**Accuracy of placement of ultrasound-guided corticosteroid injection for subacromial pain (impingement) syndrome does not influence pain and function: secondary analysis of a randomised controlled trial**

**Abstract**

**Objectives:**

To investigate whether the accuracy of placement of ultrasound-guided (US-guided) corticosteroid injections for subacromial pain (impingement) syndrome (SAPS) influences pain and function outcomes.

**Methods:**

This was a secondary analysis of data collected in a previous randomised controlled trial (RCT). Video images of US-guided subacromial corticosteroid injections delivered in the RCT were reviewed to categorise injection accuracy into three groups: definitely/probably not in the subacromial bursa (Group 1); probably in the subacromial bursa (Group 2); and definitely in the subacromial bursa (Group 3). The primary outcome was the Shoulder Pain and Disability Index (SPADI) total score. Secondary outcomes included SPADI pain and function subscales and participants’ self-reported global impression of change. Outcomes were compared between the accuracy groups after adjusting for pre-selected baseline characteristics.

**Results:**

US-guided injection accuracy data were available for 114 participants: 22 categorised into Group 1, 21 into Group 2 and 71 into Group 3. There were no significant differences in mean total SPADI scores between the three injection accuracy groups at 6 weeks (Group 2 versus 1: 8.22 (95% CI -4.01, 20.50); Group 3 versus 1: -0.57 (95% CI -10.27, 9.13) or 6 months (Group 2 versus 1: 12.38 (95% CI -5.34, 30.10); Group 3 versus 1: 3.10 (95% CI -11.04, 17.23).

**Conclusions:**

The accuracy of injection placement in SAPS did not influence pain and function, suggesting that improvements in patients’ outcomes using subacromial corticosteroid injections can be achieved without US guidance.

**Keywords:**

“subacromial pain syndrome”; “corticosteroid injection”; “shoulder pain”; “ultrasound”

**Introduction**

Painful shoulder problems are a common cause of impaired function, affecting 1 in 3 adults (Chard, Hazleman, Hazleman, King, & Reiss, 1991; Picavet & Schouten, 2003). Subacromial pain (impingement) syndrome (SAPS) is the most common cause of shoulder pain, comprising of approximately half of all shoulder pain sufferers (van der Windt, D A, Koes, de Jong, & Bouter, 1995). SAPS typically presents with pain during arm elevation and is thought to arise as a result of bony abnormalities, rotator cuff weakness, impaired scapulohumeral rhythm, scapular instability and poor posture (Bigliani & Levine, 1997; Hanchard et al., 2012; Roddy et al., 2014).

Corticosteroid injections are commonly used to reduce pain and inflammation associated with SAPS although there is debate about their efficacy (Akbari, Ozen, Senlikci, Haberal, & Cetin, 2020). Traditionally, needle placement is guided by palpation of anatomical landmarks. Inefficacy of corticosteroid injections has been attributed to inaccurate placement. Studies of large joints such as the shoulder and knee demonstrate that the accuracy of injection placement varies from 26% to 93% (Jackson, Evans, & Thomas, 2002; Jones et al., 1993; Sethi, Kingston, & Elattrache, 2005; Sethi & El Attrache, 2006). Consequently, guidance of injections with ultrasound (US) has been recommended to increase accurate needle placement for diagnostic and therapeutic purposes as well as safety (Caglar-Yagci, Unsal, Yagci, Dulgeroglu, & Ozel, 2005; Carson & Wong, 1999; Qvistgaard et al., 2001).

However, it is still uncertain whether accuracy of corticosteroid injection for SAPS influences pain and function outcomes (Aly, Rajasekaran, & Ashworth, 2015; Sage, Pickup, Smith, Denton, & Toms, 2013). A systematic review reported greater improvements in pain, function and range of movement from US-guided corticosteroid shoulder injections than unguided injections, although in the included trials, eligibility criteria were heterogeneous, sample sizes were small, follow-up duration was short, and between-group differences were modest (Sage et al., 2013). Another systematic review also found that US-guided subacromial injections led to greater improvement in pain and function than landmark-guided injections, however it identified only three studies comparing pain and function outcomes between US-guided and landmark-guided subacromial injections and there was no difference in placement accuracy between the two approaches, based on a single study (Aly et al., 2015). More recently, the SUPPORT randomised trial showed that US-guided corticosteroid injections conferred no additional benefit over unguided corticosteroid injections for SAPS (Roddy et al., 2021).

Despite this conflicting evidence, US is increasingly used to guide therapeutic joint injections as it is relatively low cost and can be carried out quickly and safely at the bedside (Grassi, Filippucci, & Busilacchi, 2004; Nazarian, 2008). The primary aim of this secondary data analysis was to investigate whether the accuracy of subacromial corticosteroid injection influences pain and functional outcomes in patients with SAPS.

**Materials and Methods**

*Study design*

This secondary analysis used data from the SUPPORT trial (Roddy et al., 2021), a 2x2 factorial randomised controlled trial, which compared the clinical and cost-effectiveness of (1) US-guided corticosteroid injection with unguided corticosteroid injection, and (2) a physiotherapist-delivered individualised, supervised and progressed exercise programme with provision of a standardised advice and exercise leaflet, for treatment of adults with SAPS. The trial protocol and results have been published previously (Oppong et al., 2021; Roddy et al., 2014; Roddy et al., 2021). Ethical approval was obtained from XXXX and all patients provided written informed consent.

Participants were recruited from two NHS community musculoskeletal services in Staffordshire, England. A diagnosis of SAPS required pain in the deltoid insertion area, positive Neer or Hawkins-Kennedy tests, and pain on shoulder abduction. Participants were randomised on a 1:1:1:1 basis to one of four treatment arms: (1) US-guided subacromial corticosteroid injection and physiotherapist-led individualised, supervised and progressed exercise, (2) US-guided subacromial corticosteroid injection and an advice and exercise leaflet, (3) unguided subacromial corticosteroid injection and physiotherapist-led individualised, supervised and progressed exercise, or (4) unguided subacromial corticosteroid injection and an advice and exercise leaflet. This analysis used data from participants who received an US-guided subacromial corticosteroid injection, i.e arms 1 and 2.

*US-guided subacromial corticosteroid injection*

US-guided subacromial corticosteroid injection was performed by a rheumatologist, rehabilitation medicine specialist, extended scope physiotherapist, musculoskeletal sonographer or GP with a special musculoskeletal interest who had either extensive clinical experience in performing US-guided injections or who had completed an accredited course on this procedure. All attended a half-day injection protocol workshop and passed a clinical competency test by a consultant musculoskeletal sonographer (AH). The participant sat with the shoulder internally rotated and the ipsilateral hand on the buttock to maximise visibility of and access to the subacromial bursa. The transducer was placed anterolaterally, the hypoechoic subacromial bursa visualised, and a 21G needle inserted under real-time US guidance until the needle-tip entered the bursa. A commercially available pre-mixed solution of methylprednisolone 40 mg and 1 mL 1% lidocaine was injected into the bursa.

*Accuracy stratification*

Dynamic ultrasound video images of all US-guided subacromial injections performed were reviewed by a consultant sonographer (AH) who categorised the accuracy of injection placement into one of the following categories: 1) definitely not in the subacromial bursa, 2) probably not in the subacromial bursa, 3) probably in the subacromial bursa, and 4) definitely in the subacromial bursa. Accuracy of injection placement was determined by seeing the needle-tip within the bursa and subsequent distension of the bursa with injectate.When visualisation of the needle tip was not possible due to attenuation of the beam by surrounding soft tissues but distension of the bursa was evident, these were labelled as 'probably in the subacromial bursa’. In videos where it was not possible to see the needle tip or distension of the bursa, a label of 'probably not in the subacromial bursa' was given. Videos were labelled as 'definitely not in the subacromial bursa' when the needle tip and injectate were seen outside the bursa.

*Data collection*

Baseline data were collected on socio-demographic characteristics including age, gender, body mass index (BMI) calculated from self-reported height and weight, smoking status (previously smoked or currently smoking) and living arrangements. The following clinical characteristics were also collected at baseline: body pain location derived from a pain manikin (Lacey, Lewis, Jordan, Jinks, & Sim, 2005), diabetes, general health status (Short Form-12 (SF-12) physical (PCS) and mental component scores (MCS)) (Brazier & Roberts, 2004; Ware, Kosinski, & Keller, 1996); and participants’ treatment experiences, preferences and expectations (having had a previous steroid injection, preference for corticosteroid injection with or without US, and expectation of improvement of their shoulder problem with US-guided or unguided subacromial corticosteroid injection).

Outcome measures were collected by questionnaires at the baseline visit and then postally at 6 weeks and 6 months. The primary outcome was the Shoulder Pain And Disability Index (SPADI) total score (Roach, Budiman-Mak, Songsiridej, & Lertratanakul, 1991). Secondary outcomes included in this analysis were the SPADI pain and disability subscores and participants’ self-reported global impression of change (van der Windt, D A et al., 1998).

*Statistical analysis*

Owing to small numbers, the ‘definitely not in the subacromial bursa’ and ‘probably not in the subacromial bursa’ groups were combined into one category, resulting in three accuracy groups: definitely/probably not in the subacromial bursa (Group 1); probably in the subacromial bursa (Group 2); and definitely in the subacromial bursa (Group 3).

Baseline socio-demographic characteristics, clinical characteristics and outcome measures were summarised using descriptive statistics (mean and standard deviation (SD) for continuous variables and frequency and percentage for categorical variables). Mixed-effect models (linear for SPADI total and subscale scores and logistic for dichotomised global assessment of overall change) were used to generate the effect of accuracy of US-guided subacromial corticosteroid injection on the outcomes at 6 weeks and 6 months, adjusted for *a priori* selected baseline socio-demographic and clinical characteristics (age, gender, BMI, previous steroid injection, expectation of unguided steroid injection on shoulder pain improvement, SF-12 physical component summary scores, presence of widespread pain measured by the Manchester Widespread Pain criteria (MacFarlane, Croft, Schollum, & Silman, 1996) and exercise treatment allocation). The mixed models utilised all available follow-up data and included an interaction between the accuracy of injection placement categories and the time-point at which the effect of accuracy was measured to estimate effects at each time-point. Group 1 (“definitely/probably not in the subacromial bursa”) was used as the reference category for the accuracy groups. Results were presented as treatment effects (difference in mean SPADI scores between Groups 2 and 3 and the reference category (Group 1), 95% confidence interval (CI)). For global impression of change, the odds (odds ratio, 95% CI) of participants reporting being completely recovered or much better was compared with being somewhat better, about the same, somewhat worse or much worse (van der Windt, D A et al., 1998). All tests were performed at 5% significance level. Analyses were performed using Stata V.14 (StataCorp).

**Results**

In the SUPPORT trial (Roddy et al., 2021), 256 participants were randomised: 64 to each arm. Of the 128 participants randomised to the two US-guided injection arms, 114 had video images taken during­ the corticosteroid injection and were included in this analysis.

*Baseline characteristics*

Participants’ mean (SD) age was 54.8 (10.4) years, 59 (51.8%) were female (**Table 1**). Subacromial corticosteroid injection was categorised as definitely/probably not in the subacromial bursa (Group 1) in 22 (19.3%) patients, probably in the subacromial bursa (Group 2) in 21 (18.4%) and definitely in the subacromial bursa (Group 3) in 71 (62.3%). Compared to those in Group 3, participants in Group 2 were more likely to smoke, live alone, be obese/morbidly obese, have widespread pain, and had higher baseline SPADI scores, whereas those in group 1 were younger and more likely to be female or have a preference for US-guided corticosteroid injection.

The mean (SD) total SPADI score reduced from baseline to 6 weeks and then remained stable at 6 months in all injection accuracy groups, from 60.3 (25.2) at baseline to 36.1 (32.2) at 6 months in Group 1, 63.3 (15.0) at baseline to 46.0 (23.1) at 6 months in Group 2, and 60.4 (17.6) at baseline to 40.6 (24.6) at 6 months in Group 3. Group 2 had higher mean (SD) total SPADI scores at 6 weeks and 6 months compared with Groups 1 and 3, indicating worse shoulder pain and function. (**Figure 1a & 1b**).

*Accuracy of US-guided corticosteroid injection between-group comparisons*

There was no significant difference in the mean SPADI total scores between accuracy groups 2 and 3 and the reference category (group 1) at 6 weeks or 6 months, after adjusting for baseline SPADI scores (**Table 2**). Results did not change when the model was adjusted for the other selected baseline characteristics. There were no significant between-group differences for the SPADI pain and disability subscales at 6 weeks and 6 months or global assessment of overall change at 6 weeks. At 6 months, the odds of being completely recovered or much better were lower amongst those in Group 2 (“probably in the subacromial bursa”) compared with Group 1 (“definitely/probably not in the subacromial bursa”). Participant global assessment of overall change did not differ between Group 3 (“definitely in the subacromial bursa”) and Group 1 at 6 months.

**Discussion**

Subacromial corticosteroid injections are widely used in the treatment of SAPS (Artus et al., 2017). However, their efficacy is debated and inefficacy has been attributed to inaccurate needle placement. US-guidance is commonly employed to improve placement accuracy yet it is uncertain whether accuracy of injection placement influences outcome from corticosteroid injection for SAPS. We found that accuracy of corticosteroid injection placement into the subacromial bursa did not appear to influence pain or function after 6 weeks or 6 months among patients with SAPS.

Our findings are surprising in the context of previous systematic reviews, which found that US-guided corticosteroid injections for shoulder pain were more effective than landmark-guided injections (Aly et al., 2015; Sage et al., 2013), although few empirical studies were identified for inclusion. One of these systematic reviews included people with a heterogeneous range of shoulder pathologies, rather than focusing on people with SAPS (Sage et al., 2013).A later systematic review identified only three studies to inform its conclusion that US-guided subacromial corticosteroid injection for SAPS led to greater reduction in pain and improvement in function at 6 weeks than landmark-guided injection, whereas its finding that accuracy of injection placement did not differ between the US and landmark-guided approaches was based on a single study (Aly et al., 2015). The trials included in these reviews were characterised by small sample sizes, short-term follow-up and modest between-group differences in outcomes. Furthermore, a double-blind randomised trial did not find differences in shoulder pain and function between gluteal corticosteroid injection and US-guided subacromial injection in patients with rotator cuff disease, suggesting that accurate placement in the subacromial bursa may not be required for treatment response (Ekeberg et al., 2009). Subsequently, the SUPPORT trial found that US-guided subacromial corticosteroid injection provided no additional clinical benefit over unguided injection, despite injections being undertaken by trained clinicians who demonstrated competent performance of US-guided injections (Roddy et al., 2021).

Participants in Group 2 (‘probably in the subacromial bursa’) rated their global change at 6 months as lower than those in Group 1 (‘definitely/probably not in the subacromial bursa’) and their SPADI scores were numerically higher at 6 weeks and 6 months, suggesting worse shoulder pain and function, although there were no statistically significant differences in SPADI scores. This finding is difficult to explain. Corticosteroid injections have a rapid analgesic effect, yet the effect on global assessment of overall change in Group 2 at 6 weeks was smaller than at 6 months and was not statistically significant. Furthermore, if accuracy of injection placement is associated with response, a greater effect would be expected in Group 3 (‘definitely in the subacromial bursa’), whereas we observed no significant differences in outcomes between Group 3 and Group 1. However, there were some differences in baseline characteristics between the placement accuracy groups. Participants in Group 2 were more likely to smoke, live alone, be obese/morbidly obese, have widespread pain, and had slightly higher SPADI scores at baseline. These differences could explain poorer response to corticosteroid injection in Group 2.

Few previous studies have attempted to investigate the effect of accuracy of injection placement on clinical outcomes of patients with shoulder symptoms. (Esenyel et al., 2003) found that inaccurate placement of an unguided subacromial corticosteroid injection was associated with pain, range of movement and Constant scores returning to pretreatment values after 2 weeks. A similar study demonstrated clinical outcomes at 2-week follow-up to be associated with accuracy of unguided subacromial or glenohumeral corticosteroid injection (Eustace, Brophy, Gibney, Bresnihan, & FitzGerald, 1997). However, these studies differed from ours when radiographic contrast rather than ultrasound was used to assess the accuracy of unguided injection placement.

Subacromial corticosteroid injections are routinely performed in a musculoskeletal outpatient clinic. Whether palpation-guided or US-guided, both methods offer, on average, immediate analgesic effect and clinical benefits. US-guided injections, however, additionally require individuals with additional US skills, often from a different department. Our finding that injection accuracy did not influence response suggests that clinicians can confidently perform these injections under palpation-guidance of anatomical landmarks, with the expectation of similar clinical outcomes to that of US-guided injections (Cole, Peters, Hackett, & Murrell, 2016).

*Strengths and Limitations*

Strengths include the use of data from a factorial randomised trial (Roddy et al., 2021), with follow-up data up to 6 months. One limitation is that the number of participants with data available for analysis was dictated by the number recruited to the original trial. There were few participants whose injections were categorised as definitely or probably not in the subacromial bursa, necessitating combination of these participants into one group. Due to the small number of patients in placement accuracy groups 1 (‘definitely/probably not in the subacromial bursa’) and 2 (‘probably in the subacromial bursa’), the confidence intervals in the mean SPADI scores and the participants’ global assessment of overall change were quite wide, signaling imprecision of the estimates. The diagnosis of SAPS was made clinically and did not require radiological confirmation, although clinical diagnosis is commonplace in practice. Outcomes and covariates were limited to those evaluated in the trial, self-reported and did not include objective outcomes such as range of motion.

**Conclusion**

In conclusion, placement accuracy of US-guided subacromial corticosteroid injection via the anterolateral approach in SAPS did not influence pain and function outcomes. Given the widespread availability of practitioners to perform unguided injections in primary and secondary care, our findings suggest that subacromial corticosteroid injections can be performed without US guidance. The rise in use of ultrasound guidance in shoulder injections for SAPS appears unwarranted.

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**Table 1** Baseline socio-demographic and clinical variable characteristics of trial participants, overall and by placement accuracy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Key characteristics** | **All participants with video image data on US-guided placement accuracy**  ***n* = 114** | **Definitely/Probably not in the subacromial bursa (Group 1)**  **n=22** | **Probably in the subacromial bursa (Group 2)**  **n=21** | **Definitely in the subacromial bursa (Group 3)**  **n=71** |
| **Socio-demographic characteristics** |  |  |  |  |
| Age, mean (SD) | 54.8 (10.4) | 51.2 (10.0) | 56.9 (10.0) | 55.3 (10.5) |
| Females, n (%) | 59 (51.8) | 15 (68.2) | 12 (57.1) | 32 (45.1) |
| Previous or current smokers, n (%) | 60 (52.6) | 11(50.0) | 13 (61.9) | 36 (50.7) |
| Live alone, n (%) | 21 (18.6) | 5 (22.7) | 6 (30.0) | 10 (14.1) |
| BMI categories, n (%) |  |  |  |  |
| Normal/ underweight | 30 (26.3) | 8 (36.4) | 4 (19.1) | 18 (25.4) |
| Overweight | 34 (29.8) | 5 (22.7) | 6 (28.6) | 23 (32.4) |
| Obese/morbidly obese | 50 (43.9) | 9 (40.9) | 11 (52.4) | 30 (42.3) |
|  |  |  |  |  |
| **Clinical characteristics** |  |  |  |  |
| SPADI, mean (SD) |  |  |  |  |
| Pain subscale score | 70.4 (16.4) | 51.8 (29.2) | 60.6 (22.9) | 55.0 (25.1) |
| Disability subscale score | 55.0 (22.1) | 42.2 (30.7) | 47.3 (24.0) | 41.6 (25.0) |
| Total SPADI score | 60.9 (18.7) | 45.8 (29.6) | 52.4 (22.2) | 46.9 (24.1) |
| Previous Steroid Injection, n (%) | 37 (33.9) | 10 (45.5) | 4 (20.0) | 23 (34.3) |
| Preference for US-guided shoulder injection, n (%) | 65 (57.0) | 16 (72.7) | 11 (52.4) | 38 (53.5) |
| SF12- PCS, mean (SD) | 37.9 (9.1) | 36.8 (8.2) | 34.3 (10.8) | 39.2 (8.7) |
| SF12- MCS, mean (SD) | 47.6 (13.0) | 44.7 (14.8) | 46.6 (15.2) | 48.7 (11.7) |
| Diabetes, n (%) | 14 (12.3) | 3 (13.6) | 3 (14.3) | 8 (11.3) |
| Widespread pain, n (%) | 31 (27.9) | 7 (31.8) | 10 (52.6) | 14 (20.0) |
| **US** |  |  |  |  |
| **US corticosteroid injection** |  |  |  |  |
| Accuracy of US corticosteroid injection |  |  |  |  |
| Definitely not in the subacromial bursa, n (%) | 6 (5.3) | N/A | N/A | N/A |
| Probably not in the subacromial bursa, n (%) | 16 (14.0) | N/A | N/A | N/A |
| Probably in the subacromial bursa, n (%) | 21 (18.4) | N/A | N/A | N/A |
| Definitely in the subacromial bursa, n (%) | 71 (62.3) | N/A | N/A | N/A |
|  |  |  |  |  |

All values are mean (and standard deviation) or frequency and percentage (%)

SPADI: Shoulder Pain and Disability Index (each scale/subscale ranges from 0 to 100; 0=no pain/difficulty, 100=worst pain/so difficult it required help), BMI: Body Mass Index, US: Ultrasound, SF12 - PCS: Short-Form 12 Physical Component Summary Scores, SF12 – MCS: Short-Form 12 Mental Component Summary Scores, N/A: Not applicable

**Table 2:** Effect of accuracy of placement of US-guided subacromial corticosteroid injections on SPADI total, SPADI pain and disability subscales and global assessment of overall change.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **6 weeks** | | | | **6 months** | | | | |
|  | **Baseline adjusted difference in mean\* (95% CI)** | **p-value** | **Baseline and covariate† adjusted difference in mean (95% CI)** | **p-value** | **Baseline adjusted difference in mean\* (95% CI)** | **p-value** | **Baseline and covariate† adjusted difference in mean (95% CI)** | **p-value** |
| **SPADI Total** |  |  |  |  |  |  |  |  |
| Probably in the subacromial bursa | 5.94 (-5.45, 17.32) | 0.307 | 8.22 (-4.05, 20.50) | 0.189 | 7.54 (-9.22, 24.29) | 0.378 | 12.38 (-5.34, 30.10) | 0.171 |
| Definitely in the subacromial bursa | -2.14 (-11.34, 7.06) | 0.648 | -0.57 (-10.27, 9.13) | 0.908 | -0.06 (-13.63, 13.52) | 0.994 | 3.10 (-11.04, 17.23) | 0.668 |
| **SPADI Pain** |  |  |  |  |  |  |  |  |
| Probably in the subacromial bursa | 5.06 (-7.06, 17.17) | 0.413 | 6.72 (-6.31, 19.75) | 0.312 | -4.83 (-14.61, 4.96) | 0.334 | 13.63 (-5.02, 32.28) | 0.152 |
| Definitely in the subacromial bursa | 9.98 (-7.59, 27.55) | 0.265 | -3.84 (-14.18, 6.50) | 0.467 | 3.57 (-10.60, 17.73) | 0.622 | 6.00 (-8.82, 20.83) | 0.427 |
| **SPADI Disability** |  |  |  |  |  |  |  |  |
| Probably in the subacromial bursa | 5.82 (-5.79, 17.44) | 0.326 | 8.09 (-4.51, 20.68) | 0.208 | -1.19 (-10.58, 8.21) | 0.804 | 11.75 (-6.29, 29.79) | 0.202 |
| Definitely in the subacromial bursa | 7.17 (-9.67, 24.02) | 0.404 | 0.73 (-9.18, 10.64) | 0.886 | -1.28 (-14.94, 12.39) | 0.855 | 1.73 (-12.60, 16.05) | 0.813 |
| **Global assessment of overall change‡** | **Unadjusted OR§ (95% CI)** | **p-value** | **Adjusted† OR (95% CI)** | **p-value** | **Unadjusted OR§ (95% CI)** | **p-value** | **Adjusted† OR (95% CI)** | **p-value** |
| Probably in the subacromial bursa | 0.57 (0.05, 7.27) | 0.668 | 0.79 (0.05, 13.80) | 0.875 | 0.03 (0.00, 0.54) | **0.017** | 0.02 (0.00, 0.57) | **0.023** |
| Definitely in the subacromial bursa | 2.59 (0.34, 19.78) | 0.359 | 2.78 (0.28, 28.06) | 0.386 | 0.22 (0.03, 1.61) | 0.137 | 0.19 (0.02, 1.93) | 0.158 |
|  |  |  |  |  |  |  |  |  |
| SPADI: Shoulder Pain and Disability Index  \*Effects are the differences in mean SPADI score between each accuracy placement group and the reference group (definitely/probably not in the subacromial bursa) and the 95% confidence intervals (CI) after adjusting for the baseline pain/disability; negative numbers indicate less pain/disability in each category compared to the reference group; positive numbers indicate worse pain/disability compared to reference group.  **†**Further adjusted for age, gender, BMI, previous steroid injection, expectation of unguided steroid injection on shoulder pain improvement, SF-12 physical component summary scores, presence of widespread pain and exercise treatment allocation  **‡**Dichotomised into completely recovered or much better versus somewhat better, about the same, somewhat worse or much worse.  **§**Effects are the odds of being completely recovered or feeling much better in each accuracy placement group compared to the reference group (definitely/probably not in the subacromial bursa). | | | | | | | | |

**Figure legends**

**Figure 1a** Mean unadjusted total SPADI score over time by the US-guided placement accuracy

**Figure 1b** Mean adjusted total SPADI score over time by the US-guided placement accuracy