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

Omar Khatib, MD, Ikemefuna Onyekwelu, MD, Joseph D. Zuckerman, MD*

Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, NY, USA

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.

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.

*Reprint requests: Joseph D. Zuckerman, MD, Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, 301 E 17th St, 14th Floor, New York, NY 10003, USA.

E-mail address: joseph.zuckerman@nyumc.org (J.D. Zuckerman).

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. The increased prevalence of osteoporosis and falls has led to an increasing incidence of proximal humeral fractures in this patient population. According
Proximal humeral fractures in elderly patients

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 ± 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 ± 7.4 years and 78.8 ± 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 ± 7.0 years and 77.0 ± 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

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

Most proximal humeral fractures are minimally displaced and can be treated nonoperatively with satisfactory results.31 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.27 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.29

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.22 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.9,15,23,30,31

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 χ² test. All statistical analyses were analyzed with SAS software, version 9.3 (SAS Institute, Cary, NC, USA).
femoral neck fractures compared with patients without concomitant femoral neck fractures (7.1% vs 3.6%, \( P < .0001 \)) (Fig. 4). Male patients had a higher mortality rate than female patients (7.8% vs 3.7%, \( P < .0001 \)), despite an equal rate of concomitant femoral neck fractures (13.3% vs 13.0%).

**Table 1** Incidence of proximal humeral fractures in New York State from 1990 through 2010 with surgical treatment

<table>
<thead>
<tr>
<th>Year</th>
<th>PHFx</th>
<th>PHFx in patients aged ≥65 y</th>
<th>TSA</th>
<th>HA</th>
<th>ORIF</th>
<th>CRIF</th>
<th>Surgical treatment *</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>2,763</td>
<td>1,851</td>
<td>24</td>
<td>104</td>
<td>220</td>
<td>29</td>
<td>20.37%</td>
</tr>
<tr>
<td>1991</td>
<td>2,820</td>
<td>1,932</td>
<td>27</td>
<td>126</td>
<td>234</td>
<td>22</td>
<td>21.17%</td>
</tr>
<tr>
<td>1992</td>
<td>3,234</td>
<td>2,263</td>
<td>27</td>
<td>170</td>
<td>256</td>
<td>44</td>
<td>21.96%</td>
</tr>
<tr>
<td>1993</td>
<td>3,264</td>
<td>2,299</td>
<td>27</td>
<td>173</td>
<td>274</td>
<td>51</td>
<td>22.84%</td>
</tr>
<tr>
<td>1994</td>
<td>3,140</td>
<td>2,172</td>
<td>21</td>
<td>154</td>
<td>278</td>
<td>47</td>
<td>23.02%</td>
</tr>
<tr>
<td>1995</td>
<td>3,181</td>
<td>2,257</td>
<td>22</td>
<td>181</td>
<td>278</td>
<td>50</td>
<td>23.53%</td>
</tr>
<tr>
<td>1996</td>
<td>3,165</td>
<td>2,336</td>
<td>23</td>
<td>188</td>
<td>277</td>
<td>43</td>
<td>22.73%</td>
</tr>
<tr>
<td>1997</td>
<td>3,076</td>
<td>2,203</td>
<td>20</td>
<td>182</td>
<td>294</td>
<td>43</td>
<td>24.47%</td>
</tr>
<tr>
<td>1998</td>
<td>3,074</td>
<td>2,210</td>
<td>21</td>
<td>196</td>
<td>262</td>
<td>51</td>
<td>23.98%</td>
</tr>
<tr>
<td>1999</td>
<td>3,097</td>
<td>2,251</td>
<td>24</td>
<td>207</td>
<td>287</td>
<td>47</td>
<td>25.10%</td>
</tr>
<tr>
<td>2000</td>
<td>3,296</td>
<td>2,385</td>
<td>19</td>
<td>228</td>
<td>307</td>
<td>63</td>
<td>25.87%</td>
</tr>
<tr>
<td>2001</td>
<td>3,325</td>
<td>2,414</td>
<td>20</td>
<td>248</td>
<td>282</td>
<td>55</td>
<td>25.06%</td>
</tr>
<tr>
<td>2002</td>
<td>3,353</td>
<td>2,451</td>
<td>11</td>
<td>239</td>
<td>274</td>
<td>49</td>
<td>23.38%</td>
</tr>
<tr>
<td>2003</td>
<td>3,476</td>
<td>2,523</td>
<td>9</td>
<td>263</td>
<td>331</td>
<td>49</td>
<td>25.84%</td>
</tr>
<tr>
<td>2004</td>
<td>3,526</td>
<td>2,520</td>
<td>12</td>
<td>237</td>
<td>322</td>
<td>63</td>
<td>25.16%</td>
</tr>
<tr>
<td>2005</td>
<td>3,542</td>
<td>2,598</td>
<td>10</td>
<td>249</td>
<td>329</td>
<td>60</td>
<td>24.94%</td>
</tr>
<tr>
<td>2006</td>
<td>3,547</td>
<td>2,551</td>
<td>10</td>
<td>243</td>
<td>362</td>
<td>45</td>
<td>25.87%</td>
</tr>
<tr>
<td>2007</td>
<td>3,852</td>
<td>2,796</td>
<td>16</td>
<td>282</td>
<td>389</td>
<td>42</td>
<td>26.07%</td>
</tr>
<tr>
<td>2008</td>
<td>3,771</td>
<td>2,723</td>
<td>15</td>
<td>273</td>
<td>392</td>
<td>40</td>
<td>26.44%</td>
</tr>
<tr>
<td>2009</td>
<td>3,848</td>
<td>2,721</td>
<td>34</td>
<td>281</td>
<td>408</td>
<td>31</td>
<td>27.71%</td>
</tr>
<tr>
<td>2010</td>
<td>3,708</td>
<td>2,644</td>
<td>57</td>
<td>222</td>
<td>449</td>
<td>28</td>
<td>28.59%</td>
</tr>
</tbody>
</table>

*PHFx*, proximal humeral fractures.  
* Surgical treatment of proximal humeral fractures represented approximately 20% of cases in 1990 and approximately 30% of cases in 2010.

**Figure 1** Overall incidence of proximal humeral fractures (PHFx) in patients aged 65 years or older in New York State from 1990 through 2010. The overall incidence of PHFx in the elderly has increased from 1,851 fractures in 1990 to 2,644 fractures in 2010.
Discussion

Several published reports indicate that the incidence of proximal humeral fractures has been increasing in the elderly population in recent decades. This study provides further support to these previous reports, as shown by the 28% increase in the population-adjusted incidence of proximal humeral fractures in patients aged 65 years or older in New York State over the past 2 decades. Interestingly, the incidence of proximal humeral fractures in...
patients aged younger than 65 years did not increase significantly during the same period. Therefore, the overall increase is more likely attributable solely to the increase in incidence in the elderly population. This is a trend that we expect will continue due to the increased frequency of falls and osteopenia in this population.22

Most of the current epidemiologic literature on proximal humeral fractures in the elderly states that 80% to 85% of fractures are nondisplaced and can be treated nonoperatively.8,11,18,25 Our study indicates that approximately 20% of all reported proximal humeral fractures were treated operatively in 1990; however, this increased to almost 30% in 2010. This trend may represent a tendency toward more aggressive treatment of proximal humeral fractures over the past 2 decades in conjunction with the development of new fixation devices and treatment approaches, or it may indicate that the fractures that occur are increasing in severity in the elderly population. Regardless of the reason for this finding, it does contradict the frequently quoted statistic that only 15% to 20% of proximal humeral fractures are displaced and require operative management.8,11,17,18,21,25

The rate of ORIF steadily decreased from 1990 to 2001 before the introduction of the PHLP; there was a simultaneous rise in the use of HA during this same period. Since the advent of the PHLP, the trend of increasing use of HA has completely reversed. The introduction of PHLP technology extended the indications for ORIF to fractures that may not have been considered suitable previously. Although the impact of this new technology on surgical trends is impressive, the rise in ORIF using PHLP technology has also resulted in a greater number of complications than initially anticipated.26 Thanasas et al26 performed a systematic review of the treatment of proximal humeral fractures with locking plates and showed high incidences of osteonecrosis and screw cutout, as well as high reoperation rates. They concluded that “definition of indications for the use of locking plates and attention to technical aspects of applying them would help optimization of the results.” Spross et al25 recently published a retrospective study in Neer Group VI proximal humeral fractures comparing the PHLP and HA and concluded that there was no difference in Constant-Murley and Short Form 36 scores; however, the fixation group had a much greater revision rate at a minimum follow-up of 12 months (45.5% for PHLP compared with 4.5% for HA).

In 2006, Cazeneuve and Cristofari5 published the first study on the use of reverse TSA for the treatment of acute proximal humeral fractures. Since then, several reports have documented the use of RSA for this indication.3-5,12,14,16,32,33 The data we report certainly indicate this changing treatment approach. Although a specific RSA International Classification of Diseases, Ninth Revision, Clinical Modification code was not introduced until 2010, we believe that it is reasonable to conclude that the 5-fold increase in TSA that we identified was attributable to the use of RSA for acute proximal humeral fractures.

Previous reports have discussed the coincidence of other fractures in this patient population.6,20,24,32 The SPARCS
database showed a total of 5,923 coincident femoral neck fractures, representing 11.82% of all cases. The mortality rate in those patients with a concomitant femoral neck fracture was 7.12% compared with 3.61% in patients without a concomitant femoral neck fracture. Robinson et al. recently published report concluding that hip fractures with associated proximal humeral fractures had higher 30-day, 90-day, and 1-year mortality rates. They stated that such patients were more likely to be frail compared with patients with isolated hip fractures. Clement et al. also reported on the mortality rates of patients with isolated proximal humeral fractures compared with patients with concurrent fractures. They found a 1-year mortality rate of 2.06% in patients with isolated proximal humeral fractures compared with 4.95% in patients with concurrent fractures. Our data are in agreement with these reports, showing that the mortality rate doubled in patients who sustained proximal humeral fractures with concomitant femoral neck fractures. However, the same cannot be said about coincident forearm fractures, where the mortality rate did not increase in our analysis.

Interestingly, in our study, the mortality rate in male patients with proximal humeral fractures was twice that of female patients despite equal rates of coincident femoral neck fractures. There are no studies, to our knowledge, that have examined the severity of proximal humeral fractures in men compared with women, but the higher mortality rate in men suggests that male patients have a higher comorbidity index than their female counterparts. To our knowledge, this is the first study that has identified an increased mortality rate in male patients compared with their female counterparts who sustained this injury.

The limitations of this study are similar to those of any study that uses a large statewide or national database. First, New York State patients diagnosed with proximal humeral fractures outside of New York State would not be captured in this database; similarly, non–New York State patients treated within New York State would have been included. However, this bias should be considered negligible in the context of the overall data.

Second, because an ICD-9 code for RSA was not used until 2010, we made the assumption that the increased use of TSA documented in the later years of this study reflected the increased use of RSA. Although we believe this to be a reasonable assumption, reanalysis of the post-2010 database would be needed to confirm this trend.

Conclusion

The incidence of proximal humeral fractures has significantly increased over the past 20 years in patients aged 65 years or older in New York State. There has been a trend toward increased operative management of these patients with a renewed enthusiasm for ORIF after the introduction of the PHLP. Reports of the successful use of RSA, along with concern about the complications of internal fixation and HA, may certainly be a factor in the 5-fold increase in the use of TSA for proximal humeral fractures. There was a noted increase in the mortality rate in male patients compared with female patients who sustained proximal humeral fractures and in patients with coincident femoral neck fractures but not in patients with coincident forearm fractures.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References