A Stricter Approach for Commotio Cordis in Lethal Cases

Dear Dr. William C. Roberts,

Cooper and colleagues recently proposed an interesting article that depicted the most important characteristics of the commotio cordis (CC) phenomenon as cause of sudden death in United Kingdom (UK) sports.[1] Nevertheless, as it happened for other articles that dealt with CC lethal cases,[2] in the aforementioned article the authors risk nullifying their precious work. Indeed, one of the most important things that they should have clearly reported in the article is the specific definition of CC that they used to identify CC lethal cases in their database. This method may allow to avoid uncorrected reports and to make stricter the approach to the CC topic.[2] In order to clarify the latter statement, it is useful to focalize the analysis on the case of the aforementioned article in which the authors described the presence of a broken rib. The inclusion of this case in the article is not obvious. Indeed, in the literature there are 2 different definition of CC. The first was proposed by Maron and colleagues in 1999: CC is characterized by an "instantaneous cardiac arrest that is produced by non-penetrating chest blows in the absence of heart disease or identifiable morphologic injury to the chest wall or heart".[3,4] The second definition was proposed by Nesbit and colleagues in 2001; they defined CC "as a mechanical stimulation of the heart by non-penetrating, impulse-like impact to the precordium that, through intrinsic cardiac mechanisms, gives rise to disturbances of cardiac rhythm of varying type, duration, and severity, including sudden cardiac death, in the absence of structural damage that would explain any observed effects".[5] According to Maron and colleagues the presence of rib fractures should exclude the CC diagnosis; on the contrary Nesbit and colleagues did not necessarily exclude CC in such cases.[3,5] That said, even if Cooper and colleagues did not report the CC definition that they used, a careful analysis of their article allows to hypnotize that they founded their evaluations on Maron's studies.[1] Therefore, they should have excluded from their study the case in which the rib fracture was described or they should have proposed the CC diagnosis only as possible, not as definitive.

It is important to note that the differences between the 2 definitions mentioned above and the critical issues that may come from a different approach to the diagnosis of CC lethal cases had been discussed in a recent review of all CC lethal cases available in the literature.[2] The analysis of this review could have explained one of the reasons why Cooper and colleagues stated that the incidence of CC seems to be 21.6 times greater in the United States (US National Registry of Sudden Death in Athletes) than in the UK.[1] Among all CC cases of the US National Registry of Sudden Death in Athletes, 107 cases were lethal. However, it is important to note that in 25/107 cases the autopsy had not been performed.[6] According to the literature, in these cases the definitive CC diagnosis is questionable because the autopsy is a mandatory tool to achieve a definitive diagnosis in case of sudden death.[7] In the light of the above, in their article Cooper and colleagues should have explained the limitations of the comparisons between the US CC cases and the UK ones. In particular, they compared the incidence of a series of CC definitive diagnoses (the autopsy had been performed in all UK cases) with a sample (US National Registry of Sudden Death in Athletes) that also included cases in which CC was identified without the execution of an autopsy. In the light of the above, it can be stated that this approach negatively influenced the statements of the authors.

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Defining Commotio Cordis

We appreciate the interest in commotio cordis expressed by Drs. Lupariello and Di Vella from Turin, Italy. As this entity emerged as a new cause of unexpected sudden death in young people (athletes and nonathletes alike), the criteria and definition for such events has been paramount to victims, families, researchers, and the legal community.

Although perhaps expressed somewhat differently by various authors, there is general agreement that commotio cordis is a witnessed and potentially reversible collapse (including sudden death) triggered virtually instantaneously by a blunt nonpenetrating blow of various force to the anterior precordium, and which most importantly does not inflict structural damage to the heart itself (usually documented by postmortem examination). Therefore, commotio cordis is a diagnosis of exclusion in which any other cause of arrhythmic collapse is not involved.

This is essentially the stated definition of commotio cordis that appears in our report, Cooper et al., from the United Kingdom in the *American Journal of Cardiology* (2019; June 7). Therefore, we do not believe there should be any major confusion in this regard for the readership with respect to any of the 17 cases in that report, all of which had autopsy confirmation that structural cardiac abnormalities or injury ("cardiac contusion") were absent.

In regard to the specific case at question, where broken ribs were found at postmortem examination, Drs. Lupariello and Di Vella highlight an important

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