MLTJ
Muscles, Ligaments and Tendons Journal

ORIGINAL ARTICLE

ADHESIVE CAPSULITIS SECONDARY TO COVID-19 VACCINATION: A RETROSPECTIVE STUDY FROM SOUTHERN ITALY

Raffaele Natella[1], Michela Bruno[1], Maria Chiara Brunese[1], Gianfranco Vallone[1], Giulia Pacella[1], Laura Recchia[1], Luca Brunese[1], Marcello Zappia[1,2]

[1] Department of Medicine and Health Sciences Vincenzo Tiberio, University of Molise, Campobasso, Italy
[2] Varelli Institute, Naples, Italy

Corresponding author's e-mail: raffaele.natella@gmail.com

Received: 29/12/2024
Accepted: 31/12/2025
Published: 31/03/2026

Conflict of interests: The Authors declare that there are no competing interests.
Fundings: This study received no specific funding from public, commercial, or not-for-profit sectors.
Data availability: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.
Contributions: MZ conceived and designed the study. RN, MB, MCB and GP conducted the experiments and collected data. Data analysis was performed by LR with input from all authors. GV and LB supervised the study. RN prepared the initial manuscript draft, and all authors contributed to revisions and approved the final version of the manuscript.
This article is licensed under a CC Attribution-NonCommercial-NoDerivatives 4.0 License

LEVEL OF EVIDENCE: 3

ABSTRACT

Purpose: To evaluate the prevalence of adhesive capsulitis changes in MRI examinations after COVID-19 vaccine administration.

Materials and methods: We performed a retrospective cohort study of 940 participants who underwent shoulder MRIs between 2018 and 2022 in a single institution. Two groups were identified: group 1, consisting of 470 reports (261 males, 209 females, mean age 55 years old) during the pre-vaccination period from 2018 to 2020, and group 2, including 470 reports (267 males, 203 females, mean age 53 years old) during the vaccination period from 2021 to the end of 2022. MRI images were reviewed by a single radiologist with 17 years' experience in musculoskeletal radiology and evaluated for the presence of capsulitis.

Results: Based on the reports from group 1 (2018–2020), the prevalence of positive reports of AC was 16.2% CI95% (13.0-19.9). There was a total of 76 cases, with 33 women and 43 men affected. Group 2 (2021–2022) observed that adhesive capsulitis had a prevalence rate of 23.4% CI95% (19.7–27.55); among the 110 reported cases, 50 were women and 60 were men. Analyzing the sample by focusing on the difference in prevalence by gender, group 1 has a prevalence of 56.6% (43/76) CI95% (44.7-67.6) of men and 43.42% (33/76) CI95% (32.3-55.3) of women, while group 2 has a prevalence of 54.6% (60/110) CI95% (44.8-64) in men and 45.5% (50/110) CI95% (36.0-55.2) in women. Considering the total number of capsulitis cases, a statistically significant difference is highlighted between the pre-vaccination and post-vaccination periods (Fisher's exact test p=0.007).

KEYWORDS

Adhesive capsulitis, shoulder, MRI, COVID-19, vaccination

Publisher smc media srl

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

INTRODUCTION

Adhesive capsulitis (AC) is a diffuse cause of discomfort and restricted range of motion[1]. It is frequently linked to chronic diseases such as diabetes and thyroid disorders, according to literature[2-4]. In 1934, Codman introduced the term "frozen shoulder" to describe a notable restriction in the range of motion of the shoulder. Adhesive capsulitis progresses through various stages, starting with inflammation and fibrosis of the joint capsule, and can lead to spontaneous fibrosis resolution[5,6].

The prevalence of AC in the general population is 2–5%, with a larger occurrence among those over 40 years old and a slightly higher prevalence in women compared to men[7].

Given the inflammatory and fibrotic underpinnings of AC, conditions that perturb systemic immunity may act as precipitating factors. The musculoskeletal manifestations of COVID-19 are include involvement of muscles, nerves, joints, soft tissues, and bones. Musculoskeletal symptoms are commonly reported during acute SARS-CoV-2 infection. In a pooled analysis including 12,046 COVID-19 patients, fatigue was observed in 25.6% of cases, while myalgia and/or arthralgia occurred in 15.5%. These manifestations may be present from the earliest stages of the illness and can persist through more severe phases, supporting the concept of a systemic inflammatory involvement of the musculoskeletal system[8].

The pathophysiological mechanisms involve TMPRSS2 (protease transmembrane, serine 2) and angiotensin conversion enzyme 2 (ACE2), which connect with SARS-CoV-2 and let it get into cells. Several synovial cells, including fibroblasts and monocytes, express both ACE2 and TMPRSS2. Despite the lack of specific SARS-CoV-2 detection in these tissues, these observations suggest that the synovia could potentially serve as a site for direct viral infection. This outcome may represent one of the primary direct impacts of SARS-CoV-2 on the synovial and fibroblast, thereby correlating with the fibrosis of capsular and pericapsular tissues in adhesive capsulitis[9-12].

The direct symptoms of COVID-19 add to secondary disorders linked to so-called "cytokine storms" (molecules associated with the immune response) and a state of inflammation that affects the entire organism, including the musculoskeletal system. There are a lot of signaling molecules and pro-inflammatory cytokines in the blood. These include IL-1β, IL-6, IL-8, IL-17, TNF-α, granulocyte colony-stimulating factor, IFN-γ, and other chemokines. This leads to the hypothesis that COVID-19 could potentially contribute to the development of the "frozen shoulder"[12-14].

Common side effects at the vaccination injection site usually manifest as moderate and temporary symptoms such as discomfort, swelling, and redness. The purpose of administering a vaccination with an intramuscular injection is to deliver it to a location with abundant blood vessels, which helps it spread effectively throughout the body. Because of its characteristics, vaccine administration commonly uses the deltoid muscle, situated at shoulder level. Next to this muscle are additional components with fewer blood vessels: subcutaneous adipose tissue, pouches, tendons, and nerves. Administering the vaccine in locations with inadequate blood supply can reduce its effectiveness by weakening the immune response, perhaps leading to Shoulder Injuries Related to Vaccination Administration (SIRVA). SIRVA is defined by localized shoulder pain and restricted range of motion and usually starts within 48 hours of getting a vaccine, lasting approximately 7 days. The influenza vaccination is sometimes associated with SIRVA because of its widespread global use. Misadministration can lead to subacromial deltoid bursitis because the medicine is directly injected into the bursa. The medical literature has reported various issues such as nerve damage, adhesive capsulitis, tendon lesions, and septic arthritis. The outcome and prediction of shoulder dysfunction associated with the COVID-19 vaccination remain unclear[15-20].

The purpose of our study was to evaluate the prevalence of adhesive capsulitis changes in MRI examinations after COVID-19 vaccine administration.

MATERIAL AND METHODS

The study received Institutional Review Board of University of Molise approval (prot. n. 27598) and all procedures were conducted in accordance with the standards highlighted in the 1964 Declaration of Helsinki and its later amendments. This is a retrospective cohort study of

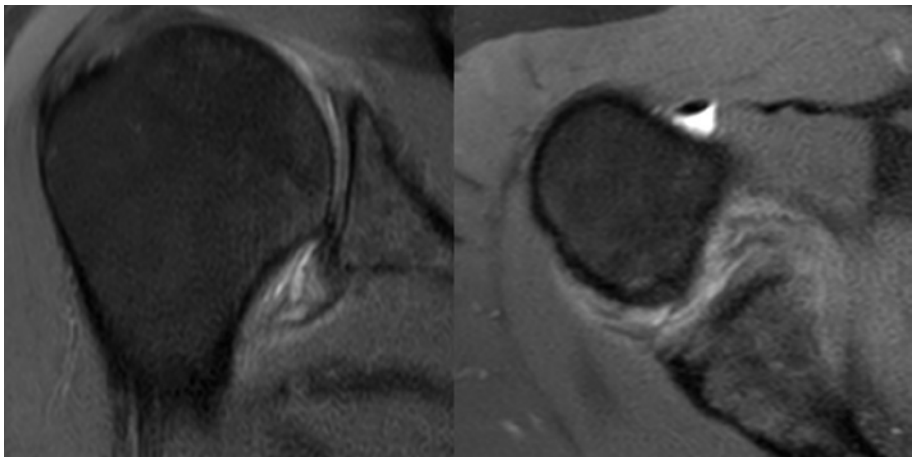


Figure 1. *Oblique and axial coronal PD fat sat images showing signal hyperintensity at the level of the inferior glenohumeral recess.*

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

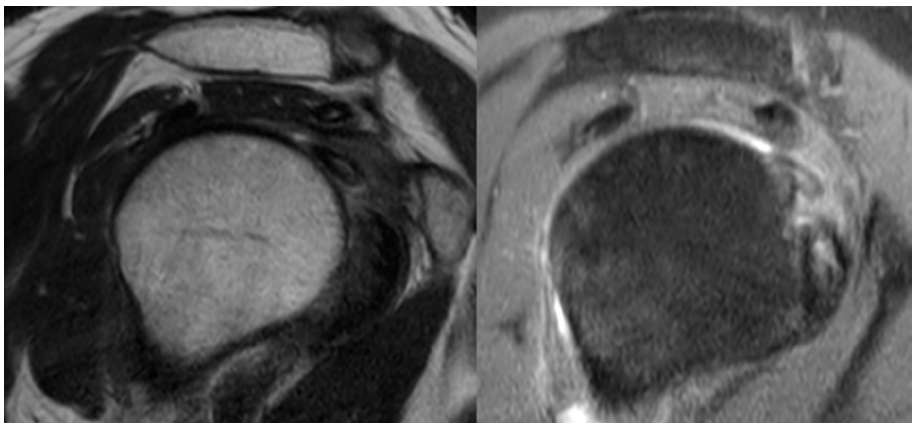


Figure 2. T2 and PD weighted oblique sagittal images showing fibrous obliteration with edema at the level of the rotator interval.

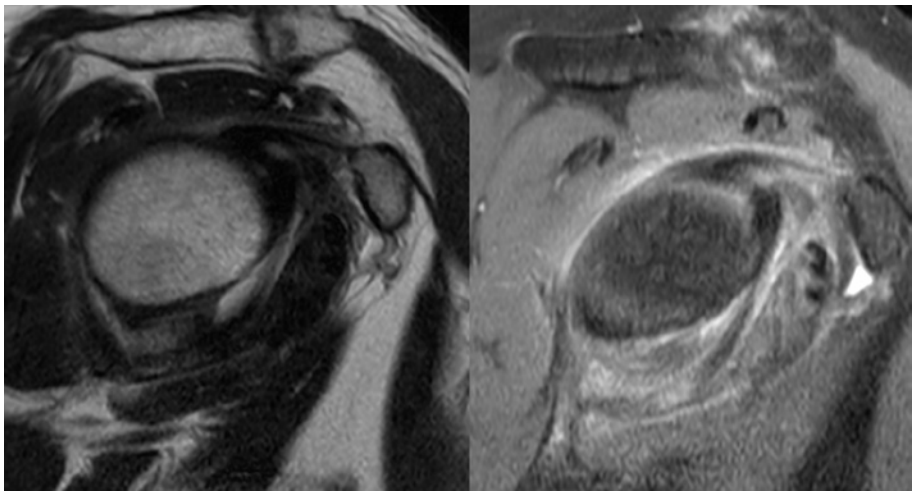


Figure 3. Oblique sagittal images weighted in T2 and PD fat sat showing edema of the joint capsule with fibrotis.

940 participants who underwent shoulder MRIs between 2018 and 2022 in a single Institution (Institute Varelli, Naples). All examinations were performed on the same MRI scanner 1.5 T MRI equipment (Siemens® Aera) The MRI acquisition protocol included the following sequences: axial fat-saturated proton density (PD), oblique coronal T1-weighted, oblique coronal fat saturated intermediate, oblique sagittal T2-weighted, oblique sagittal fat-saturated intermediate. The exclusion criteria were poor-quality MRI exams, lack of clinical information on vaccination, and non-adherence to informed consent. Study participants were divided into two groups:

The first group (group 1) consisted of 470 reports of 261 males and 209 females, with ages ranging from 9 to 87 and a mean age of 55 during the pre-vaccination period from 2018 to 2020.

The second group (group 2) included 470 reports, with 267 males and 203 females, ages 18 to 82 and a mean age of 53, during the vaccination period from 2021 to the end of 2022. MRI images were reviewed by a single radiologist with 17 years' experience in musculoskeletal radiology and evaluated for the presence of capsulitis *(Fig. 1, 2 and 3)*. The percentage of references testing positive for adhesive capsulitis was obtained using sources containing the term "capsulitis" in the radiological report.

STATISTICAL ANALYSIS

Descriptive statistics were used to summarize the prevalence of adhesive capsulitis (AC) in each group, providing measures such as percentages and confidence intervals (CI95%) to describe the distribution of cases by gender and overall. The Fisher exact test was conducted to determine the statistical significance of differences in prevalence rates between the two periods. A prevalence comparison was performed to analyze the differences in AC prevalence by gender within each group.

Variable	Pre-Vaccination (2018–2020)	Post-Vaccination (2021–2022)	p-value[21]
Total MRIs	470	470	–
Positive AC cases (n, %)	76 (16.2%) *CI95% (13.0–19.9)*	110 (23.4%) *CI95% (19.7–27.6)*	**0.007**
Male AC cases (n, %)	43 (56.6%)	60 (54.6%)	0.79
Female AC cases (n, %)	33 (43.4%)	50 (45.5%)	0.82

Table 1. Comparison of Adhesive Capsulitis Prevalence between Study Periods.

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

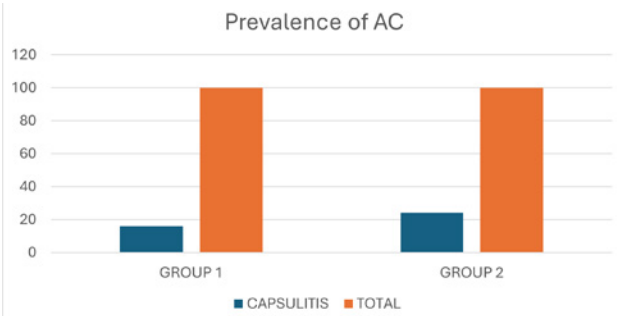


Figure 4. *Graph showing the prevalence of adhesive capsulitis (AC) in the two study groups.*

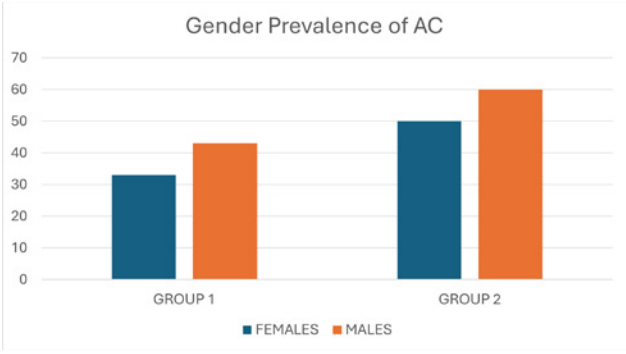


Figure 5. *Graph showing the gender distribution in the two study groups.*

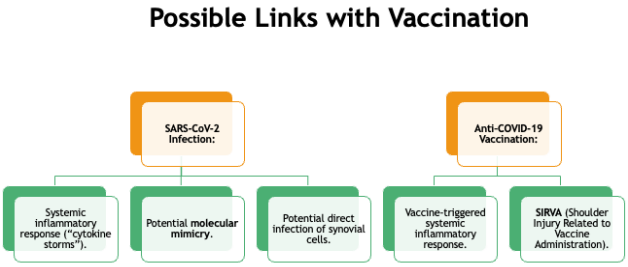


Figure 6. *Graph showing possible links with vaccination.*

RESULTS

Regarding group 1 (2018–2020), the prevalence of positive reports of AC was 16.2% CI95% (13.0-19.9). There was a total of 76 cases, with 33 women and 43 men affected. Group 2 (2021–2022) observed that adhesive capsulitis had a prevalence rate of 23.4% CI95% (19.7–27.55); among the 110 reported cases, 50 were women and 60 were men *(Fig. 4)*.

Group 1 consisted of a prevalence of men = 56.6% (43/76) CI95% (44.7-67.6) and 43.42% (33/76) CI95% (32.3-55.3) of women; group 2 was composed of a prevalence of 54.6 (60/110) CI95% (44.8-64) of men and 45.5 (50/110) CI95% (36.0-55.2) of women *(Fig. 5)*.

Considering the total number of capsulitis, a statistically significant difference is highlighted between the pre-vaccination and post-vaccination periods (Fisher exact test p=0.007), as reported in *Table 1*.

DISCUSSION

The emergence of the COVID-19 pandemic has led to the rapid development and deployment of various vaccines against the virus. While these vaccines have been shown to be safe and effective, there have been reports of adverse events following immunization, including the development of different types of shoulder injury or inflammation, described under the umbrella term SIRVA. Among the manifestations of SIRVA, cases of pain, bursitis, and adhesive capsulitis have been described.

Adhesive capsulitis, also known as "frozen shoulder," is a condition characterized by a gradual onset of pain, stiffness, and limited range of motion in the shoulder joint. The condition has been observed in some individuals following COVID-19 vaccination, particularly after the second dose of the mRNA vaccines[19,20,22-24].

Recent studies have reported a potential link between COVID-19 vaccination and the development of adhesive capsulitis. The Centers for Disease Control and Prevention maintain a Vaccine Adverse Events Reporting System that has received reports of shoulder-related adverse events following COVID-19 vaccination[25]. Additionally, the Advisory Committee on Immunization Practices has reviewed data on serious adverse events associated with COVID-19 vaccination, including the occurrence of shoulder-related conditions[1].

While the exact mechanism behind the association between COVID-19 vaccination and adhesive capsulitis is not fully understood, several hypotheses have been proposed. One possible explanation is that the immune response triggered by the vaccine may lead to an inflammatory reaction in the shoulder joint, resulting in the development of adhesive capsulitis[1,26]. Another theory suggests that the physical trauma of the injection, particularly if the vaccine is not administered properly, may contribute to the development of the condition[15].

While there have been isolated reports of cases or series of adhesive capsulitis following COVID-19 vaccination, it's currently difficult to determine the exact prevalence.

Despite the need for large-scale epidemiological studies to accurately assess the prevalence of this condition post-vaccination, our study is, to our knowledge, the one with the largest number of patients present in the literature in which a prevalence of AC is estimated in a population undergoing MRI examination. Furthermore, there are no studies in the literature based on the diagnosis of AC through MRI; all previous reports are based on clinical referrals. Our results highlight a significant difference in the prevalence of AC in the pre-vaccination period compared to the post-vaccination period in our patient cohort.

A previously published case series in the literature[27], investigates the incidence of adhesive capsulitis (frozen shoulder) following COVID-19 vaccination. The authors reviewed cases at their institution from March 2021 to December 2022, identifying seven patients (6 females, average age 60 years) who developed adhesive capsulitis within four weeks of vaccination. While the exact cause is unknown, researchers suggest improper vaccine administration, prolonged immobility due to pain, and

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

underlying inflammation from the vaccine itself may contribute. In their cohort, all patients were treated non-surgically with physiotherapy, and some also received hydrodilatation (injection of fluid to stretch the joint capsule). All patients experienced improvement in pain and range of motion. All patients in the series have been vaccinated, receiving the Covishield vaccine, the Indian version of the Oxford AstraZeneca recombinant ChAdOx1 nCoV-19 vaccine[28]. In the totality of cases, patients experienced improvement in pain score and range of motion after 8 weeks of conventional treatments, including nonsteroidal anti-inflammatory drugs, intra-articular steroid injections, and suprascapular nerve steroid blocks.

Other reports describe the occurrence of different forms of SIRVA; for example, Rodrigues et al.[29], discusses the occurrence of subacromial-subdeltoid bursitis after receiving the AstraZeneca COVID-19 vaccine. In this case, the occurrence of bursitis was caused by an inaccurate injection technique, too high and too close to the greater tubercle of the humerus, and the authors emphasize the importance of proper vaccination technique to minimize the risk of SIRVA and highlight the need for healthcare professionals to be aware of this potential complication.

Nevertheless, not all cases arise immediately after the injection, and therefore the infiltrative technique is not the only causal element in the development of these complications, especially in the case of adhesive capsulitis. In fact, several theories in literature have been proposed, highlighting the current lack of consensus on this topic.

One theory suggests that the vaccine-induced immune response, while intended to target the virus, might also trigger an inflammatory reaction in the shoulder joint, leading to capsular contracture and restricted movement characteristic of frozen shoulder.

Another possibility is molecular mimicry, where the immune system, activated by the vaccine, mistakenly attacks the body's own tissues, including those in the shoulder joint, due to similarities between viral and human proteins.

While the time between receiving the Covishield vaccine and the onset of adhesive capsulitis symptoms, as reported in the document by Ghosh et al.[28], was 12.3 days on average, in the series of 10 cases of adhesive capsulitis after COVID-19 vaccination described by Sau et al., symptoms developed immediately after the vaccination (within 24 hours) in 60% of patients, but the mean duration of presentation since the onset of symptoms described in was 8.4 ± 3.6 weeks (range, 6-18 weeks).

Due to the lack of clinical data in our dataset on the precise timeframe of symptom onset after immunization, it is probable that many participants had a delayed start of symptoms before receiving a secondary examination, such as an MRI.

There is no relevant data regarding an increased risk of complications of this type with different types of vaccines. While mentions both Covishield (90%) and Covaxin (10%), it focuses on the overall occurrence of frozen shoulder after and doesn't directly compare the incidence rates between these two vaccine types[19].

The occurrence after different vaccines is described by another report[30], which describes 6 patients (85.7% females, mean age 60 years) who developed adhesive capsulitis within 4 weeks of receiving the COVID-19 vaccine (57.1% Moderna (mRNA-1273), 42.9% Pfizer-BioNTech (BNT162b2).

In addition to the type of vaccine, we must also consider potential risk factors related to the patient's characteristics. Our data reveal a significant gender difference in the incidence of capsulitis, with a higher proportion of men in both group 1 and group 2. These data are in contrast with the evidence of the previous report by Sahu et al. in which 90% of patients were women[19], 9 out of the 10 patients were women (90%). In another series by Ghosh et al. of 9 patients (mean age 48.7 ± 12.7 yrs), the authors found a less significant difference in patients' gender (5 males, 4 females)[28]. However, these latter studies have a small sample size, so it's not possible to draw definitive conclusions about gender differences based on this data alone.

The likelihood of complications is certainly more frequent in the adult population compared to the young, with a mean age across studies above 50 years old.

Previous studies show that certain clinical conditions can be significant comorbidities for the development of complications related to SIRVA; among these, particularly diabetes and thyroid disorders could be potential risk factors for developing frozen shoulder[19]. Also, Gosh et al. mentions that the presence of pre-existing shoulder pathology and/or medical comorbidities *might* predispose individuals to developing adhesive capsulitis after vaccination[28]. Some authors suggest that the absence of common risk factors for adhesive capsulitis might contribute to a delayed onset of complications.

The treatment of adhesive capsulitis after COVID vaccination, as reported by previous studies of frozen shoulder after COVID-19 vaccination[28], included nonsteroidal anti-inflammatory drugs to manage pain and inflammation, intra-articular steroid injection, and suprascapular nerve steroid block to provide pain relief and improve shoulder function. The article notes that this treatment combination led to improvements in pain scores and range of motion within 8 weeks. Conservative management remains the cornerstone of treatment for adhesive capsulitis, including physiotherapy, anti-inflammatory drugs, and intra-articular steroid injections, as confirmed by a recent systematic review of randomized controlled trials by Albishi et al., which supports the effectiveness of nonoperative approaches in improving shoulder function and reducing pain[31].

In the series by BMC et al., patients who received hydrodilatation in addition to physiotherapy demonstrated particularly notable improvements in their range of motion and VAS scores.

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

The follow-up period in the study was relatively short (9.4 ± 5.7 months (range, 2.5-12 months)[19]. However, the same authors mention that complete recovery from frozen shoulder can take more than a year. At the time of the study's publication, the average follow-up duration was only 9.4 months, so the authors could only provide a preliminary assessment of recovery.

Recent literature consists mainly of case reports and small series describing shoulder symptoms shortly after COVID-19 vaccination, supporting biological and technique-related plausibility but not proving causation or quantifying population risk. For example, two series reported AC emerging within about 4 weeks of Covishield (Oxford–AstraZeneca) with improvement after conservative care (physiotherapy, intra-articular steroids or hydrodistension)[27,28]; SIRVA due to suboptimal needle placement has been linked to subacromial-subdeltoid bursitis[29], and AC has also been described after mRNA vaccines[30]. Against this backdrop, in our referral cohort the proportion of MRI-confirmed AC rose from 16.2% (2018–2020) to 23.4% (2021–2022), an absolute difference of 7.2 percentage points (relative increase ~44%; Fisher's exact p=0.007).

This temporal signal is noteworthy but not, by itself, proof of causation. Persistent musculoskeletal complaints after SARS-CoV-2 infection have been increasingly reported in the recovery phase. In a cross-sectional study on 367 PCR-confirmed COVID-19 patients evaluated up to 6 months after infection, fatigue (55%), myalgia (39%), arthralgia (25%), and muscle weakness (12%) were frequently observed, and symptom burden was not clearly related to the initial severity of illness. These data support the concept that post-acute COVID-19 may be accompanied by prolonged musculoskeletal symptoms requiring clinical attention and, in selected cases, rehabilitation[32].

Multiple, non-mutually-exclusive mechanisms are plausible: immune-mediated pathways (e.g., transient cytokine surges involving IL-6, TNF-α, IFN-γ, and potential molecular mimicry) that could enhance synovial fibroblast activation and capsular/pericapsular edema–fibrosis in susceptible hosts; SIRVA-related factors (suboptimal deltoid injection site/angle/depth) that may produce local tissue injury and pain-limited mobility, secondarily favoring stiffness; and pandemic-era behavioral/contextual contributors (reduced activity, delayed physiotherapy, "protective" hypomobility). Host susceptibility—including age >50 years, diabetes, and thyroid disease—likely modulates risk irrespective of the trigger.

Beyond organ-specific damage, as COVID-19 has been associated with a complex systemic inflammatory and immune-dysregulation milieu, several adjunctive strategies have been explored to mitigate susceptibility and severity. In an evidence-based systematic review, Migliorini et al. reported that the clinical evidence on vitamin C and vitamin D supplementation in COVID-19 remains inconsistent and controversial, with substantial heterogeneity in dose, timing, setting (inpatient/outpatient), and patient characteristics, and with no evidence-based guidelines supporting routine supplementation[33].

Consistent with prior literature dominated by case reports and small series of AC or SIRVA shortly after COVID-19 vaccination, our MRI-based approach adds objective imaging endpoints but does not resolve temporality at the individual level, dose–response, or specificity. Clinically, these findings underscore the importance of accurate injection technique and early mobilization/physiotherapy in post-vaccination shoulder pain. Methodologically, prospective multicenter studies linking verified vaccination exposure (including laterality and time-to-symptom onset), comorbidities, and standardized MRI/clinical endpoints—with blinded, multi-reader assessments—are needed to determine whether the observed increase reflects a causal effect, an indirect pandemic artifact, or both *(Fig. 6)*.

The present study is the first to evaluate the occurrence or prevalence of this syndrome using instrumental imaging techniques, namely MRI, in comparison to prior reports in the literature. Indeed, prior research has evaluated the result by considering the decrease in range of motion and clinical examinations. Incidentally, in the study by Sahu et al. only 3 patients presented with an MRI of the shoulder but had no abnormal findings compatible with capsulitis.

There exist certain constraints of the study that warrant acknowledgment. Initially, the lack of clinical documentation creates doubts regarding the direct cause-and-effect relationship between the development of capsulitis and the vaccination, the existence of other medical conditions, or other secondary factors.

As a retrospective study, it relies on medical records and patient recall, which can be subject to bias.

In conclusion, the incidence of painful shoulder pathology following COVID-19 vaccination is infrequent but not insignificant. We validate the precise diagnosis of adhesive capsulitis in patients exhibiting symptoms of SIRVA by MRI scans.

CONCLUSION

In this single-center, MRI-based retrospective analysis, the proportion of adhesive capsulitis (AC) increased from 16.2% in 2018–2020 to 23.4% in 2021–2022 (absolute +7.2 percentage points; ~44% relative increase; Fisher's exact p=0.007), indicating a temporal association with the vaccination era but not establishing causality. Causal inference is constrained by key limitations inherent to our design: an ecological, period-based comparison without individual-level verification of vaccination exposure (status, dose, type/lot, *laterality* vs imaged shoulder) or injection technique; incomplete clinical covariates (timing of symptoms vs injection, diabetes, thyroid disease, prior shoulder pathology), making residual confounding likely; potential information/misclassification bias related to evolving reporting thresholds; lack of multivariable adjustment and of a population denominator to estimate

incidence; and limited generalizability from a single MRI platform and regional referral patterns. The external evidence base remains modest, being dominated by case reports and small series, and thus insufficient to accept or reject a causal link between COVID-19 vaccination and AC. Taken together, our findings are hypothesis-generating: they underscore practical measures (accurate deltoid injection technique; early mobilization/physiotherapy for post-injection shoulder pain) and motivate prospective, multicenter studies that verify exposure (including laterality and time-to-onset), capture comorbidities, and apply standardized clinical/MRI endpoints with blinded multi-reader assessment and appropriate population denominators to yield adjusted risk estimates—while reaffirming the public-health value of vaccination.

REFERENCES

1. Oliver SE, Gargano JW, Marin M, Wallace M, Curran KG, Chamberland M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Pfizer-BioNTech COVID-19 Vaccine - United States, December 2020. MMWR Morb Mortal Wkly Rep. 2020;69(50):1922–4. doi: 10.15585/mmwr.
2. Picasso R, Pistoia F, Zaottini F, Marcenaro G, Miguel-Perez M, Tagliafico AS, et al. Adhesive Capsulitis of the Shoulder: Current Concepts on the Diagnostic Work-Up and Evidence-Based Protocol for Radiological Evaluation. Diagnostics (Basel). 2023;13(22). doi: 10.3390/diagnostics13223410.
3. Corban J, Shah S, Ramappa AJ. Current Evidence Based Recommendations on Rehabilitation following Arthroscopic Shoulder Surgery: Rotator Cuff, Instability, Superior Labral Pathology, and Adhesive Capsulitis. Curr Rev Musculoskelet Med. 2024;17(7):247–57. doi: 10.1007/s12178-024-09899-7.
4. Moleesaide A, Saengsuwan J, Sirasaporn P. Musculoskeletal ultrasound of the shoulder in patients with adhesive capsulitis. Biomed Rep. 2024;21(6):190. doi: 10.3892/br.2024.1878.
5. Tamai K, Hamada J, Nagase Y, Morishige M, Naito M, Asai H, et al. Can magnetic resonance imaging distinguish clinical stages of frozen shoulder? A state-of-the-art review. JSES Rev Rep Tech. 2024;4(3):365–70. doi: 10.1016/j.xrrt.2024.05.002.
6. Brindisino F, Sciscione S, Andriesse A, Cioeta M, Struyf F, Feller D. Frozen shoulder: subjects' needs and perspectives and clinicians' beliefs and management strategies: do they align? A cross-sectional study. BMC Musculoskelet Disord. 2024;25(1):745. doi: 10.1186/s12891-024-07803-5.
7. Sun G, Li Q, Yin Y, Fu W, He K, Pen X. Risk factors and predictive models for frozen shoulder. Sci Rep. 2024;14(1):15261. doi: 10.1038/s41598-024-66360-y.
8. Cipollaro L, Giordano L, Padulo J, Oliva F, Maffulli N. Musculoskeletal symptoms in SARS-CoV-2 (COVID-19) patients. J Orthop Surg Res. 2020;15(1):178. doi: 10.1186/s13018-020-01702-w.
9. da Silva LNM, Filho AGO, Guimaraes JB. Musculoskeletal manifestations of COVID-19. Skeletal Radiol. 2024;53(10):2009–22. doi: 10.1007/s00256-023-04549-4.
10. Finsterer J. The musculoskeletal manifestations of SARS-CoV-2 infections/vaccinations are more diverse than expected. Skeletal Radiol. 2024;53(10):2285–6. doi: 10.1007/s00256-024-04607-5.
11. Mahmoud H, Ebid A, Alghamdi M, Ibrahim A, Almoosa A. Prevalence of Musculoskeletal, Neurological and Physical Disorder After COVID-19 in Saudi Arabia: A Cross Sectional Study. F1000Res. 2022;11:463. doi: 10.12688/f1000research.109007.3.
12. Vladulescu-Trandafir AI, Onose G, Munteanu C, Iancu I, Balanescu AR, Opris-Belinski D, et al. Unraveling the Impact of COVID-19 on Rheumatoid Arthritis: Insights from Two Romanian Hospitals-Preliminary Results. Biomedicines. 2024;12(9). doi: 10.3390/biomedicines12092145.
13. Sinha PR, Mallick N, Sahu RL. Orthopedic Manifestations and Post-COVID-19 Infection. J Pharm Bioallied Sci. 2023;15(Suppl 1):S665–S8. doi: 10.4103/jpbs.jpbs_88_23.
14. Thi Khanh HN, Cornelissen L, Castanares-Zapatero D, De Pauw R, Van Cauteren D, Demarest S, et al. Association between SARS-CoV-2 variants and post COVID-19 condition: findings from a longitudinal cohort study in the Belgian adult population. BMC Infect Dis. 2023;23(1):774. doi: 10.1186/s12879-023-08787-8.
15. Alshehri M, Alsalman M, Alsebayel FM. Adhesive capsulitis following COVID-19 vaccination: a case report and review of literature. J Surg Case Rep. 2023;2023(11):rjad611. doi: 10.1093/jscr/rjad611.
16. Haas JW, Oakley PA, Harrison DE. Alleviation of shoulder injury related to vaccine administration (SIRVA) pain and disability following COVID-19 vaccine with chiropractic biophysics((R)) (CBP((R))) methods: a case report and long-term follow-up with global implications. J Phys Ther Sci. 2023;35(12):831–7. doi: 10.1589/jpts.35.831.
17. Li Z, Chen S, Zhao M. An analysis of reported cases shoulder injury related to vaccine administration of after COVID-19 vaccination. Hum Vaccin Immunother. 2024;20(1):2321672. doi: 10.1080/21645515.2024.2321672.
18. Miyano M, Tsukuda Y, Hiratsuka S, Hamasaki M, Iwasaki N. Chronic shoulder injury related to vaccine administration following coronavirus disease 2019 vaccination: a case report. J Med Case Rep. 2023;17(1):456. doi: 10.1186/s13256-023-04198-0.
19. Sahu D, Gupta S, Shetty G, Choudhury HS. Frozen shoulder after COVID-19 vaccination versus idiopathic frozen shoulder: similar clinical features and functional improvement at 1-year follow-up. JSES Rev Rep Tech. 2024;4(1):41–7. doi: 10.1016/j.xrrt.2023.09.013.
20. Weinberg D, McDaniel M, Pan J. Adhesive Capsulitis Following Improper Tetanus-Diphtheria (Td) Booster Administration. Cureus.

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606

2024;16(3):e57113. doi: 10.7759/cureus.57113.
21. Hassett AL, Williams DA, Harris RE, Harte SE, Kaplan CM, Schrepf A, et al. An Interventional Response Phenotyping Study in Chronic Low Back Pain: Protocol for a Mechanistic Randomized Controlled Trial. Pain Med. 2023;24(Suppl 1):S126–s38. doi: 10.1093/pm/pnad005.
22. Petrakis N, Addison M, Penak B, Schrader S, Mallard J, Clothier HJ, et al. Shoulder injury following COVID-19 vaccine administration: a case series and proposed diagnostic algorithm. Expert Rev Vaccines. 2023;22(1):299–306. doi: 10.1080/14760584.2023.2189463.
23. Sukhija S, Singh S, Saxena S, Ambwani S, Khera PS. Shoulder Injury Related to Vaccine Administration (SIRVA) with COVID-19 vaccination - A case report. J Family Med Prim Care. 2022;11(12):7937–40. doi: 10.4103/jfmpc.jfmpc_798_22.
24. Wright JO, Wiggins W, Smith MS, King JJ, Wright TW. Shoulder Pain and Dysfunction After Vaccination: A Systematic Review. JBJS Rev. 2023;11(1). doi: 10.2106/JBJS.RVW.22.00134.
25. Alhossan A, Alsaran AK, Almahmudi AH, Aljohani ZS, Albishi MR, Almutairi AK. Adverse Events of COVID-19 Vaccination among the Saudi Population: A Systematic Review and Meta-Analysis. Vaccines (Basel). 2022;10(12). doi: 10.3390/vaccines10122089.
26. Deb A, Abdelmalek J, Iwuji K, Nugent K. Acute Myocardial Injury Following COVID-19 Vaccination: A Case Report and Review of Current Evidence from Vaccine Adverse Events Reporting System Database. J Prim Care Community Health. 2021;12:21501327211029230. doi: 10.1177/21501327211029230.
27. Foong B, Ho S, Tan L, Lee KT, Jegathesan T. Adhesive Capsulitis Secondary to COVID-19 Vaccination - A Case Series. Malays Orthop J. 2023;17(2):43–8. doi: 10.5704/MOJ.2307.007.
28. Ghosh S, Pandey SK, Biswas A, Pandey J. Adhesive Capsulitis After COVID-19 Vaccination: A Case Series. Am J Phys Med Rehabil. 2023;102(6):e79–e82. doi: 10.1097/PHM.0000000000002194.
29. Cantarelli Rodrigues T, Hidalgo PF, Skaf AY, Serfaty A. Subacromial-subdeltoid bursitis following COVID-19 vaccination: a case of shoulder injury related to vaccine administration (SIRVA). Skeletal Radiol. 2021;50(11):2293–7. doi: 10.1007/s00256-021-03803-x.
30. Honarmand AR, Mackey J, Hayeri R. Shoulder injury related to vaccine administration (SIRVA) following mRNA COVID-19 vaccination: Report of 2 cases of subacromial-subdeltoid bursitis. Radiol Case Rep. 2021;16(12):3631–4. doi: 10.1016/j.radcr.2021.08.019.
31. Albishi W, Murad K, Alaseem A, Awwad W, Alsanawi H. The Effectiveness of Nonoperative Treatment Modalities in the Management of Frozen Shoulder: a Systematic Review of Randomized Controlled Trials. Muscle Ligaments and Tendons Journal. 2022;12:104. doi: 10.32098/mltj.02.2022.03.
32. Gulzar R, e Haque Mahmud T, Rasheed A, Riaz S, Akhtar Adnan W, Hafeez U, et al. Musculoskeletal Symptoms in Patients Recovering from COVID-19. Muscle Ligaments and Tendons Journal. 2022;12(01). doi: 10.32098/mltj.01.2022.02.
33. Migliorini F, Vaishya R, Eschweiler J, Oliva F, Hildebrand F, Maffulli N. Vitamins C and D and COVID-19 Susceptibility, Severity and Progression: An Evidence Based Systematic Review. Medicina (Kaunas). 2022;58(7). doi: 10.3390/medicina58070941.
34. Diallo TD, Wiedemann S, Berkarda Z, Strecker R, Nickel D, Bamberg F, et al. Ultra-fast single-sequence magnetic resonance imaging (MRI) for lower back pain: diagnostic performance of a deep learning T2-Dixon pprotocol. Clin Radiol. 2025;88:106987. doi: 10.1016/j.crad.2025.106987.

© 2026 The Author(s) - Doi: 10.32098/mltj_2026_6606