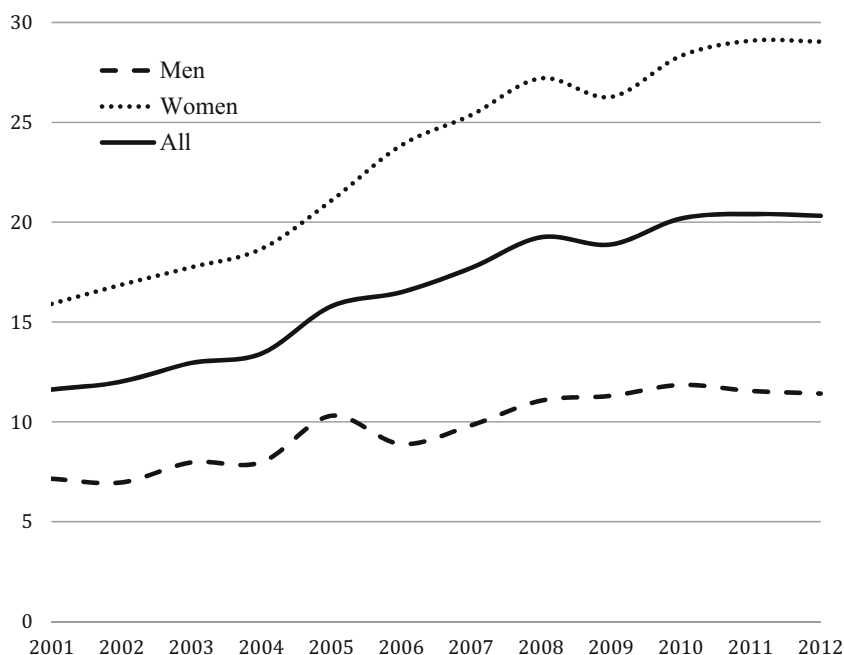
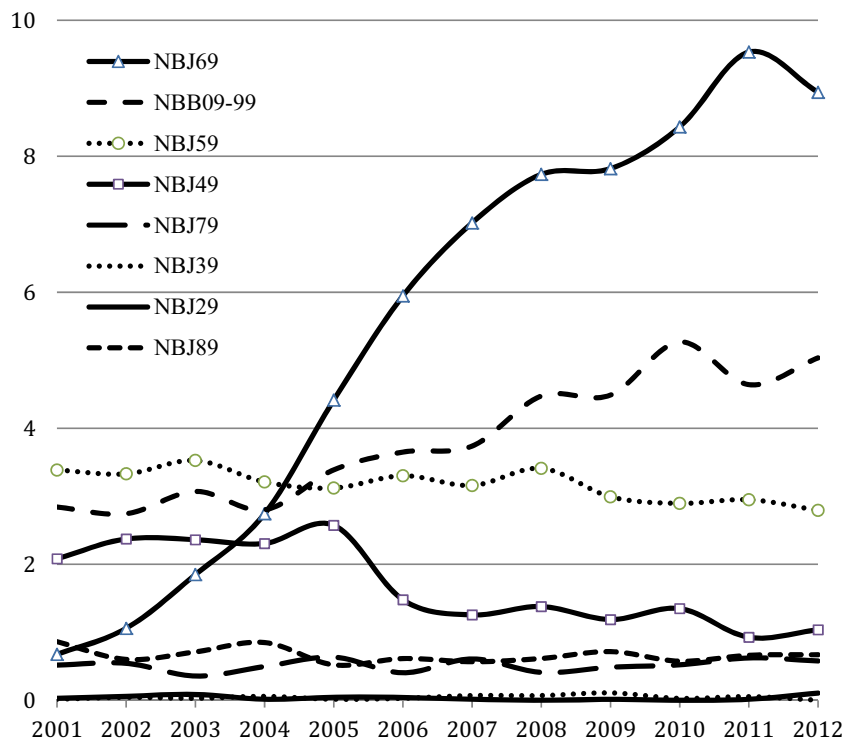
Fig. 2 Surgical treatment rate of proximal humeral fractures in Swedish adults per 100,000 person-years between 2001 and 2012

Fig. 3 Rate of different surgical treatment methods for proximal humeral fractures in Swedish adults per 100,000 person-years between 2001 and 2012. *NBJ69* plate, *NBB09-99* arthroplasty, *NBJ59* nail, *NBJ49* tension band/pinning, *NBJ79* screw, *NBJ39* bioimplant, *NBJ29* external fixation, *NBJ89* other

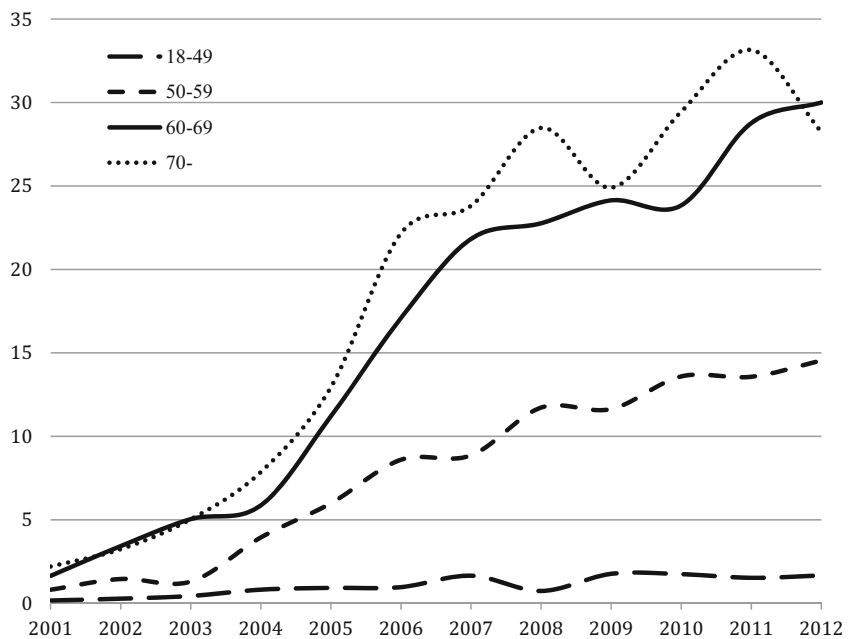


not observe the steep increase anticipated by Palvanen et al. [10]. In fact, we observed that the incidence almost plateaued in all age groups during the last 3 years of our study, and the incidence slightly decreased in patients 60 years of age and older. Additional SHDR years should be surveyed to document whether the trend of proximal humeral fracture incidence in the elderly is similar to other osteoporotic fractures.

The treatment rate of ORIF with plate increased from 0.7 per 100,000 person-years in 2001 to 8.9 per 100,000 person-

years in 2012. Huttunen et al. reported a similar increase of ORIF with plate in Finland from 5.9 per 100,000 person-years in 1998 to 13.9 per 100,000 person-years in 2009 [20]. While plating seemed to be much more common in Finland in 2001, the treatment protocols have since diverged. Indeed, the rate of plating increased more than 12-fold in Sweden between 2001 and 2012 (Fig. 3), while in Finland, it only doubled between 1998 and 2009 [20]. The reason for this exceptionally rapid increase is unknown as there is no high-quality evidence

Fig. 4 Age-specific rate of ORIF with plate for proximal humeral fractures in Swedish female adults per 100,000 person-years between 2001 and 2012.



showing a superiority of plating. In fact, recent randomized controlled trials, systematic reviews, and meta-analyses show equivalent results between surgical and non-surgical treatment of proximal humeral fractures among elderly people [21, 22].

The increase in the incidence of proximal humeral fractures ranged from 9 up to 85 % in different age groups between 2001 and 2012; interestingly, the rate of surgical treatment increased disproportionately in the 50 years and older population (Table 1). The increase in the operative treatment rate of proximal humeral fractures in the 50 years and older population cannot be solely explained by an increase in the fracture incidence.

During the 12 years of our study, the rate of surgically treated proximal humeral fractures increased from 11.6 per 100,000 person-years to 20.3 per 100,000 person-years in 2012. ORIF with plate contributed the most to this rise with its rate going up from 0.7 per 100,000 person-years in 2001 to 8.9 per 100,000 person-years in 2012. To put that in perspective, the percentage of fractures treated by ORIF with plate rose from 6 % in 2001 to 46 % in 2012. Coincidentally, the rate of arthroplasty almost doubled from 2.8 per 100,000 person-years in 2001 to 5.0 per 100,000 persons in 2012, while the rate of other operative procedures decreased (Fig. 3). These findings are in accordance with earlier publications [20, 5]. The overall percentage of conservatively treated fractures declined from 87 % in 2001 to 83 % in 2012.

To our knowledge, this is the first nationwide population-based register study in adults that includes both inpatient and outpatient visits. Thus, we were able to report the true incidence rates and trends in the treatment of proximal humeral fractures. In case of multiple hospitalizations, we included only the first because we were unable to reliably differentiate whether the re-hospitalization was due to a new fracture of the contralateral humerus or a complication, such as a new fracture, in the original humerus. Multi-trauma and open fractures were included to avoid misrepresenting the incidence of proximal humeral fractures in the younger population; this did not significantly affect the accuracy of our reported incidence on osteoporotic proximal humeral fractures in the elderly as can be concluded from a study by Bergdahl et al. in which no more than 8 % of all proximal humeral fractures in the 50 years and older population of the second largest city in Sweden was documented as being due to high-energy trauma; the mean age of proximal humeral fracture caused by high-energy trauma was 56.6 in traffic-related injury and 49.9 in miscellaneous injury [23]. M80- diagnosis and external reason for injury were not included in the analysis as this would have led us to underestimate the overall incidence of proximal humeral fractures.

The SHDR is well known for its accuracy and reliability [11]. The weakness of our study is the lack of information about patient characteristics, fracture classification, and patient-reported outcomes. The total incidence rate may be

slightly underestimated as we included only the first visit (inpatient or outpatient) due to a proximal humeral fracture. Thus, contralateral fractures and re-fractures are lost from our analysis. Another weakness of the present study is that even though the coverage of public in- and outpatient care is excellent (nowadays nearing 100 %), the private hospital outpatient visits are not covered in the register [11].

When considering the merit of surgical treatment in the elderly, one must look at the evidence. A recent systematic review of randomized controlled trials involving two- to four-part proximal humeral fractures in patients over 60 years of age by Launonen and colleagues concluded that non-surgical treatment over locking plate systems and tension banding is weakly supported, and found weak to moderate evidence that in four-part fractures, shoulder function is not better with hemiarthroplasty compared with non-surgical treatment [21]. The reasons for this striking imbalance between clinical practice and current evidence must be further studied.

Conclusion

The Swedish national incidence of proximal humeral fractures increased from 2001 to 2012, though it seems to have peaked in the elderly population during 2008–2010. Although the increase in the surgical treatment rate is clear, the reason for the increase remains unknown. Randomized controlled trials are needed to compare the main three treatment methods (ORIF with plate, arthroplasty, and conservative treatment) in older patients.

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Compliance with ethical standards The Regional Ethics Committee of Stockholm approved the study (Dnr 2013/5:6).

Conflicts of interest None.

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