Brief Communication

Changes in percutaneous coronary intervention practice in Japan during the COVID-19 outbreak: LIFE Study

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Aim: The global outbreak of coronavirus disease (COVID-19) has had widespread effects on clinical practice, and is reportedly associated with reduced percutaneous coronary intervention (PCI) rates in the US and Italy. This study aimed to ascertain the influence of the COVID-19 outbreak on PCI practice in Japan.

Methods: In a retrospective analysis of claims data from National Health Insurance and Later-Stage Elderly Healthcare System enrollees in Kobe City, Japan, we examined the changes in PCI incidence before and during the COVID-19 outbreak. Percutaneous coronary intervention incidence during the COVID-19 outbreak in 2020 was compared with that of the same (pre-outbreak) period in 2019 using a Poisson regression analysis with the monthly number of PCIs as the dependent variable.

Results: A total of 639 patients underwent PCI in Kobe City between February and May 2020. The results showed a 19% reduction in all PCI procedures during the outbreak relative to the pre-outbreak period ($P = 0.001$). There were no significant changes in non-elective PCIs for acute coronary syndrome (ACS) cases, but a 25% reduction in elective PCIs for non-ACS cases ($P < 0.001$).

Conclusions: The COVID-19 outbreak was associated with a decline in elective PCIs for non-ACS cases, but did not appear to influence non-elective PCIs for ACS cases in Japan.

Key words: Acute coronary syndrome, COVID-19 pandemic, elective surgical procedure, emergency medicine, percutaneous coronary intervention

INTRODUCTION

PERCUTANEOUS CORONARY INTERVENTION (PCI) is a well-established revascularization procedure used throughout the world to treat ischemic heart disease. The findings of the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial led to a reexamination of PCI appropriate use criteria,[1] which was subsequently followed by a general downward trend in elective procedures.[2] A comparison of PCI trends in the US and Japan found that, while non-elective PCIs had increased in the US between 2013 and 2017, elective PCIs had increased in Japan during the same period.[3] This indicated a need for improvements in the clinical practice of PCI in Japan.

The global outbreak of coronavirus disease (COVID-19) has had extensive and profound effects on clinical practice, with reports of reductions in PCI rates in the US and Italy.[4,5] In Japan, the impact of COVID-19 on PCI has been reported by a survey of hospitals,[6] but little is known from population-based surveys. This study was undertaken to ascertain the influence of the COVID-19 outbreak on PCI practice in Japan using claims data.

METHODS

THIS RETROSPECTIVE OBSERVATIONAL study was carried out using municipal-level data from the

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Received 11 Jan, 2021; accepted 15 Feb, 2021

Funding information

No funding information provided.

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LIFE Study, which is a large-scale multiregional cohort study that collects and analyzes claims data from National Health Insurance and Later-Stage Elderly Healthcare System enrollees. Data from Kobe City, Japan, were obtained for this analysis. The study was designed to investigate the changes in PCI incidence before and during the COVID-19 outbreak.

Kobe City is Japan's seventh most populous city (population: 1.5 million). The study data covered 96.1% of Kobe City residents aged ≥75 years, 66.4% of residents aged 65–74 years, and 16.5% of residents aged <65 years. The study period was from February 2020 (when COVID-19 was officially declared a "designated infectious disease" under Japan's Infectious Diseases Act) to May 2020 (when the national state of emergency was lifted). The use of PCI during this period was compared with that of the same (pre-outbreak) period in 2019. The *t*-test and χ^2-test were used to compare the differences in patient age, sex, and Charlson Comorbidity Index scores between patients in both time periods. Changes in PCI incidence were examined using a Poisson regression analysis with the monthly number of PCIs as the dependent variable. The independent variable of interest was a dummy variable of the pre-outbreak period and the outbreak period. Percutaneous coronary intervention incidence rate ratios (IRRs) and 95% confidence intervals (CIs) were calculated. The analytical models included an offset term that was the monthly number of patients who had received medical care within the past 6 months per 100,000 persons according to sex and age categories. First, a differential analysis according to disease type was undertaken to examine the changes in PCI incidence before and during the COVID-19 outbreak. Next, a subgroup analysis of sex and age categories was carried out to explore the changes in PCI incidence. A comparison with patients in 2018 was also undertaken as a sensitivity analysis.

Using an approach described in a recent study, disease types were categorized into three groups according to International Classification of Diseases, 10th Revision codes.[7] Acute coronary syndrome (ACS) cases were first classified into ST-elevation myocardial infarction (STEMI) cases and non-STEMI cases, and all other patients were classified as non-ACS cases.[7] Percutaneous coronary interventions carried out in STEMI and non-STEMI cases were considered to be non-elective, whereas PCIs carried out in non-ACS cases were considered to be elective. Age was divided into four groups: <55 years, 55–64 years, 65–74 years, and ≥75 years. The study was approved by the Institutional Review Board of Kyushu University (No. 2020-415).

RESULTS

A TOTAL OF 639 patients (mean ± standard deviation age, 75.7 ± 8.9 years; men, 70.4%) underwent PCI in Kobe City between February and May 2020. There were no significant differences in patient characteristics between 2019 and 2020 (Table 1). Acute coronary syndrome cases accounted for 42.6% of PCIs in 2020 (vs 38.0% in 2019 and 35.4% in 2018). The results showed a 19% reduction in all PCI procedures (regardless of disease type) during the outbreak relative to the pre-outbreak period ($IRR_{Overall}$, 0.81; 95% CI, 0.73–0.90; Fig. 1A). Among the disease types, there was a 25% reduction in PCIs for non-ACS cases ($IRR_{Non\text{-}ACS}$, 0.75; 95% CI, 0.66–0.86; Fig. 1B), but no significant changes in STEMI (IRR_{STEMI}, 0.97; 95% CI, 0.77–1.23) or non-STEMI ($IRR_{Non\text{-}STEMI}$, 0.86; 95% CI, 0.69–1.08) cases.

For the sex-specific subgroup analysis, men showed a 29% reduction in PCIs for non-ACS cases during the outbreak ($IRR_{Non\text{-}ACS}$, 0.71; 95% CI, 0.61–0.83; Fig. 1C); there were no significant changes in STEMI (IRR_{STEMI}, 0.93; 95% CI, 0.69–1.24) or non-STEMI ($IRR_{Non\text{-}STEMI}$, 0.81; 95% CI, 0.62–1.05) cases. No changes in PCI use

Table 1. Characteristics of patients who underwent percutaneous coronary intervention (PCI) in Kobe City, Japan, according to year

		P-value[†]
PCI numbers		
2020	639	–
2019	827	–
2018	840	–
Age, years; mean ± SD		
2020	75.7 ± 8.9	–
2019	76.1 ± 8.5	0.370
2018	76.0 ± 8.0	0.520
Sex, male; *n* (%)		
2020	450 (70.4)	–
2019	600 (72.6)	0.370
2018	581 (69.2)	0.600
CCI,[‡] mean ± SD		
2020	1.5 ± 1.2	–
2019	1.5 ± 1.1	0.360
2018	1.4 ± 1.1	0.003

–, no applicable; SD, standard deviation.
[†]*P*-values were calculated between patients before (2019 or 2018) and during the COVID-19 outbreak (2020).
[‡]Charlson Comorbidity Index (CCI) scores were calculated using diagnostic codes recorded in each patient's data during the index hospitalization.

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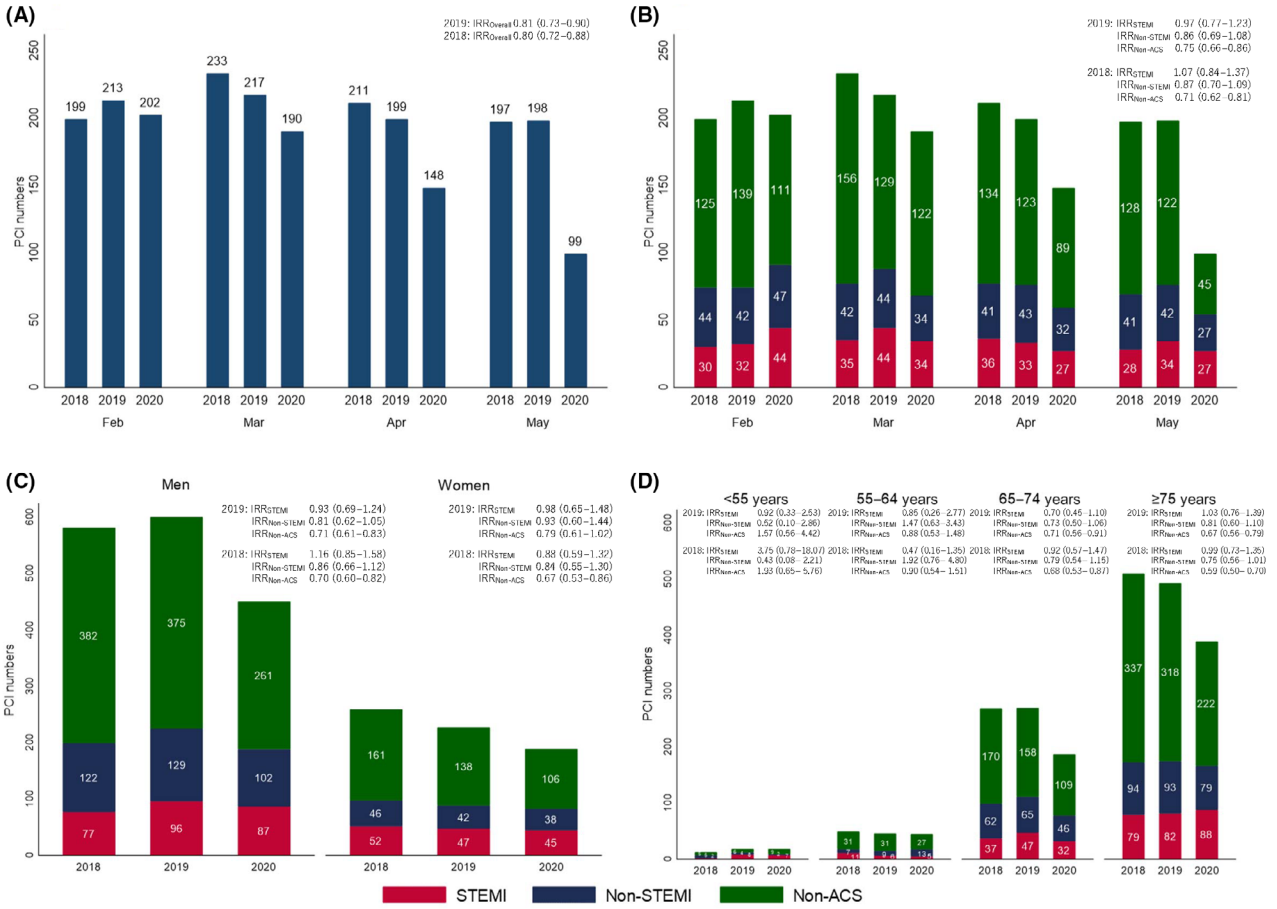

Fig. 1. Number of percutaneous coronary interventions (PCIs) in ischemic heart disease patients before and during the COVID-19 outbreak in Japan. A, PCI numbers per month during the COVID-19 outbreak in 2020 and the corresponding periods in 2019 and 2018. B, PCI numbers per month during the COVID-19 outbreak in 2020 and the corresponding periods in 2019 and 2018 according to disease type. C, Sex-specific PCI numbers during the COVID-19 outbreak in 2020 and the corresponding periods in 2019 and 2018 according to disease type. D, Age category-specific PCI numbers during the COVID-19 outbreak in 2020 and the corresponding periods in 2019 and 2018 according to disease type. ACS, acute coronary syndrome; IRR, incidence rate ratio (95% confidence intervals); Non-ACS, chronic ischemic heart disease (I25.1; I25.2; I25.3; I25.4; I25.5; I25.6; I25.8; I25.9) and other angina (I20.1; I20.8; I20.9); Non-STEMI, non-ST-elevation myocardial infarction (I21.4), myocardial infarction (unknown type) (I21.9; I22.0; I22.1; I22.8; I22.9), unstable angina (I20.0), and other acute ischemic heart disease (I24.0; I24.1; I24.8; I24.9); STEMI, ST-elevation myocardial infarction (I21.0; I21.1; I21.2; I21.3).

were observed for all disease types in women. Among the age categories, there were no changes in PCI use for patients aged <55 years and 55–64 years. For patients aged 65–74 years, the analysis showed a 29% reduction in PCIs for non-ACS cases ($IRR_{Non\text{-}ACS}$, 0.71; 95% CI, 0.56–0.91; Fig. 1D), but no significant changes in STEMI (IRR_{STEMI}, 0.70; 95% CI, 0.45–1.10) and non-STEMI ($IRR_{Non\text{-}STEMI}$, 0.73; 95% CI, 0.50–1.06) cases. For patients aged ≥75 years, the analysis showed a 33% reduction in PCIs for non-ACS cases ($IRR_{Non\text{-}ACS}$, 0.67; 95% CI, 0.56–0.79; Fig. 1D), but no significant changes in STEMI (IRR_{STEMI}, 1.03; 95% CI, 0.76–1.39) or non-STEMI ($IRR_{Non\text{-}STEMI}$, 0.81; 95% CI, 0.60–1.10) cases. The results of the sensitivity analysis (2018 vs. 2020) were almost the same as the main analysis. However, women showed a 33% reduction in PCIs for non-ACS cases during the outbreak ($IRR_{Non\text{-}ACS}$, 0.67; 95% CI, 0.53–0.86; Fig. 1C) in the sex-specific subgroup analysis.

DISCUSSION

THIS STUDY COMPARATIVELY analyzed the changes in PCI practice in Kobe City before and during the COVID-19 outbreak using IRRs.

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A study on ACS cases (including STEMI and non-STEMI) in Italy reported PCI reductions of 32–33% following the COVID-19 outbreak.[4] Although our study found a 25% reduction in elective PCIs for non-ACS cases, it detected no significant changes in non-elective PCIs for ACS cases in Japan. These results were similar to previous studies in Japan.[6] When considered together, these findings indicated that the COVID-19 outbreak did not affect urgent PCI procedures in the Japanese health-care setting.

In our sex-specific subgroup analysis, neither sex showed a reduction in PCIs for ACS cases. The previous Italian study found that PCIs for female ACS cases had substantially decreased after the emergence of COVID-19,[4] suggesting that these procedures could have been avoided or deferred for women. We found no similar trend in Japan. The subgroup analysis of age categories revealed that patients aged 65–74 years and ≥75 years experienced PCI reductions of 29% and 33%, respectively, in non-ACS cases. There were no changes for ACS cases across all age categories. The pandemic appeared to have led to a decline in elective PCIs for non-ACS cases, especially in men and older patients aged ≥65 years. Before the COVID-19 outbreak, elective PCIs were more common in Japan than the US.[3] We posit that the pandemic imposed practical limits on elective care, thereby providing an impetus for Japanese physicians to rethink the indication of these procedures. This could have manifested as our observed reduction in elective PCIs. In contrast, urgent PCI for ACS was carried out as usual in emergency medicine.

This study has the following limitations. First, the analyses were undertaken using data from a single Japanese city, and the findings have limited generalizability. Second, the disease type classifications were based on recorded diagnoses in claims data. We were therefore unable to undertake classifications based on clinical criteria, such as the degree of stenosis. Third, the offset term was the monthly number of patients who had received medical care within the past 6 months. This would have excluded patients (especially in the younger age groups) who did not use any care within that timeframe, and might have led to an underestimation of PCIs when calculating the IRRs. Finally, our study was carried out using claims data, which did not include laboratory test data. Accordingly, we could not compare laboratory test results among patients in the different periods.

CONCLUSIONS

THIS IS THE first study to examine the shifts in PCI practice following the COVID-19 outbreak using claims data in Japan. Our results showed that the pandemic was associated with a reduction in elective PCIs for non-ACS cases, but did not appear to affect urgent PCIs for ACS cases.

ACKNOWLEDGEMENTS

THIS STUDY WAS funded by a JSPS KAKENHI Grant-in-Aid for Scientific Research (Grant Number JP20H00563). The data used in this study were provided by Kobe City.

DISCLOSURES

Approval of the research protocol: The study was approved by the Institutional Review Board of Kyushu University (No. 2020-415).
Informed Consent: We posted information about this study on the city website and gave participants the opportunity to opt-out, and those who did not were considered to have provided tacit consent for study participation.
Registry and the Registration No. of the study/Trial: N/A.
Animal Studies: N/A.
Conflict of Interest: None declared.

REFERENCES

1 Boden WE, O'Rourke RA, Teo KK, *et al*. Optimal medical therapy with or without PCI for stable coronary disease. N. Engl. J. Med. 2007; 356: 1503–6.
2 Kim LK, Feldman DN, Swaminathan RV, *et al*. Rate of percutaneous coronary intervention for the management of acute coronary syndromes and stable coronary artery disease in the United States (2007 to 2011). Am. J. Cardiol. 2014; 114: 1003–10.
3 Inohara T, Kohsaka S, Spertus JA, *et al*. Comparative trends in percutaneous coronary intervention in Japan and the United States, 2013 to 2017. J. Am. Coll. Cardiol. 2020; 76: 1328–40.
4 Piccolo R, Bruzzese D, Mauro C, *et al*. Population trends in rates of percutaneous coronary revascularization for acute coronary syndromes associated with the COVID-19 outbreak. Circulation 2020; 141: 2035–7.
5 Garcia S, Albaghdadi MS, Meraj PM, *et al*. Reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 pandemic. J. Am. Coll. Cardiol. 2020; 75: 2871–2.
6 Ishii H, Amano T, Yamaji K, Kohsaka S, Yokoi H, Ikari Y. Implementation of percutaneous coronary intervention during the COVID-19 Pandemic in Japan - Nationwide Survey Report of the Japanese Association of Cardiovascular Intervention and Therapeutics for Cardiovascular Disease -. Circ. J. 2020; 84: 2185–9.
7 Mafham MM, Spata E, Goldacre R, *et al*. COVID-19 pandemic and admission rates for and management of acute coronary syndromes in England. Lancet 2020; 396: 381–9.

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