



Clavicle fractures do not increase the occurrence of later subacromial pain syndrome. A registry-based case-control study with 15-25 years of follow-up of 131.838 persons from the Danish National Patient Register



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Background: A clavicle fracture often changes the mechanical axes of the shoulder girdle due to displacement and shortening, potentially leading to scapular protraction and decreased subacromial space. If protraction of the scapula is a major risk factor for developing subacromial pain syndrome (SAPS), a previous clavicle fracture could increase the risk of later SAPS. The purpose of this study was to investigate if a previous clavicle fracture correlates with a higher occurrence or earlier diagnosis of SAPS. **Methods:** In this retrospective case-control study with data from the Danish National Patient Register, all persons aged 18-60 years, with any hospital contact due to a clavicle fracture (DS420) between January 1, 1996, and December 31, 2005, were identified as cases. For each case, five controls, matched on age and sex, were identified. Primary outcome was the first hospital contact with a SAPS diagnosis (DM751-755) registered more than 180 days following the fracture. Follow-up was until November 01, 2021.

Results: 21.973 cases and 109.865 controls were included. The incidence of clavicle fractures was 76 fractures per 100.000 persons per year. Twenty-three percent were female. 1.640 (7.46%) cases and 8.072 (7.35%) controls received a SAPS diagnosis within the following 15-25 years, demonstrating no significant difference in the occurrence of SAPS ($P = .56$). The mean time from fracture to SAPS diagnosis was shorter for cases compared to controls (4040 vs. 4442 days, $P < .001$), and cases were slightly younger when receiving the diagnosis (51.3 vs. 53.6 years, $P < .001$). 1614 cases underwent surgical fixation. This subgroup had a statistically significant higher occurrence of later SAPS diagnosis (205 cases, 13%, $P < .001$). **Conclusions:** Persons with a previous clavicle fracture did not have an increased occurrence of receiving a SAPS diagnosis compared to matched controls. However, the diagnosis was given 1-2 years earlier for people with a previous fracture. Based on these findings, no strong argument for protraction of the scapula as a major risk factor for the development of SAPS was found.

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The study was approved prior to onset of the study by the local research committee (Videnscenter for Dataanmeldelser, Region Hovedstaden, journal no. P-2020-1178).

Data availability statement: Data are available via the Danish National Patient Registry but require specific approval for obtaining data. Specific data request forms with specified variables and help obtaining data are available at reasonable request from Anne Marie Nyholm.

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Subacromial pain syndrome (SAPS)¹⁸ is the most common shoulder diagnosis.^{1,17} The etiology is not fully understood but is believed to be multifactorial. Many potential risk factors for the development of SAPS have been suggested. Narrowing of the subacromial space, leading to impingement and irritation of the subacromial structures, is one of the predominant theories. Narrowing of the subacromial space occurs as a consequence of scapular protraction, as demonstrated by magnetic resonance imaging.¹⁶ Several studies have noted significantly altered scapular kinematics in patients with SAPS,^{5,7,15} further pointing toward scapular dysfunction being an important risk factor for the

development of SAPS. However, these findings have been observed in patients already diagnosed with SAPS and it has not been possible to determine if the observed altered scapular kinematics are causative or a consequence of SAPS.^{6,8} A possible correlation between scapular protraction and the later development of SAPS has never been investigated thoroughly or with long-term follow-up.

Clavicle fractures are common, with reported frequencies of approximately 30 fractures per 100,000 population per year. Due to the divergent pull from the muscles attached to the clavicle, a displacement of the fracture will often result in shortening of the clavicle. It is estimated that more than 60% of clavicle fractures are displaced.¹⁴ If left uncorrected, the shortening will be permanent. This may lead to changes in the mechanical axes of the shoulder joint, resulting in protraction and winging of the scapula.⁴ Assuming that scapular protraction is a risk factor for the development of SAPS, a clavicle fracture with shortening increases the risk of later development of SAPS.

The primary purpose of this study was to investigate if a previous clavicle fracture correlates with a higher occurrence, or earlier diagnosis, of SAPS. The secondary purpose was to evaluate if osteosynthesis of the clavicle fracture had any impact on this occurrence.

Materials and methods

Study design and data collection

This study is a case-control study based on registry data from the Danish National Patient Registry. It is mandatory for all hospitals in Denmark to report each patient contact (emergency visits, outpatient clinic visits, and admissions) with a specific diagnosis for the contact.²

To include as many data points as possible, data on all available contacts age 18–60 years, including emergency department contacts, admissions, and outpatient clinic visits, registered in the national patient registry (Landspatientregisteret, LPR) from January 1, 1996, to December 31, 2005, with a contact diagnosis of a clavicular fracture, DS420 (International Classification of Diseases [ICD]-10), were collected as cases. For each case, 5 controls, matched for age (born within the same calendar year) and sex, were included. All included persons were without any previous diagnosis of a fracture in the shoulder, dia810*, dia811*, or dia812* (ICD8, before 1994) or DS42* (ICD10, after 1994).

Any later contact with an ICD-10 diagnosis of DM751 Rotator cuff syndrome, DM751A Supraspinatus syndrome, DM751B Tendinitis supraspinata, DM751C Ruptura non traumatica tendinis supraspinati, DM752 Bicipital tendinitis, DM753 Calcific tendinitis of shoulder, DM753A, Calcified bursa of the shoulder, DM754 Impingement syndrome of the shoulder, DM755 Bursitis of shoulder, DM755A Subacromial bursitis, were collected for all cases and controls.

Data on population size at risk during the inclusion period were collected from Danmarks Statistik (www.statistikbanken.dk), which holds demographic information on all Danish citizens.

Data were collected on November 1, 2021.

Primary outcome was defined as a contact with the diagnosis of DM751–DM755 more than 180 days following fracture diagnosis (SAPS diagnosis).

Data analysis

Data outcome was compared using paired *t*-test or chi-square test. All data handling was performed in R Studio (Boston, MA, USA).¹²

Results

131,838 unique persons were included in the study; 21,973 cases with a fracture to the clavicle in the inclusion time period, with 109,865 matched controls. Twenty-three percent were female. The fracture frequency was stable across the age groups, with no marked decline with increasing age (Fig. 1).

During the inclusion period, the population aged 18–60 ranged between 2,800,000 and 2,950,000. The incidence of clavicle fracture for persons aged 18–60 was 76 per 100,000 person-years.

During the 15–25-year follow-up, 1,640 (7.46%) cases and 8,072 (7.35%) controls received a SAPS diagnosis (Table I), demonstrating no significant difference between the cases and the controls ($P = .56$).

The mean time from fracture to SAPS diagnosis was shorter for cases compared to controls (4040 vs. 4442 days, $P < .001$), and cases were slightly younger when receiving the diagnosis (mean age 51.3 vs. 53.6 years, $P < .001$, Table I, Fig. 2). The distribution of time of diagnosis was comparable in the two groups indicating that the younger mean age of the cases was not due to differences in the distribution of the time of diagnosis (Fig. 2).

Of the 21,973 included cases, 1,614 (7.35%) underwent surgical fixation, 643 as primary treatment within 21 days of fracture, 334 within 22–180 days, 251 within 181–365 days, and 386 later than 365 days following initial fracture diagnosis. The cases that underwent surgical fixation had a statistically significant higher occurrence of SAPS diagnosis later in life (205 cases, 12.7%, $P < .001$, Table II). This higher occurrence was mainly driven by cases who underwent surgery later than 21 days from fracture with an occurrence of SAPS of only 9% for cases who underwent surgery within 21 days (Table II).

Discussion

In this nationwide, retrospective, registry-based cohort study with 15–25 years of follow-up, no increased occurrence of SAPS following a clavicle fracture was found. However, persons with a previous clavicle fracture did receive a SAPS diagnosis 1–2 years earlier than persons without a previous fracture. This could be because scapular protraction is not a direct causative factor for the development of SAPS, but it may accentuate a pathophysiological process in predisposed individuals. These findings seem to challenge the current etiological understanding of SAPS in suggesting that scapular protraction is not a major contributing factor for the development of SAPS.

Another important finding of our study is the high occurrence of SAPS (7.46% in cases and 7.35% in controls) during the follow-up. This correlates to one in thirteen in the working population being diagnosed with SAPS within a time period of 15–25 years. As SAPS is a common reason for sick leave, these findings emphasize the importance of further research to understand and, if possible, reduce the risk of developing SAPS.

Clavicle fracture and protraction of the scapula

SAPS is characterized by insidious onset of pain and most likely takes years to develop. Due to its slow development and multifactorial origin, it is challenging to investigate scapular protraction as a possible risk factor in a prospective study with sufficient power. Similarly, it is challenging to investigate scapular protraction retrospectively because it may not be possible to determine whether the protraction was present prior to or has developed as a consequence of SAPS.^{6,8} Furthermore, a clear definition of protraction of the scapula is lacking, making planning and performing a study of the possible correlation difficult.

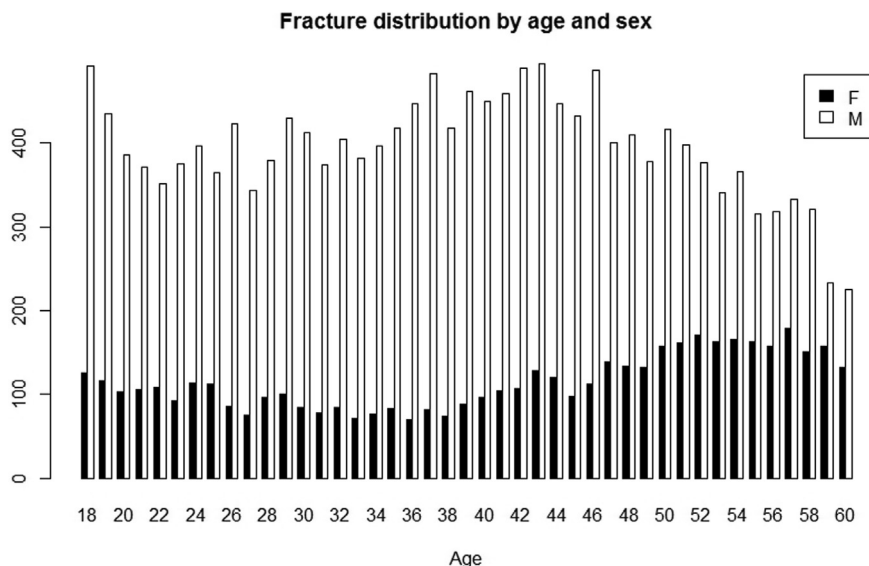


Figure 1 Age and sex of cases with clavicular fracture.

Table 1
Number and timing of a later diagnosis of SAPS following a diagnosis of a clavicular fracture for cases and controls.

	Cases	Controls	Total
Number of persons	21.973	109.865	131.838
SAPS diagnosis later than 180 days after fracture diagnosis	1.640 (7.46%)	8.072 (7.35%)	9.712 (7.37%)
Time from fracture to diagnosis			
Median (d)	3.994	4.489	
Mean (d)	4.040	4.442	
Age at the time of SAPS diagnosis (y)			
<20	0 (0.00%)	1 (0.00%)	1 (0.00%)
20-24	12 (0.05%)	31 (0.03%)	43 (0.03%)
25-29	37 (0.17%)	123 (0.11%)	160 (0.12%)
30-34	73 (0.33%)	239 (0.22%)	312 (0.24%)
35-39	127 (0.58%)	466 (0.42%)	593 (0.45%)
40-44	209 (0.95%)	781 (0.71%)	990 (0.75%)
45-49	241 (1.10%)	1.089 (0.99%)	1.330 (1.01%)
50-54	284 (1.29%)	1.433 (1.31%)	1.717 (1.30%)
55-59	284 (1.29%)	1.443 (1.31%)	1.727 (1.31%)
60-64	182 (0.83%)	1.168 (1.06%)	1.350 (1.02%)
65-69	102 (0.46%)	769 (0.70%)	871 (0.66%)
70-74	63 (0.29%)	392 (0.36%)	455 (0.35%)
>74	26 (0.12%)	137 (0.12%)	163 (0.12%)

SAPS, subacromial pain syndrome.

To mitigate these concerns, this study was designed as a registry-based study with as long a follow-up as possible, which was 15–25 years in our setting. Since scapula protraction is not systematically registered, a previous clavicle fracture was chosen as a surrogate variable for protraction of the scapula, as the presence of a clavicle fracture is a well-defined diagnosis with well-validated clinical and radiological tests, and it is systematically registered in the Danish National Patient Registry.

An assumption for this study is that the clavicle fracture leads to scapula protraction. Postacchini et al found that 65% of clavicle fractures are displaced and that >80% of all clavicle fractures are located midshaft.¹¹ Furthermore, Rasmussen et al have demonstrated that shortening of the clavicle is to be expected in midshaft clavicle fractures.¹³ Hillen et al have demonstrated, in a cadaveric setup, that shortening of the clavicle leads to protraction of the scapula.⁴ Based on these previous findings, we estimate that at least

50% of the included cases would have some degree of shortened clavicle fracture, and therefore scapular protraction. That not all included cases can be expected to have shortening introduces bias of a type two error, the risk of overlooking a possible association. However, based on the size of the material, a detectable signal between cases and controls would be expected if protraction was a major risk factor for later SAPS.

Effect of surgical treatment of clavicle fractures on occurrence of SAPS

The cases who underwent surgical treatment of their clavicle fracture within 21 days had the same occurrence of SAPS as cases treated without surgery, while cases who underwent surgery later than 21 days had a higher occurrence of SAPS. It is likely that patients treated with surgical fixation within 21 days are selected for surgery based on the severity of the fracture, whereas patients treated with surgery later than 21 days are selected for surgery due to complications to the primary nonoperative treatment. Due to the biased populations, we are reluctant to draw conclusions regarding the effect of surgery on the later occurrence of SAPS.

Clavicle fracture incidence

Clavicle fractures have previously been described as a fracture of young males and middle-aged females, with a clear decrease in incidence with increasing age.^{10,14} In this study, we did confirm that only 1 in 5 fractures occur in females, but no clear decline in incidence was seen with increasing age. The incidence of 76 clavicle fractures per 100.000 persons per year is higher than previously reported.^{10,14}

The high incidence could be due to the fact that only the part at risk of inclusion in our study, ages 18–60, was considered in the calculation and not the entire population. Another explanation could be another pattern of injuries compared to the populations described in previous studies. Denmark is a “cycling nation” where everybody owns and uses a bike on a regular basis through all ages. Cycling has previously been shown as the most common injury mechanism for clavicle fractures and acromioclavicular joint dislocations.^{3,9} This may also explain the stable distribution across the age intervals.

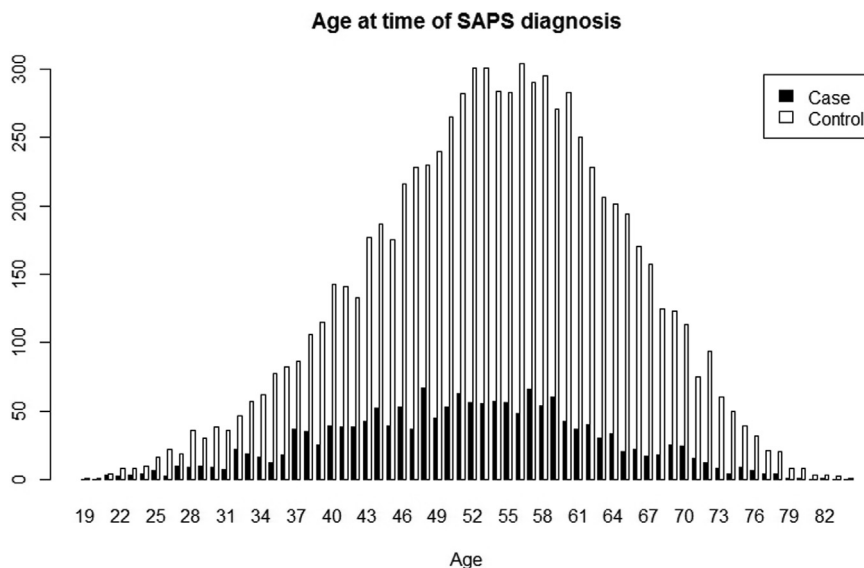


Figure 2 Age at the time of SAPS diagnosis. SAPS, subacromial pain syndrome.

Table II Patients who underwent surgical fixation with regard to later SAPS diagnosis.

Days from fracture to surgery	Later SAPS	No later SAPS	Total
0-21	58 (9.0%)	585 (91.0%)	643 (39.8%)
22-180	47 (14.1%)	287 (85.9%)	334 (20.7%)
180-365	39 (15.5%)	212 (84.5%)	251 (15.6%)
365-700	28 (16.4%)	143 (83.6%)	171 (10.6%)
>700	33 (15.3%)	182 (84.7%)	215 (13.3%)
Total	205 (12.7%)	1.409 (87.3%)	1.614 (100.0%)

SAPS, subacromial pain syndrome.

Strengths and limitations of the study

The registry setup comes with inherent strengths and limitations. A strength of the setup is the possibility to evaluate the influence of a rare complication with a medium-sized effect occurring many years after the primary event. No other setup allows for this. A strength of the present study is the high number of included cases and the long follow-up with matched controls allowing for the abovementioned analyses. The most important limitation in the present study is the inability to select a clean population of cases, introducing a bias toward a type two error. However, as previously discussed, the size of the material partly compensates for this limitation. Also, we have no validation of the given diagnoses (both fracture and later SAPS), we have no data on the fracture pattern or the result of the chosen treatment, and we have no information about shoulder problems prior to inclusion or new injuries.

Conclusion

Clavicle fractures were not correlated to an increased occurrence of later diagnosis of SAPS. However, the diagnosis was given 1-2 years earlier for people with a previous fracture. The results do not suggest protraction of the scapula as a major risk factor for the development of SAPS.

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