point that an adjusted definition of commotio cordis is required in cases of resuscitation. This issue will become increasingly prominent in medico-legal cases dealing with this condition as most cases will have resuscitation due to increased awareness and training, especially in sporting events, as indicated in our report. The breaking of ribs during resuscitation is a very common occurrence, a point also made by Drs. Lupariello and Di Vella in their recent review on the role of the autopsy in the diagnosis of commotio cordis. For this reason, this case was included in our report as a definitive commotio cordis diagnosis as the autopsy showed a normal heart with no contusion. We hope we have clarified this important definitional issue which we do not regard as "nullifying our work" as suggested by Drs. Lupariello and Di Vella.

With regard to the concern over the comparison to US National Registry of Sudden Death in Athletes cases, we understand the questioning over certain cases being given a diagnosis of commotio cordis without postmortem examination. Our fundamental aim with comparison to the United States was to highlight the similar demographic profile, rather than stressing numerical differences. We have highlighted the different sports that can lead to the occurrence of the condition as well as provide a broader definition outside of sport by underlining the medico-legal aspect.

We very much appreciate the requirement of postmortem examination in the diagnosis of commotio cordis, and all of our cases in this UK-based report had a full autopsy with toxicology. The aim of this report was to highlight the importance of this condition in the UK, both in sport and the wider community. We believe that this concern does not negatively influence our overarching statement that increased awareness of commotio cordis is necessary for both the pathology and forensic medicine communities.

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Temporal Trends in the Use of Intravascular Imaging Among Patients Undergoing Percutaneous Coronary Intervention for ST Elevation Myocardial Infarction in the United States

Subject Codes: ST Elevation Myocardial Infarction; Intravascular Ultrasound; Optical Coherence Tomography; Temporal Trends.

Intravascular imaging (intravascular ultrasound, IVUS and optical coherence tomography, OCT) are recommended tools to optimize stent placement during percutaneous coronary intervention (PCI).[1] The use of intravascular imaging is increasing among patients undergoing PCI for non-ST elevation myocardial infarction (NSTEMI).[2] Data on temporal trends of intravascular imaging use in the setting of ST elevation myocardial infarction (STEMI) are unknown. We performed this study to analyze trends of intravascular imaging for PCI in setting of STEMI.

We analyzed data from the National Inpatient Sample (NIS) database from 2007 to 2016. We extracted admissions with primary International Classification of Disease (ICD) 9&10 diagnosis and procedural codes for STEMI and associated PCI respectively. We then identified cases with procedural codes for IVUS and OCT. We described trend in use and compared demographic characteristics and vascular/pericardial complications between cases, both with and without intravascular imaging.

From 2007 to 2016, we identified 1,920,315 cases with a primary diagnosis of STEMI. Of these, 1,341,971 underwent PCI. The rates of STEMI decreased by 21.5% from 224,753 in 2007 to 176,440 in 2016 (p_{Trend} <0.01). The number of PCIs for STEMI increased by 5.1% from 130,601 in 2007 to 137,295 in 2016. Due to the reduction in the number of STEMIs however, the percentage of PCI for STEMI cases steadily increased for those years of our study (58.1% to 77.8%, p_{Trend} <0.01).

In the 10 years of our study, 51,118 (3.8%) and 1,390 (0.1%) of all PCIs were performed with IVUS and/or OCT guidance, respectively (Total of 52,403 [3.9%] cases). There was a significant increase in the number (3,466 [2.7%] to 7,145 [5.4%], p <0.01) and trend of increase in IVUS-guided PCI between 2007 and 2016. Although the number of OCT-guided PCI in this population also doubled between 2011 and 2016, the numbers were much lower (130 [0.1%] in 2011 and 290 [0.2%] in 2016, p = 0.22) and the trend of increase was not significant (Illustration 1a).

Patients that underwent intravascular imaging were younger and less likely to be female. There was a significant gender difference (73.8% male) in the use of intravascular imaging. Almost all (94.7%) were performed in urban hospitals. The use of imaging guided PCI was more prevalent in hospitals located in the Southern and Western United States. There were no differences in reported complications that may have been related to intravascular imaging (Illustration 1b).

Over the 10 years of this study, among cases admitted with a primary diagnosis of STEMI, there was a significant increase in the use of IVUS-guided PCI. There was a numerical increase without a significant trend of OCT-guided PCI, although these numbers remained low.

In multiple randomized control trials (RCTs) and meta-analyses of these trials, the use of imaging to optimize PCI has been shown to be beneficial in the drug eluting stent (DES) era.[3] However, in registry data of patients with STEMI, IVUS-guided PCI use did not reduce the rates of target vessel revascularization or stent thrombosis.[4] Since there are no RCTs of intravascular imaging in patients presenting with STEMI, the increase may be indirectly driven by society recommendations for its use to optimize stent placement.[1]

The use of OCT in particular continues to be very low, although increasing modestly. Interventional operators may simply be less comfortable with this newer technology. However, studies have shown that OCT is at least as good as IVUS for stent optimization.[5]

We are uncertain why imaging guided PCI in STEMI is more commonly performed in male patients, in urban centers, or in the Southern and Western parts of the country. The equivalent rates of complications related to the use of imaging catheters during PCI for STEMI is reassuring; whereas

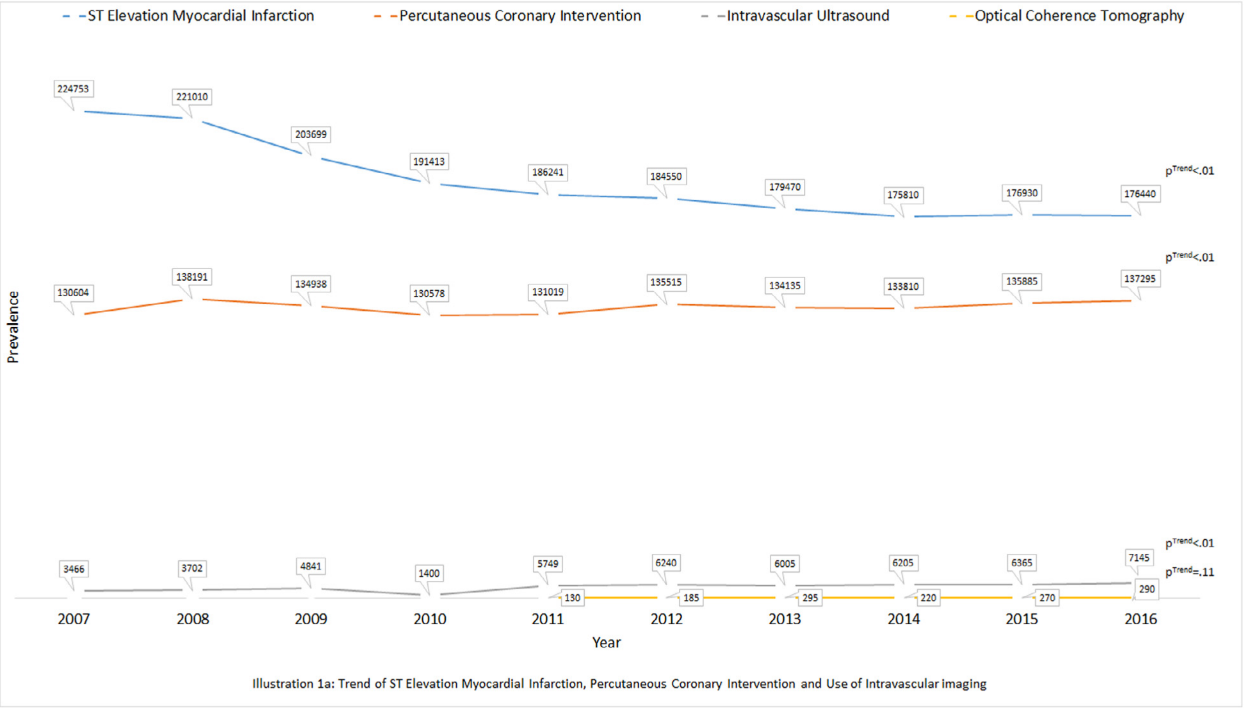

Illustration 1a. Trend of ST elevation myocardial infarction, percutaneous coronary intervention, and use of intravascular imaging.

Illustration 1b

Characteristics of cases that underwent imaging-guided percutaneous coronary intervention for ST elevation myocardial infarction versus those that did not

	Intravascular imaging (N = 54,203)	No intravascular imaging (N = 1,289,568)	p Value
Age	60.4±12.7	61.5±12.9	<0.01
Female*	13753 (26.2)	372240 (28.9)	<0.01
Caucasian	36066 (68.8)	880272 (68.3)	0.65
Black	3655 (7)	86467 (6.7)	0.57
Hispanic	3476 (6.6)	82942 (6.4)	0.60
Asian/Pacific Islander	1204 (2.3)	26769 (2.1)	0.12
Native American	325 (0.6)	6805 (0.5)	0.27
Other race	1919 (3.7)	42740 (3.3)	0.11
History of percutaneous coronary intervention	7782 (14.9)	141376 (11)	<0.01
Insurance			
Medicare	18795 (35.9)	500154 (38.8)	<0.01
Medicaid	4686 (8.9)	100440 (7.8)	<0.01
Commercial insurance	22323 (42.6)	507818 (39.4)	<0.01
Self-Pay	4544 (8.7)	118564 (9.2)	0.06
Region of hospital			
West	16465 (31.4)	238226 (18.5)	<0.01
South	17584 (33.6)	514611 (39.9)	<0.01
Midwest	11501 (21.9)	322662 (25)	<0.01
Northeast	6852 (13.1)	214069 (16.6)	<0.01
Type of institution			
Teaching hospital**	30406 (58.2)	3709929 (55.3)	0.05
Urban hospital**	49502 (94.7)	1199438 (93.5)	0.07
Complications			
Pericardial effusion	464 (0.9)	9929 (0.8)	0.26
Hemopericardium	28 (0.1)	604 (0)	0.72
Cardiac tamponade	87 (0.2)	2050 (0.2)	0.78
Pericardiocentesis	82 (0.2)	1408 (0.1)	0.11
Pericardiotomy	39 (0.1)	1001 (0.1)	0.96
Vascular complications	350 (0.7)	7426 (0.6)	0.26
Vascular complications requiring surgery	202 (0.4)	3874 (0.3)	0.10

* 141 missing.

** 124 missing.

routine use of this technology has not demonstrated a mortality advantage in this population, at least it does not increase in-hospital morbidity.

Our conclusions are limited because all data is extracted from an administrative database that is subject to coding errors and lacks many granular details of procedure-related metrics. Our study suggests that although the use of intravascular imaging for PCI in patients with STEMI remains low, there has been a subtle increase over the past 10 years.

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1. Sousa-Uva M, Neumann FJ, Ahlsson A, Alfonso F, Banning AP, Benedetto U, Byrne RA, Collet JP, Falk V, Head SJ, Jüni P, Kastrati A, Koller A, Kristensen SD, Niebauer J, Richter DJ, Seferovic PM, Sibbing D, Stefanini GG, Windecker S, Yadav R, Zembala MO. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur J Cardiothorac Surg* 2019;55:4–90.
2. Elgendy IY, Ha LD, Elbadawi A, Ogunbayo GO, Olorunfemi O, Mahmoud AN, Mojadidi MK, Abuzaid A, Anderson RD, Bavry AA. Temporal trends in inpatient use of intravascular imaging among patients undergoing percutaneous coronary intervention in the United States. *JACC Cardiovasc Interv* 2018;11:913–915.
3. Elgendy IY, Mahmoud AN, Elgendy AY, Bavry AA. Outcomes with intravascular ultrasound-guided stent implantation. *Circ Cardiovasc Interv* 2016;9:1–8.
4. Nakatsuma K, Shiomi H, Morimoto T, Ando K, Kadota K, Watanabe H, Taniguchi T, Yamamoto T, Furukawa Y, Nakagawa Y, Horie M, Kimura T. Intravascular ultrasound guidance vs. angiographic guidance in primary percutaneous coronary intervention for ST-segment elevation myocardial infarction − long-term clinical outcomes from the CREDO-Kyoto AMI registry −. *Circ J* 2015;80:477–484.
5. Jiang Y, He L-P, Gong R, Lei G-T, Wu Y-Q. Comparison of clinical outcomes between intravascular optical coherence tomography-guided and angiography-guided stent implantation. *Medicine (Baltimore)* 2019;98:e14300.

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Outcomes With Intravascular Ultrasound-Guided Drug Eluting Stent Implantation for Unprotected Left Main Coronary Lesions: A Meta-analysis

Randomized controlled trials (RCTs) have demonstrated that intravascular (IVUS) guidance improves outcomes after drug-eluting stent (DES) implantation.[1,2] However, left main coronary artery (LMCA) lesions were excluded or under-represented in these trials. With the projected increase in the rates of LMCA percutaneous coronary intervention (PCI) procedures after the publication of recent DES versus bypass surgery trials,[3] we sought to perform a meta-analysis examining the effect of IVUS-guidance on individual outcomes after DES implantation for LMCA lesions.

Electronic databases were searched from 2005 until April 2019 for published RCTs and propensity-matched or propensity-adjusted observational studies comparing IVUS-guided PCI versus angiography-guided PCI for DES LMCA implantation. Details for the keywords and databases searched have been described previously.[2] The outcomes of interest included all-cause mortality, cardiovascular mortality, myocardial infarction (MI), stent thrombosis, and target lesion revascularization. Summary estimates were calculated using the adjusted hazard ratio (HR) reported by each study. If a study did not report the HR, we used a previously validated formula to calculate the log HRs and variance log-HRs.[4] Statistical heterogeneity was evaluated using I^2, and publication bias was assessed using Egger's test. A subgroup analysis was performed to compare RCTs versus observational studies. The analysis for interaction was evaluated using random effects analysis. This meta-analysis was performed according to the PRISMA guidelines and was prospectively registered in the PROSPERO database (CRD42019132938).

A total of 9 studies (2 RCTs and 7 propensity-matched or propensity-adjusted observational studies) with 4,971 patients (2,612 in the IVUS-guided group and 2,359 in the angiography-guided group) were included. All of the included studies were specific to LMCA lesions except for one study which reported a subgroup analysis of LMCA lesions for cardiovascular mortality.[5] IVUS-guidance was associated with more frequent postdilation (70.1% vs 65.2%, p <0.001). Only 2 studies reported data pertinent to postintervention minimum lumen diameter so a meta-analysis for this outcome was not performed. The follow-up ranged from 1 to 10 years. IVUS-guidance was associated with lower incidence of all-cause mortality (HR 0.53, 95% confidence interval [CI] 0.40 to 0.70, $I^2 = 0\%$), cardiovascular mortality (HR 0.40, 95% CI 0.28 to 0.59, $I^2 = 44\%$), MI (HR 0.69, 95% CI 0.50 to 0.96, $I^2 = 0\%$), and stent thrombosis (HR 0.47, 95% CI 0.32 to 0.70, $I^2 = 0\%$; Figure 1). There was also a trend toward lower target lesion revascularization with IVUS-guidance (HR 0.76, 95% CI 0.50 to 1.16, $I^2 = 0\%$). There was no evidence of publication bias for any of the clinical outcomes using Egger's test. The benefit of IVUS-guidance was seen for both RCTs and observational studies on all the outcomes (all $P_{interaction} > 0.05$).

A consensus statement from the European Bifurcation Club has concluded that IVUS-guidance is beneficial in guiding revascularization decisions for LMCA lesions.[6] Our meta-analysis of 2 RCTs and 7 propensity-matched or adjusted observational studies with 2,612 patients in the IVUS-guided group and 2,359 in the angiography-guided group supports this consensus document indicating that IVUS-guidance of LMCA PCI with DES is associated with a lower incidence of hard outcomes—all-cause mortality, cardiovascular mortality, MI, and stent thrombosis—with no evidence of statistical heterogeneity for most outcomes.

This meta-analysis is limited by the lack of patient-level data, which might help to better identify patient and lesion-related characteristics (e.g., location of LMCA lesion) associated with the most benefit from IVUS guidance. In addition, as most of the included studies are