



# The incidence of proximal humeral fractures in New York State from 1990 through 2010 with an emphasis on operative management in patients aged 65 years or older

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**Background:** Proximal humeral fractures are commonly encountered injuries. The development of locking plate technology and reverse shoulder arthroplasty may have changed the treatment patterns of these fractures.

**Methods:** We used the Statewide Planning and Research Cooperative System database in New York State to determine the incidence of proximal humeral fractures from 1990 through 2010 and the choice of treatment: closed reduction–internal fixation, open reduction–internal fixation (ORIF), hemiarthroplasty (HA), or total shoulder arthroplasty (TSA).

**Results:** The population-adjusted incidence per 100,000 increased from 15.35 in 1990 to 19.4 in 2010 ( $P < .0001$ ). In patients aged 65 years or older, the incidence increased from 78.9 in 1990 to 101.0 in 2010 ( $P < .0001$ ). In 1990, 20.4% of proximal humeral fractures were treated operatively; in 2010, this increased to 28.6% ( $P < .0001$ ). Closed reduction–internal fixation/ORIF accounted for 58.4% of operative cases in 1990, decreasing to 46.6% in 2001 and increasing to 59.4% in 2010. HA was used in 27.1% of operative cases in 1990, increasing to 41% in 2001 and decreasing to 29.4% in 2010. TSA was used in 6.4% of operative cases in 1990, decreasing to 1.5% in 2001 with an increase to 7.5% in 2010.

**Discussion:** The incidence of proximal humeral fractures in patients aged 65 or older increased by 28% between 1990 and 2010, and operative management increased by more than 40%. The use of ORIF increased between 2001 and 2010, corresponding with the use of locking plate technology. There was an associated decrease in HA. TSA increased between 2006 and 2010, corresponding to the use of reverse shoulder arthroplasty.

**Level of evidence:** Epidemiology Study, Database Analysis.

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**Keywords:** SPARCS; proximal humeral fractures; reverse shoulder arthroplasty; closed reduction–internal fixation; open reduction–internal fixation; hemiarthroplasty; total shoulder arthroplasty

We confirm that no institutional review board approval was required for this study because only non-identifiable data were used via authorization from the Statewide Planning and Research Cooperative System database.

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Proximal humeral fractures account for approximately 5% of all fractures; however, in the elderly population, only hip fractures and distal radial fractures are more common.<sup>1,18,28</sup> The increased prevalence of osteoporosis and falls has led to an increasing incidence of proximal humeral fractures in this patient population.<sup>2,19</sup> According

to published reports, 95% of all proximal humeral fractures in elderly women are due to falls from a standing height.<sup>7</sup>

Most proximal humeral fractures are minimally displaced and can be treated nonoperatively with satisfactory results.<sup>11</sup> Operative management options include closed reduction–internal fixation (CRIF) with percutaneous pinning, open reduction–internal fixation (ORIF), humeral head arthroplasty (hemiarthroplasty [HA]), and total shoulder arthroplasty (TSA). The optimal operative management of the elderly patient with a 3- or 4-part fracture remains undefined because of the lack of high-quality comparative studies.<sup>27</sup> The literature predominantly consists of case series, with very few studies comparing specific techniques. A multicenter randomized trial comparing locked plating versus HA is currently under way and should shed more light on the comparative outcomes of these two techniques.<sup>29</sup>

The development of proximal humerus locking plate (PHLP) technology in 2002 expanded the indications for ORIF in patients with osteoporotic bone. Recently, there have been a number of prospective studies showing less-than-desirable results in complex proximal humeral fractures treated with ORIF.<sup>22</sup> Locking plate technology has clearly resulted in an increase in the number of patients undergoing ORIF. In addition, the use of reverse shoulder arthroplasty (RSA) for the treatment of comminuted and displaced proximal humeral fractures has added another treatment option. In this context, we decided to study the epidemiology of proximal humeral fractures in New York State and to evaluate the changing trends in the operative management of proximal humeral fractures over the past 2 decades.

## Methods

The Statewide Planning and Research Cooperative System (SPARCS) database from the New York State Department of Health, a census of all hospital admissions, was used for this study. Since 1982, SPARCS has maintained discharge records for all hospital emergency visits and inpatient hospitalizations submitted, according to the Universal Data Set specifications, by trained personnel in each hospital. The database contains information about the patient's age, race, sex, admission status, cost, physician identifiers, principal and secondary diagnoses, and disposition. SPARCS has been used previously in similar published studies to describe the epidemiology of orthopaedic diagnoses and procedures.<sup>9,15,23,30,31</sup>

Proximal humeral fractures were identified by use of the *International Classification of Disease, Ninth Revision* (ICD-9) codes 812.0X and 812.1X from the years 1990 through 2010. Only patients aged 65 years or older were selected for further analysis in the study because our goal was to evaluate a specific at-risk group, that is, elderly patients with osteoporosis. Operative management of proximal humeral fractures was considered if the patient had either ORIF, CRIF, HA, or TSA identified by *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 79.31, 79.11, 81.81, or 81.80.

Demographic variables, as well as in-hospital death and coincidence of femoral neck fractures and forearm fractures,

identified by ICD-9 codes 820 and 813, respectively, were analyzed within subsets. Continuous variables were compared by use of *t* tests, and categorical variables were analyzed with a  $\chi^2$  test. All statistical analyses were analyzed with SAS software, version 9.3 (SAS Institute, Cary, NC, USA).

## Results

Overall, 70,058 proximal humeral fractures were identified in all age groups between 1990 and 2010 (Table I). Patients aged 65 years or older sustained 50,100 proximal humeral fractures, representing 71.5% of proximal humeral fractures occurring in all age groups (Table I). The population-adjusted incidence of proximal humeral fractures overall increased from 15.35 per 100,000 in 1990 to 19.14 per 100,000 in 2010 ( $P < .0001$ ). In patients aged younger than 65 years, the population-adjusted incidence increased from 5.82 per 100,000 in 1990 to 6.35 per 100,000 ( $P = .05647$ ). In patients aged 65 years or older, 1,851 fractures were reported in 1990 compared with 2,644 fractures in 2010 (Fig. 1). The population-adjusted incidence increased from 78.90 per 100,000 in 1990 to 101.00 per 100,000 in 2010 ( $P < .001$ ) (Fig. 2). The mean age of this cohort population was  $80.29 \pm 7.99$  years. Women represented 79.8%; white patients represented 90.8%, African Americans represented 3.2%, and Asians represented 0.9%.

In 1990, 20.4% of proximal humeral fractures were treated operatively compared with 28.6% of proximal humeral fractures in 2010 ( $P < .0001$ ). ORIF/CRIF represented 58.4% of the surgical cases in 1990, subsequently decreasing to 46.6% in 2001; in 2010, ORIF/CRIF increased to 59.4% of all cases, just surpassing the 1990 level. HA was used in 27.6% of cases in 1990. This increased to 41.0% of cases in 2001 and subsequently decreased to 29.4% in 2010. TSA was used in 6.4% of cases in 1990, decreased to 1.5% in 2006, and increased to 7.5% in 2010. This recent increase correlates with the emergence of RSA as a treatment for displaced proximal humeral fractures (Fig. 3).

The mean age of patients undergoing ORIF and CRIF was  $76.9 \pm 7.4$  years and  $78.8 \pm 7.7$  years, respectively; female patients represented 78.4% in each treatment category. The mean age of patients undergoing HA and TSA was  $77.0 \pm 7.0$  years and  $77.0 \pm 6.8$  years, respectively. Female patients represented 83.6% and 86.2% of cases, respectively. The in-hospital mortality rates after CRIF, ORIF, TSA, and HA were 2.6%, 1.4%, 0.7%, and 0.8%, respectively.

The overall crude in-hospital mortality rate in proximal humeral fracture patients was 4.0%. The in-hospital mortality rate decreased significantly from a peak of 5.9% in 1993 to 3.0% in 2010 ( $P < .0001$ ). The mortality rates were similar in patients who sustained a concomitant radial and/or ulnar fracture and those who did not (4.2% and 4.0%, respectively;  $P = .5599$ ). The mortality rate was significantly higher in patients with concomitant

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