

## Declining incidence of acromioplasty in Finland

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**Background and purpose** — An increased incidence rate of acromioplasty has been reported; we analyzed data from the Finnish National Hospital Discharge Register.

**Patients and methods** — During the 14-year study period (1998–2011), 68,877 acromioplasties without rotator cuff repair were performed on subjects aged 18 years or older.

**Results** — The incidence of acromioplasty increased by 117% from 75 to 163 per 10<sup>5</sup> person years between 1998 and 2007. The highest incidence was observed in 2007, after which the incidence rate decreased by 20% to 131 per 10<sup>5</sup> person years in 2011. The incidence declined even more at non-profit public hospitals from 2007 to 2011. In contrast, it continued to rise at profit-based private orthopedic clinics.

**Interpretation** — We propose that this change in clinical practice is due to accumulating high-quality scientific evidence that shows no difference in outcome between acromioplasty and non-surgical interventions for rotator cuff disease with subacromial impingement syndrome. However, the exact cause of the declining incidence cannot be defined based solely on a registry study. Interestingly, this change was not observed at private clinics, where the number of operations increased steadily from 2007 to 2011.

Shoulder pain is one of the most common musculoskeletal complaints, and rotator cuff disease is considered the leading cause of prolonged shoulder pain and disability (Mitchell et al. 2005). The treatment and morbidity of rotator cuff disorders place a substantial economic burden on society (Mitchell et al. 2005, Oh et al. 2007). Rotator cuff disease is classically considered to be a continuum that ranges from acute inflammation of the tendons to full-thickness rotator cuff tear (Neer 1983).

The etiology of rotator cuff disease is multifactorial, and it has been attributed to both extrinsic and intrinsic mechanisms (Seitz et al. 2011).

Acromioplasty, i.e. subacromial decompression procedure, is the most common surgical operation performed on the shoulder. The usual indication for acromioplasty is Neer stage-II rotator cuff disease with subacromial pain or partial tear of the supraspinatus or infraspinatus tendons (Chaudhury et al. 2010, Papadonikolakis et al. 2011). The operation is performed by partially removing the anterior-inferior surface of the acromion and the subacromial bursa. The procedure can be performed using either an open approach or an arthroscopic approach, which give similar results in the long term (Davis et al. 2010). The effectiveness of surgical management of stage-II impingement has been questioned recently. 3 high-quality randomized controlled trials (RCTs) compared arthroscopic subacromial decompression to supervised exercises and found no statistically significant or clinically relevant differences between surgical and non-surgical treatment (Brox et al. 1999, Haahr et al. 2005, Haahr and Andersen 2006, Ketola et al. 2009, 2013). Acromioplasty has also been used in combination with rotator cuff repair to protect the repaired tendon, although recently it was shown that the results of cuff repair are similar without acromioplasty (Milano et al. 2007, MacDonald et al. 2011).

A rapid and continuous increase in the incidence of acromioplasty has been reported in selected patient cohorts (Vitale et al. 2010, Yu et al. 2010, Papadonikolakis et al. 2011, Judge et al. 2014), but nationwide incidence rates are unknown. Here we conducted a nationwide hospital discharge register-based study in Finland to assess whether the incidence of acromioplasty had changed from January 1998 to December 2011. Our

hypothesis was that the overall incidence of acromioplasty is increasing. We also wanted to assess whether the change in incidence rates in public/non-profit hospitals and private/profit-based hospitals are similar.

## Patients and methods

### Design and setting

We reviewed nationwide data from the Finnish National Hospital Discharge Register (NHDR) for the period 1998–2011. The Finnish National Hospital Discharge Register (NHDR), founded in 1967, is an excellent database for epidemiological studies as it contains data on age, sex, domicile, type of hospital (public or private), length of hospital stay, primary and secondary diagnosis, and operations performed during the hospital stay. Data collection for the Finnish NHDR is mandatory for hospitals, including all public and private institutions. The validity of the NHDR has been found to be good regarding both the coverage and accuracy of data (Mattila et al. 2008, Sund 2012, Huttunen et al. 2014).

### Study population

All inhabitants of Finland aged 18 years or older were included in the study. The operative treatment codes according to the Nomesco Classification of Surgical Procedures were NBG10 (for an open acromioplasty) and NBG15 (for an arthroscopic procedure). Acromioplasties that were associated with either open or arthroscopic rotator cuff repair (procedure code NBL00) were excluded from the analyses due to the secondary nature of acromioplasty compared to rotator cuff repair. During the 14-year study period, 68,877 acromioplasties without concomitant rotator cuff repair were performed on patients aged 18 or older.

### Statistics

The primary outcome variable was the incidence of acromioplasty per  $10^5$  person years by age, sex, and study year. To compute the incidence rates, the annual population size was obtained from the Official Statistics of Finland, which is a statutory, electronic national population register (Statistics Finland 2014). The incidence was based on the size of the entire population of Finland aged 18 and older rather than on cohort-based estimates. Accordingly, confidence intervals were not calculated. Statistical analyses were performed using SPSS software version 22.0.

### Ethics

Ethics approval was granted by the Finnish National Institute of Health and Wellness (Dnr THL/89/5.05.00/2012, dated January 18, 2012).

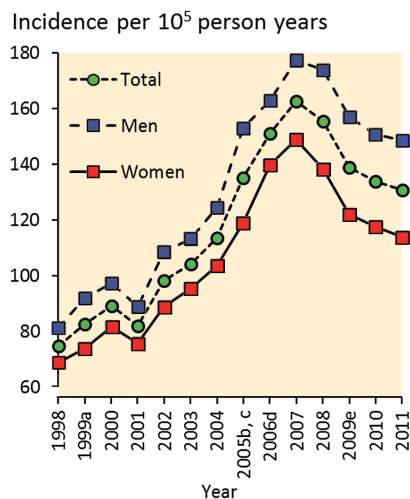


Figure 1. Incidence rates of acromioplasty in Finland, by year. Randomized controlled trials showing equal outcomes for operative and nonoperative treatment of stage-II impingement syndrome were reported by (a) Brox et al. (1999), (b) Haahr et al. (2005), (c) Ketola et al. (2005), (d) Haahr Andersen (2006), and (e) Ketola et al. (2009).

## Results

During the 14-year study period, the mean age of the patients at the time of operation was 52 (SD 10) years. The mean age of men increased from 50 (SD 10) to 53 (SD 11) years, and the mean age of women increased from 51 (SD 9) to 53 (SD 10) years. Over time, there was a consistent shift from open acromioplasty (64% of all acromioplasties in 1998) to arthroscopic procedures (93% in 2011). The mean length of hospital stay was 1.3 (0–32) days.

Between 1998 and 2007, the incidence of operations increased from 75 to 163 per  $10^5$  person years. After 2007, the incidence started to decline, gradually reaching 131 per  $10^5$  person years in 2011 (Figure 1). The incidence rate in men increased from 81 per  $10^5$  person years in 1998 to 177 per  $10^5$  person years in 2007, and then declined to 149 per  $10^5$  person years in 2011. The corresponding figures for women were 69, 149, and 114, respectively. The male-to-female ratio was 1.2 (Figure 1). Similar trends were observed in the 18- to 64-year-old population. The change in incidence of acromioplasty was less dramatic in individuals aged 65 or older (Figure 2).

The incidence rates of acromioplasty in public, non-profit hospitals peaked in 2007 at 137 per  $10^5$  person years and declined steadily thereafter, to 100 per  $10^5$  person years by the end of 2011. In contrast, the incidence in profit-based hospitals increased almost linearly from 5 to 31 per  $10^5$  person years between 1998 and 2011 (Figure 3). In the first year of the study (1998), 93% of acromioplasties were performed in public hospitals and 7% were performed in private hospitals; the corresponding percentages in 2011 were 76% and 24%.

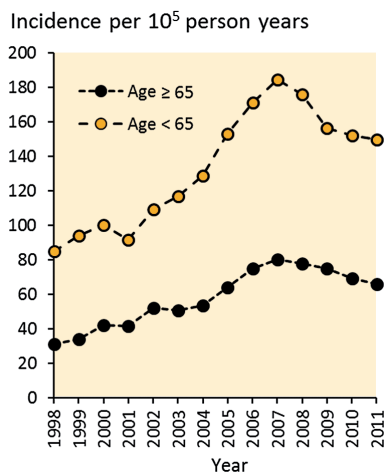


Figure 2. Incidence rates of acromioplasty in Finland by year, according to patient age.

## Discussion

Our main finding was that the overall incidence of acromioplasty increased steadily and more than doubled between 1998 and 2007. After 2007, there was a 20% decline to 131 per 105 person years in 2011. Notably, changes in the nationwide incidence rates of acromioplasty followed the publication of landmark trials showing that the results of operative and non-operative treatment of subacromial impingement syndrome are equal. The incidence of acromioplasty started to decline 1–2 years after papers were published by Haahr and co-workers (2005, 2006) and by Ketola and co-workers (2005). The decline continued following publication of a study by Ketola et al. in 2009 (Figure 1). It has been suggested that a combination of scientific, organizational, and behavioral factors drives changes in clinical practice (Ferlie et al. 1999). However, there were no organizational or economic factors in Finland during this time period that would explain the entire decline. There is evidence that surgical variation results mainly from differences in physicians' beliefs about the indications for surgery, and the extent to which patient preferences are incorporated into treatment decisions. A smaller degree of variation in regional surgery rates is caused by differences in illness burden, diagnostic practices, and patient attitudes to medical intervention (Birkmeyer et al. 2013). We therefore propose that orthopedic surgeons are increasingly practicing evidence-based medicine.

### Strengths and weaknesses

The strengths of our study are that we used reliable nationwide data and that the study population was the entire adult population of Finland. Because of this coverage of the entire country, including both public and private hospitals, the changes in the incidence of acromioplasty are representative of nationwide clinical practice and trends regarding all actively practicing

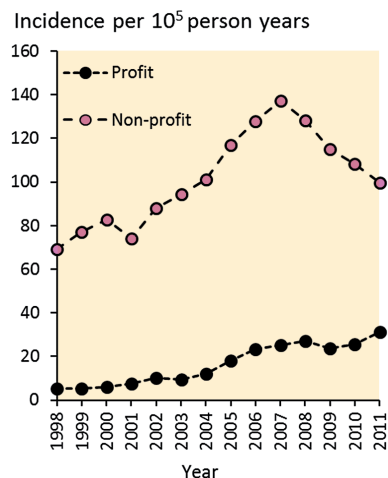


Figure 3. Incidence rates of acromioplasty in Finland by year, in non-profit and profit healthcare organizations.

orthopedic surgeons in Finland. During the study period, there were no changes in diagnostics, in the prevalence of rotator cuff disease, in coding of the surgical procedures, or in the hospital registry that could explain the trend observed. Although the accuracy and coverage of the Finnish NHDR has been found to be excellent regarding hip and knee diseases, there is no specific information about shoulder disorders. However, we assume that the coverage and accuracy are no different from what is seen with knees and hips. A weakness of the study was that NHDR data have not been validated in private healthcare. Also, a confounding factor in the study was that the registry data did not allow us to determine if there was a change in the number of patients with rotator cuff disease who sought treatment at public and private healthcare organizations during the study period. Another weakness is that we are unable to prove that scientific evidence alone has caused the declining incidence of acromioplasty. There may be other factors that influence rates of surgery.

### Relation to other studies

Others have reported a continuous increase in the incidence of acromioplasty in previous patient cohorts. In a cohort in Minnesota, Yu et al. (2010) reported that the incidence of acromioplasty increased over time from rates of 3 per 10<sup>5</sup> persons in the period 1980–1985 to 19 per 10<sup>5</sup> persons in 2000–2005. Vitale et al. (2010) studied a cohort in New York and reported that the incidence of acromioplasty both with and without rotator cuff repair increased from 30 per 10<sup>5</sup> in 1996 to 102 per 10<sup>5</sup> in 2006. In a recent study, the rate of subacromial decompression rose from 5 to 40 per 10<sup>5</sup> between 2000 and 2010 in NHS hospitals across England (Judge et al. 2014). Similar trends of increasing acromioplasty incidence have been reported using data from the Florida Healthcare Cost and Utilization Project's State Ambulatory Surgery Database (HCUP SASD; 170 per 10<sup>5</sup> person years in 2007)

and from the Centers for Medicare and Medicaid Services (CMS) in the USA (95 per 10<sup>5</sup> patients over 65 years of age, in 2006) (Papadonikolakis et al. 2011). These studies were based on highly selected samples, and our study is the first to report nationwide incidence. The increased incidence rate (from 75 to 163 per 10<sup>5</sup> adults per year) in Finland is similar to the rates reported using data from the HCUP SASD and CMS in the USA, but it is substantially higher than rates reported by others. Here we calculated the incidence rates only for those aged 18 years or older. If the entire population had been included, the incidence rates would be approximately 20% lower, ranging from 58 to 129 per 10<sup>5</sup> person years. It was reasonable to exclude individuals younger than 18 years because the incidence of acromioplasty in this population is very low. To our knowledge, we are the first to report a declining incidence of acromioplasty. Judge et al. (2014) reported an increasing incidence in England during almost the same time period. The reasons for the observed variation in incidence are likely to be multifactorial—including patient-based, surgeon-based, and systems-based factors.

#### **Clinical implications and implications for society**

Approximately half of patients who undergo acromioplasty due to rotator cuff disease with shoulder impingement syndrome are also treated using active nonoperative management (Ylinen et al. 2013). Adherence to current recommendations for exercise therapy has been found to be insufficient in clinical practice (Ylinen et al. 2013). While current research shows that operative treatment is not more effective than nonoperative management, a nonoperative approach should be preferred (Brox et al. 1999, Haahr et al. 2005, Haahr and Andersen 2006, Coghlan et al. 2008, Ketola et al. 2009, Ketola et al. 2013). Several randomized, controlled studies have shown that a progressive exercise therapy regimen that focuses on training of the rotator cuff and scapular muscles together with specific stretching exercises is effective in improving shoulder function and in reducing pain (Holmgren et al. 2012, Kromer et al. 2013, Struyf et al. 2013). The mechanism is presumed to be related to an increased range of movement and strength, which helps normalize scapulohumeral function.

Public healthcare in Finland is provided by the community, and is open to every person at a minimal cost. Surgeons receive a fixed monthly salary. People are also free to use private healthcare, in which the costs are paid for by insurance companies, employers, or by the patients themselves; in this system, surgeons receive extra fees for each operation. Interestingly, the change in the incidence of acromioplasty during the past few years has been bidirectional and appears to be associated with the type of hospital (non-profit or profit-based). A remarkable downward trend in the incidence of acromioplasty was observed in public, non-profit healthcare organizations, whereas the incidence continues to rise at private, profit-based healthcare institutions (a 490% increase over 14 years). One explanation for these contrasting trends is that there may have

been a change in the proportion of patients seeking treatment for shoulder problems in private hospitals rather than public hospitals. The absolute number of operations is likely to rise if more patients seek treatment at private orthopedic clinics, even if there are no changes in the indications for surgery. Furthermore, the Ministry of Social Affairs and Health in Finland published uniform criteria for referral to non-emergency treatment in public special healthcare regarding rotator cuff disease in 2009 (Ministry of Social Affairs and Health 2010). It is thus possible that some patients may have been denied access to a public hospital through adoption of the new guidelines, and elected to be treated by the private sector instead. However, the incidence of acromioplasty started to decline already in 2007, before these guidelines were available. Another explanation is the possible influence of financial interests on clinical practice in private hospitals, since the income of both the hospital and the orthopedic surgeon is related to the number of operations. In public hospitals, there is no such relationship between income and operations.

#### **Conclusions**

We observed a declining incidence of acromioplasty. The exact reason for this change cannot be defined based on registry data alone. This decline was not observed in private orthopedic clinics, where the incidence rates have continued to increase even in recent years. The possible influence of the type of practice (profit or non-profit) on the decision to recommend surgery or nonoperative management for rotator cuff disease merits further investigation.

JP: design of study, acquisition of data, analysis and interpretation of data, and writing of the manuscript. VL: design of study, interpretation of data, and critical revision of the manuscript. JK, JY, and VÅ: interpretation of data and critical revision of the manuscript. VM: design of study, acquisition and interpretation of data, and critical revision of the manuscript.

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