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CASE SERIES
Coronary heart disease

Do athletes play by different rules? Obstructive coronary artery disease in asymptomatic competitive Masters athletes: a case series

James McKinney [1,2]*, Nathaniel Moulson[1,2], Barbara N. Morrison [1], Jobanjit S. Phulka [3], Phillip Yeung [3], Saul Isserow[1,2], and David A. Wood[1,2]

[1]SportsCardiologyBC, University of British Columbia, 2211 Wesbrook Mall, Vancouver, British Columbia V6K 2V8, Canada; [2]Division of Cardiology, University of British Columbia, Gordon & Leslie Diamond Health Care Centre, 2775 Laurel St, 9th Floor, Vancouver, British Columbia V5Z 1M9, Canada; and [3]Undergraduate Medical Program, University of British Columbia, 317 - 2194 Health Sciences Mall, Vancouver, British Columbia V6T 1Z3, Canada

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Background Both the age and number of endurance Masters athletes is increasing; this coincides with increasing cardiovascular risk. The vast majority of sports-related sudden cardiac deaths (SCDs) occur among athletes >35 years of age. Coronary artery disease (CAD) is the most common cause of SCD amongst Masters athletes.

Case summary In our prospective screening trial, six asymptomatic Masters athletes with ischaemia on electrocardiogram exercise stress testing had their coronary anatomy defined either by cardiac computed tomography or coronary angiography. Three patients underwent coronary angiography, with fractional flow reserve (FFR) testing performed when indicated. Subsequent percutaneous revascularization was performed in one patient after a shared-decision making process involving the patient and the referring cardiologist. All six athletes identified with obstructive CAD were male. The mean age and Framingham risk score was 61.8 years (±9.5) and 22.7% (±6.1), respectively. The mean metabolic equivalent of task achieved was 14.4 (±3.8). All athletes were treated with optimal medical therapy as clinically indicated. No cardiac events occured in 4.3 years of follow-up.

Discussion Guidelines recommend revascularization of Masters athletes to alleviate the ischaemic substrate despite a paucity of evidence that revascularization will translate into a reduction in myocardial infarct or sudden cardiac arrest/death. Herein, although a limited study population, we demonstrate a lack of clinical events after 4.3 years of follow-up whether or not revascularization was performed. A prospective multicentre registry for asymptomatic Masters athletes with documented obstructive CAD is needed to help establish the role of revascularization in this population.

Keywords Sports cardiology • Case series • Masters athletes • Sudden cardiac death • Coronary artery disease • Exercise stress testing

Learning points

- Masters athletes (≥35 years) can exhibit high cardiovascular risk, significant coronary artery disease (CAD), and silent ischaemia despite high cardiorespiratory fitness and the number of athletes with this presentation is expected to grow as the number of older competitive athletes continues to increase.
- Aggressive risk factor modification should be paramount in asymptomatic Masters athletes when obstructive CAD is discovered, and a shared informed decision to revascularize should be considered.
- The optimal approach to managing ischaemia in asymptomatic Masters athletes is uncertain, and further studies are warranted to establish the role of revascularization in this population.

* Corresponding author. Tel: +1 604 376 5469, Email: james.mckinney@ubc.ca
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Introduction

There is no disputing the tremendous health benefits of moderate intensity exercise.[1] Paradoxically, there is a slight increased risk of myocardial infarction (MI) and sudden cardiac death (SCD) during vigorous activity.[2] However, regular habitual exercise lessens this risk and results in an overall marked reduction in the risk of MI and SCD compared with sedentary counterparts.[3] The vast majority of sports-related SCDs occur among Masters athletes (those ≥35 years of age).[4,5] In a prospective population study, sports-related SCD in the young competitive athlete comprised only 6% of the total SCDs.[5] Similarly, in a prospective study from Denmark, sports-related SCD was significantly higher among athletes aged 36–49 (6.64 per 100 000 person-years) compared with athletes aged 12–35 years (0.47 per 100 000 athlete person-years).[5]

Both the age and number of endurance athletes is increasing. This is paralleled with increasing levels of cardiovascular risk (primarily driven by age).[3] Coronary artery disease (CAD) is the most common cause of SCD amongst Masters athletes.[6] As demonstrated by Marijon *et al.*,[6] CAD was identified as the cause of SCD in 84% of sports-related SCD. Moreover, 56% (20) of athletes who experienced a sports-related SCD had a prior history of CAD with 12 of 20 having a prior MI and two athletes with prior revascularization procedures.

The American Heart Association/American College of Cardiology guidelines on sport participation in athletes with CAD permit participation in all competitive sporting activities provided no ischaemia is present.[7] The European Association of Preventive Cardiology (EAPC) guidelines explicitly recommend revascularization if ischaemia is present.[8] The evidence for both recommendations is lacking. When obstructive CAD is discovered in middle-aged athletes who exercise at high intensities (and frequently push their ischaemic thresholds), should more aggressive revascularization strategies be pursued in addition to optimal medical therapy (OMT) vs. OMT alone? For athletes who exercise at a high intensity, is any ischaemia tolerable? Herein, we report a case series that helps focus attention on this clinical uncertainty/question.

Timeline

Timing	Relevant data
Screening	Seven hundred and ninety-eight recreationally competitive and high-performance Masters athletes screened
	Initial screen included history and personal symptoms questionnaire, physical exam, and Framingham Risk Score calculation (FRS)
Investigations	Athletes with a positive screen (i.e. concerning history and/or personal symptoms questionnaire, abnormal physical exam, ≥65 years of age or FRS ≥10%) underwent exercise stress testing (EST)
	Six asymptomatic athletes demonstrated ischaemia on electrocardiogram EST
	Five of six patients underwent coronary computed tomography angiography as their initial follow-up test. One patient went directly to coronary angiogram
	Ultimately, three of the six patients underwent coronary angiography and two underwent fractional flow reserve testing
	Athletes were educated about revascularization and optimal medical therapy (OMT) for coronary artery disease (CAD)
	Two of six athletes demonstrated a moderate amount of psychological distress from their diagnosis of asymptomatic CAD
Treatment	All six athletes received OMT
	One athlete was revascularized via percutaneous coronary intervention with drug-eluting stents after a shared decision-making process
Follow-up	Annual clinical follow-up with EST
	No cardiac events over a period of 4.3 years
	Secondary prevention targets achieved

Case presentation

We screened 798 recreationally competitive and high-performance Masters athletes as part of the Masters Athlete Screening Study,[9] designed to assess cardiovascular risk and ascertain the prevalence of cardiovascular disease in athletes ≥35 years of age in British Columbia, Canada. Those athletes with a Framingham risk score (FRS) ≥10%, symptoms, abnormal electrocardiogram, family history, or abnormal physical examination underwent exercise stress testing (EST). This case series includes six of the athletes screened who were asymptomatic with no angina, anginal equivalents, or decreases in performance despite demonstrating ischaemia on EST.

Athletes that demonstrated ST depression on EST were counselled regarding OMT and further evaluation procedures. Athletes were educated about OMT with or without revascularization in a shared decision-making approach. Coronary anatomy was initially defined either by coronary computed tomography angiography and/or invasive coronary angiography. Ultimately, three patients underwent invasive coronary angiography with fractional flow reserve (FFR) testing performed when indicated; subsequent percutaneous revascularization with drug-eluting stents were performed after consultation with both the patient and referring cardiologist in one patient. Descriptive results were presented as absolute numbers, means, and standard deviations.

All of the athletes identified with obstructive CAD were male. Their mean age and FRS was 61.8 years (±9.5) and 22.7% (±6.1), respectively. Their mean metabolic equivalent of task (METS) achieved on EST was 14.4 (±3.8). All were able to achieve >85% maximum

Table 1 Master athletes' clinical characteristics

Patient	Age	Gender	FRS (%)	Score (%)	METS	DTS	CCTA	MIBI	Cardiac catheterization	Intervention	IMPACT score summary
1	67	Male	29.4	5	13.4	-3	Proximal RCA 70%	NA	Proximal RCA 80% (non-dominant)	No DES—shared decision-making	No impact
2	55	Male	21.0	2	18.7	8.5	Proximal LCx 70%	NA	LAD 80% (FFR 0.77)	DES to LAD	No impact
3	77	Male	29.4	2	7.9	-9	Straight to cardiac catheterization	Normal	LAD 60% (FFR 0.79); OM2 60%	No DES—shared decision-making	Moderate impact
4	60	Male	21.6	3	17.0	3	100% CTO mid RCA	Normal	NA	NA	No impact
5	62	Male	21.6	4	16.0	16	Distal LAD >90%	Normal (exercise stress ECHO)	NA	NA	Moderate impact
6	50	Male	13.3	1	13.1	EQ	OM3 70–99%; IR >90%	Normal	NA	NA	No impact

CCTA, coronary computed tomography angiography; DES, drug-eluting stent; DTS, Duke treadmill score; FFR, fractional flow reserve; FRS, Framingham Risk Score; IMPACT score, Impact of Event Scale-Revised (IES-R) assesses psychological response to a diagnosis[20]; IR, intermediate ramus; LAD, left anterior descending artery; LCx, left circumflex artery; METS, metabolic equivalents; OM, obtuse marginal; RCA, right coronary artery.

age-predicted heart rate. All athletes were treated with acetylsalicylic acid, statin, beta-blockade, and angiotensin-converting enzyme inhibitor where clinically indicated. In 4.3 years of follow-up no cardiac events occurred, and secondary prevention targets were achieved. A description of each athlete's clinical profile, investigations, and management can be seen in *Table 1*.

Discussion

Herein, we present a case series of middle-aged athletes who were found to have ischaemia on EST and obstructive CAD on subsequent testing. These athletes represent an interesting, emerging clinical dilemma. Should asymptomatic middle-aged athletes with obstructive CAD and demonstrable ischaemia be revascularized? Is any degree of ischaemia too much for an athlete with an ischaemic substrate who routinely pushes his or her physiologic limits?

The COURAGE trial demonstrated no difference in all-cause mortality between an initial strategy of percutaneous coronary intervention (PCI) plus OMT vs. OMT alone.[10] Efforts to identify subgroups of COURAGE patients who may have a survival advantage after an initial strategy of PCI + OMT have been unsuccessful.[11,12] The level of cardiorespiratory fitness prior to randomization in the COURAGE study, and the effect on outcomes has been examined.[13] No significant differences in death and/or MI were observed between patients <7 and ≥7 METS on initial exercise testing. Is it fair to extrapolate the findings of COURAGE onto middle-aged athletes who frequently push their physiologic limits? An argument could be made that if a middle-aged athlete can achieve ≥10 METS, which most athletes can do with ease, that their prognosis is excellent regardless of the presence of CAD. By virtue of these athletes' high cardiorespiratory fitness their prognosis in terms of cardiovascular and all-cause mortality should be quite favourable irrespective of the presence or severity of CAD.[14] Radford *et al.*[15] demonstrated in a large cohort study that higher cardiorespiratory fitness results in an attenuation of cardiovascular disease risk. Furthermore, the prognosis of subjects with profound ST depression (>2 mm) with good exercise capacity (>9 min) is good in medically treated CAD patients.[16] However, it could be countered that the presence of ischaemia coupled with high-intensity exercise may *potentially* increase the risk of a cardiac event in these individuals despite their expected favourable prognosis.

A number of changes and physiologic stressors that occur during vigorous activity or shortly thereafter can convert a stable substrate with underlying disease into an unstable one. The mechanisms of SCD in Masters athletes with underlying CAD include: plaque rupture and its sequelae, demand ischaemia leading to ventricular arrhythmia, or ventricular arrhythmia from a prior scar.[17] In a study of marathon runners who experienced SCD in whom serious CAD was discovered, not a single runner had evidence of plaque rupture or thrombus, suggesting mismatch or demand ischaemia may have been the underlying aetiology that leads to the SCD.[18] Although revascularization can improve blood flow and lesson or abolish ischaemia, it does not ameliorate the underlying atherosclerotic substrate of the athlete. Non-flow-limiting plaques (which would not be mechanically intervened upon) have the potential to lead to acute coronary events.[19]

Table 2 Considerations of revascularization with percutaneous coronary intervention in Masters athletes

Pro for revascularization	Con for revascularization
Athlete preference	No evidence that revascularization decreases mortality in this setting
Superior reduction in anginal symptoms	Expensive procedure
Potential avoidance of beta-blocker therapy	Early procedural risks (death, MI, stroke, vascular injury, bleeding, and renal injury)
Removal of an ischaemic substrate with potential reduction of ventricular arrhythmia	Downstream risks of PCI (in-stent restenosis, in-stent thrombosis)
May allow for participation in regulated sporting events	Cost and increased risk of bleeding with DAPT
	Does not ameliorate the athlete's underlying atherosclerotic substrate
	Possible false reassurance

DAPT, dual anti-platelet therapy; MI, myocardial infarction; PCI, percutaneous coronary intervention.

However, revascularization may favourably alter flow dynamics and lessen supply demand disparities and reduce a susceptible substrate thereby decreasing the potential for ventricular arrhythmia. This dilemma is further complicated by the suggestion that current FFR cut-off values may not be appropriate to assess for a flow-limiting lesion at the extremes of physiologic stress endured by high-level athletes. Considerations for revascularization are presented in *Table 2*.

Regardless of the decision to revascularize or not, aggressive risk factor modification is paramount, and a shared-informed decision with the athlete should take place. Despite recommendations by the EAPC supporting revascularization in individuals with CAD experiencing continued ischaemia, one must acknowledge and disclose to the athlete that the clinical benefit to revascularize an asymptomatic athlete with high fitness has not been demonstrated. The question remains: Do athletes play by different rules when it comes to revascularization? Are they at higher risk than the non-athlete COURAGE patient and we should empirically suggest revascularization? Or should we take comfort in the fact that an athletes' superior cardiorespiratory fitness affords them a favourable prognosis irrespective of revascularization?

The athletes who made the decision not to have a stent placed have not experienced any cardiac events to date, nor has the athlete who underwent left anterior descending artery stenting. The small numbers of athletes included in this case series, and the duration of follow-up limits our ability to make firm conclusions. Rather, the intent of this case series is to shine light on this emerging clinical situation and re-focus our attention on whether or not we should be empirically revascularizing these fit asymptomatic athletes without firm evidence that revascularization procedures will translate into a reduction of morbidity and mortality.

Conclusion

Despite high cardiorespiratory fitness Masters athletes are not immune to elevated cardiovascular risk and cardiac disease. In addition to aggressive risk factor modification, the optimal approach to manage their ischaemia is uncertain. Providing clarity to this clinical dilemma is a challenging endeavour. A randomized control trial would likely not be feasible given the low number of patients currently fulfilling the above criteria, and the expected low number of cardiac events in this population with high cardiorespiratory fitness. Given the interest in this expanding population, a prospective multicentre registry for asymptomatic competitive endurance Masters athletes with documented obstructive CAD is needed to help answer these crucial unresolved questions.

Lead author biography

Dr James McKinney is a Clinical Assistant Professor in the Division of Cardiology at the University of British Columbia. Dr McKinney obtained his degree in medicine from the University of Toronto. He subsequently completed internal medicine and cardiology fellowship at the University of British Columbia. Dr McKinney then completed subspecialty fellowships in cardiac rehabilitation and sports cardiology. Presently, he is the director of research at SportsCardiologyBC. Dr McKinney's clinical and research interests focus on pre-participation screening of young and Masters athletes and improving the safety of exercise in persons with underlying cardiac conditions.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

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