EPIEMIOLOGICAL SCIENCE

Two-dose COVID-19 vaccination and possible arthritis flare among patients with rheumatoid arthritis in Hong Kong

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ABSTRACT

Objectives To investigate the relationship between COVID-19 full vaccination (two completed doses) and possible arthritis flare.

Methods Patients with rheumatoid arthritis (RA) were identified from population-based electronic medical records with vaccination linkage and categorised into BNT162b2 (mRNA vaccine), CoronaVac (inactive virus vaccine) and non-vaccinated groups. The risk of possible arthritis flare after vaccination was compared using a propensity-weighted cohort study design. We designed possible arthritis flare as hospitalisation and outpatient consultation related to RA or reactive arthritis, based on diagnosis records during the episode. Weekly prescriptions of rheumatic drugs since the launch of COVID-19 vaccination programme were compared to complement the findings from a diagnosis-based analysis.

Results Among 5493 patients with RA (BNT162b2: 653; CoronaVac: 671; non-vaccinated: 4169), propensity-scored weighted Poisson regression showed no significant association between arthritis flare and COVID-19 vaccination (BNT162b2: adjusted incidence rate ratio 0.86, 95% Confidence Interval 0.73 to 1.01; CoronaVac: 0.87 (0.74 to 1.02)). The distribution of weekly rheumatic drug prescriptions showed no significant differences among the three groups since the launch of the mass vaccination programme (all p values >0.1 from Kruskal-Wallis test).

Conclusions Current evidence does not support that full vaccination of mRNA or inactivated virus COVID-19 vaccines is associated with possible arthritis flare.

INTRODUCTION

Vaccine is an effective public health measure to control the global COVID-19 pandemic. Patients with rheumatoid arthritis (RA) are twofold more vulnerable to infections that result in hospitalisation and impaired quality of life. With consideration to the benefits of vaccination outweighing the risks, the European Alliance of Associations for Rheumatology (EULAR) recommends that patients with RA should receive COVID-19 vaccines without needing major adjustment to their ongoing treatment regimens.

However, one of the major barriers to vaccine uptake among patients with RA is the fear of arthritis flare despite non-relevant evidence from landmark trials and few case reports in the post marketing.

Understanding the association between arthritis flare and vaccination is important to overcome vaccine hesitancy. Currently, the Hong Kong (HK) Government Vaccination Programme provides two authorised COVID-19 vaccines: CoronaVac (inactivated virus vaccine; recommended vaccination interval 28 days) and BNT162b2 (mRNA vaccine; recommended vaccination interval 21 days). Since the launch of the vaccination programme on 23 February 2021, more than 8 million doses have been administered with close safety monitoring. In this study, we analysed the territory-wide electronic medical records (EMRs) database and aimed to investigate the population-level risk of possible arthritis flare among patients with RA who were fully vaccinated with mRNA or inactivated virus COVID-19 vaccines.
arthritic flare following full vaccination based on two technology platforms.

METHOD

Data sources
We analysed population-based EMRs from the Hospital Authority (HA) with linked vaccination records from the Department of Health (DH) of the HK Government. HA provides publicly funded health services to around 7 million HK residents. The EMRs database managed by the HA holds centralised medical records from 42 public hospitals with high population coverage, representativeness and coding accuracy. This study linked the EMRs with the vaccination records of all HK residents ≥16 years old who ever used the HA service. We used de-identified and non-reversible series numbers for the record linkage to protect patient privacy.

Study design and population
This was a retrospective cohort study among patients with RA. Risk of possible arthritis flare was compared among vaccine recipients and non-vaccinated individuals. Based on the International Classification of Diseases Ninth version, Clinical Modification (ICD-9-CM) diagnosis (online supplemental table 1), we identified the RA cohort from the EMRs, excluding patients who had cancer or other autoimmune diseases to avoid cohort contamination. We matched each vaccine recipient with non-vaccinated individuals by age and sex using maximum ratio matching and assigned the vaccination date as the pseudo index date for non-vaccinated individuals (controls). Individuals with completed two-dose vaccination and their matched controls were followed up from the date of second dose vaccination or the age-sex matched pseudo index date until the occurrence of interest or cohort end date or the occurrence of arthritis flare (p=0.3042 for BNT162b2; p=0.5422 for CoronaVac and non-vaccinated groups were compared using Kruskal-Wallis test).

Patient and public involvement
This study used de-identified electronic medical records and was conducted without patient and public involvement.

RESULTS

We obtained 3983529 records of HA active patients with confirmed vaccination status. Following the cohort selection procedure, 5493 patients with RA (BNT162b2: 653; CoronaVac: 671; non-vaccinated individuals: 4169) were included. Compared with non-vaccinated individuals, vaccine recipients were younger and less likely to have pre-existing chronic diseases. After weighting, all variables were well balanced with a standardised difference smaller than 0.2 (table 1). Median interdose interval was 21 days (IQR 14–72) for BNT162b2 and 28 days (IQR 14–81) for CoronaVac recipients. Delays of second dose was very uncommon for both vaccine groups (BNT162b2: 0.5%; CoronaVac: 0.8%).

During a median follow-up of 32 days (IQR 14–72), 35 BNT162b2 recipients (crude incidence 0.45 (95% CI 0.32 to 0.62) per person-year) had RA or reactive arthritis-related hospitalisation or SOPC attendance. The number of CoronaVac recipients was 41 (crude incidence 0.45 (0.33 to 0.61) per person-year) with a median follow-up of 30 days (IQR 15–95). Receiving two doses of BNT162b2 (adjusted IRR 0.86 (95% CI 0.73 to 1.01)) or CoronaVac (adjusted IRR 0.87 (95% CI 0.74 to 1.02)) showed no significant association with arthritis flare as defined. Similarly, no significant association was detected when focusing on events identified from inpatient setting only (table 2). Delayed second dose was not associated with the occurrence of possible flare (p=0.3042 for BNT162b2; p=0.5422 for CoronaVac and p=0.1544 for overall from Fisher’s exact test).

Weekly prescription of four major rheumatoid drugs were presented in figure 1. Since the launch of the COVID-19 vaccination programme in HK, weekly arthritis-related prescriptions ranged between 0.09 and 0.14 per patient. NSAIDs and corticosteroids accounted for 23%–27% of overall prescriptions. The per-patient prescription and distribution of four rheumatoid drug categories showed no significant differences among the BNT162b2 and CoronaVac recipients, and the non-vaccinated individuals (all p values >0.1 from Kruskal-Wallis test).

DISCUSSION

Using territory-wide EMRs in HK, we found that after full vaccination with BNT162b2 or CoronaVac, patients with RA did not show an increased risk of possible arthritis flare. The weekly prescription trends of major rheumatoid drugs also presented no significant differences among patients with or without vaccination. Currently, safety evidence on COVID-19 vaccine among patients with rheumatic diseases are from case-reports, self-report surveys or trials among RA patients with controlled disease activities. Since the launch of vaccination in HK, uptake of the vaccine (approximate 24% (95% CI 22.99% to 25.25%) with full vaccination based on our study cohort) among patients with RA is gradually increasing (online
supplemental figure 2), although remaining suboptimal. Findings from this study provide real-world evidence of COVID-19 vaccine safety and could potentially overcome vaccine hesitancy among patients with RA.

We acknowledge that if individuals who experienced flare after the first dose, then they would be less likely to take the second dose, which could theoretically introduce biased estimations for the current two-dose analysis. To clarify this issue, we conducted post hoc analysis to estimate the number of patients received single-dose only. We included patients who received the first-dose vaccine on or before 19 June 2021 and had no record of second dose until the study end date (31 July 2021). It would ensure at least 42-day observation period after the first dose and exclude the possibility that the second dose was scheduled beyond the study period. Although the recommended dosing interval is 21 and 28 days for BNT162b2 and CoronaVac, respectively, the HK Government allows flexibility of interval between doses for logistic or clinical reasons. Analysis of the phase III efficacy data of BNT162b2 showed it was feasible to administer the second dose from 19 to 42 days. Therefore, we defined

### Table 1  | Baseline characteristics before and after multi-group inverse probability treatment weighting

<table>
<thead>
<tr>
<th></th>
<th>Before weighting</th>
<th></th>
<th>After weighting</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>BNT162b2</td>
<td>CoronaVac</td>
<td>None</td>
</tr>
<tr>
<td>Male (N (%))</td>
<td>566</td>
<td>3893.56</td>
<td>4051.97</td>
<td>4169</td>
</tr>
<tr>
<td>Age (mean (SD))</td>
<td>55.83 (11.89)</td>
<td>59.52 (11.04)</td>
<td>63.97 (14.73)</td>
<td>0.424</td>
</tr>
<tr>
<td>Comorbidities (N (%))</td>
<td></td>
<td>9 (1.4)</td>
<td>9 (1.3)</td>
<td>72 (1.7)</td>
</tr>
<tr>
<td>Asthma</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>17 (0.4)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>29 (4.4)</td>
<td>45 (6.7)</td>
<td>488 (11.7)</td>
<td>0.18</td>
</tr>
<tr>
<td>Mild liver disease</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>13 (0.3)</td>
</tr>
<tr>
<td>Moderate-severe liver disease</td>
<td>1 (0.2)</td>
<td>0 (0.0)</td>
<td>1 (0.0)</td>
<td>1 (0.0)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>4 (0.6)</td>
<td>4 (0.6)</td>
<td>48 (1.2)</td>
<td>0.086</td>
</tr>
<tr>
<td>Periportal hepatic</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>39 (0.9)</td>
</tr>
<tr>
<td>Paralysis</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>17 (0.4)</td>
</tr>
<tr>
<td>Respiratory infections</td>
<td>20 (3.1)</td>
<td>23 (3.4)</td>
<td>390 (9.4)</td>
<td>0.176</td>
</tr>
<tr>
<td>Stroke or systemic embolism</td>
<td>2 (0.3)</td>
<td>7 (1.0)</td>
<td>95 (2.3)</td>
<td>0.121</td>
</tr>
<tr>
<td>Ulcers</td>
<td>3 (0.5)</td>
<td>14 (2.1)</td>
<td>106 (2.5)</td>
<td>0.116</td>
</tr>
<tr>
<td>Vascular infections</td>
<td>0 (0.0)</td>
<td>2 (0.3)</td>
<td>43 (1.0)</td>
<td>0.104</td>
</tr>
<tr>
<td>Health service utilisation (N (%))</td>
<td></td>
<td>471 (72.1)</td>
<td>508 (75.7)</td>
<td>3464 (83.1)</td>
</tr>
<tr>
<td>Medication usage within 90 days (N (%))</td>
<td></td>
<td>641 (98.2)</td>
<td>665 (99.1)</td>
<td>4122 (98.9)</td>
</tr>
</tbody>
</table>

### Table 2  | Risk of flare among two-dose vaccine recipients vs unvaccinated individuals, after propensity score weighting

<table>
<thead>
<tr>
<th>N</th>
<th>Follow-up time (person-year)</th>
<th>Crude incidence (per person-year, 95% CI)</th>
<th>Adjusted IRR* (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT162b2</td>
<td>35</td>
<td>78.23</td>
<td>0.45 (0.32 to 0.62)</td>
<td>0.86 (0.73 to 1.01)</td>
</tr>
<tr>
<td>CoronaVac</td>
<td>41</td>
<td>91.02</td>
<td>0.45 (0.33 to 0.61)</td>
<td>0.87 (0.74 to 1.02)</td>
</tr>
<tr>
<td>None</td>
<td>330</td>
<td>612.63</td>
<td>0.54 (0.48 to 0.60)</td>
<td>Ref –</td>
</tr>
<tr>
<td>Secondary outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BNT162b2</td>
<td>33</td>
<td>78.65</td>
<td>0.42 (0.29 to 0.58)</td>
<td>0.96 (0.81 to 1.14)</td>
</tr>
<tr>
<td>CoronaVac</td>
<td>38</td>
<td>91.58</td>
<td>0.41 (0.30 to 0.56)</td>
<td>1.03 (0.87 to 1.22)</td>
</tr>
<tr>
<td>None</td>
<td>275</td>
<td>620.26</td>
<td>0.44 (0.39 to 0.50)</td>
<td>Ref –</td>
</tr>
</tbody>
</table>

* Adjusted variables with standard mean difference >0.1; IRR estimated using non-vaccinated group as reference; IRR, incidence rate ratio.
disease were observed to have a higher risk of severe conditions after COVID-19 infection compared with those without inflammatory diseases. It was established that the immunogenicity of COVID-19 vaccine could achieve an acceptable threshold for protection. Combining the current evidence of safety and effectiveness, vaccination with two doses is highly recommended to achieve adequate self-protection in patients with RA.

To the best of our knowledge, this is the first population-based analytical study with valid vaccination record linkage for COVID-19 vaccine safety monitoring among patients with RA. The study assessed the safety of two different vaccine technology platforms with relatively larger sample sizes and a longer follow-up period. Our cohort identification was based on ICD-9-CM diagnosis codes (714.xx) recorded in either inpatient or SOPC settings with clinical diagnoses made by rheumatology specialists. Furthermore, prescription data analysis showed, in our study cohort, 96% of the patients diagnosed with RA had arthritis-related prescription records (cs/b/tsDMARD, NSAIDs or corticosteroid) between 1 January 2018 and 31 July 2021 (the period of data availability), which supports the high validity of RA cohort we identified.

However, as a common drawback with EMR-based studies, information on the clinically relevant definition of flares, such as disease activity assessment (eg, Disease Activity Score-28 for Rheumatoid Arthritis) and patient-reported symptoms (eg, pain, stiffness and fever), is not available. Using arthritis-related hospital admission and SOPC consultation as a proxy of flare may underestimate the accurate occurrence. The supplementary analysis using arthritis-related prescription as a surrogate outcome of flare enables the validation of diagnosis-based outcome definition. This consistent finding further supports the non-significant association between COVID-19 vaccination and arthritis flare. Of note, almost no patients were recorded as using corticosteroids at cohort entry, indicating that those who received the vaccine were at the maintenance stage of RA with stable disease activity or in remission. The study conclusion is not entirely generalisable to patients with active RA. Our database is also restricted to patients who use the HA service. HA is the statutory body responsible for managing all the public hospitals in HK and provides a highly subsidised health service to all eligible HK residents. It is anticipated that the majority of possible flare is captured in this study, particularly severe cases resulting in hospitalisation, although we possibly missed patients consulting private rheumatologists for flare management. However, there is no evidence to show differential use of private consultants between vaccinated and unvaccinated subjects; hence, it is unlikely to affect our conclusion.

In conclusion, among patients with RA, there is no increased risk of possible flare following two doses of COVID-19 vaccination. Real-world vaccine safety surveillance with direct disease activity testing related to arthritis flare should continue to provide more robust evidence on the association.

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Figure 1 Weekly arthritis-related prescriptions among vaccine recipients and non-vaccinated individuals, between 1 February and 31 July 2021. BTDMARDs, biological or target synthetic disease-modifying antirheumatic drugs; CSDMARDs, conventional synthetic disease-modifying antirheumatic drugs; NSAID, non-steroidal anti-inflammatory drug. Kruskal-Wallis test showed all p values >0.1 for each week comparison, indicating the distribution of arthritis-related prescriptions showed no differences among BNT162b2 recipients, CoronaVac recipients and non-vaccinated individuals.

 Nevertheless, multiple factors could trigger arthritis flare, such as infection, stress and poor medication adherence. Flare is preventable, manageable and reversible if an appropriate regimen and dosing adjustment of DMARDs is followed. For possible flare resulting in hospitalisation, our data showed that the maximum length of stay was 6 days with no recorded registered death, indicating a satisfactory prognosis. Vaccine hesitancy is also related to the uncertainty of immunogenicity in patients with inflammatory diseases because of their immunocompromised conditions.
Epidemiology

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Patient consent for publication Not applicable.

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