Temporal Trends in the Prevalence, Severity, and Localization of Myocardial Ischemia and Necrosis at Myocardial Perfusion Imaging After Myocardial Infarction

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The definition, presentation, and management of myocardial infarction (MI) have changed substantially in the last decade. Whether these changes have impacted on the presence, severity, and localization of necrosis at myocardial perfusion imaging (MPI) has not been appraised to date. Subjects undergoing MPI and reporting a history of clinical MI were shortlisted. We focused on the presence, severity, and localization of necrosis at MPI with a retrospective single-center analysis. A total of 10,476 patients were included, distinguishing 5 groups according to the period in which myocardial perfusion scintigraphy had been performed (2004 to 2005, 2006 to 2007, 2008 to 2009, 2010 to 2011, 2012 to 2013). Trend analysis showed over time a significant worsening in baseline features (e.g., age, diabetes mellitus, and Q waves at electrocardiogram), whereas medical therapy and revascularization were offered with increasing frequency. Over the years, there was also a lower prevalence of normal MPI (from 16.8% to 13.6%) and ischemic MPI (from 35.6% to 32.8%), and a higher prevalence of ischemic and necrotic MPI (from 12.0% to 12.7%) or solely necrotic MPI (from 35.7% to 40.9%, p <0.001). Yet the prevalence of severe ischemia decreased over time from 11.4% to 2.0%, with a similar trend for moderate ischemia (from 15.9% to 11.8%, p <0.001). Similarly sobering results were wound for the prevalence of severe necrosis (from 19.8% to 8.2%) and moderate necrosis (from 8.5% to 7.8%, p = 0.028). These trends were largely confirmed at regional level and after propensity score matching. In conclusion, the outlook of stable patients with previous MI has substantially improved in the last decade, with a decrease in the severity of residual myocardial ischemia and necrosis, despite an apparent worsening in baseline features. **(Am J Cardiol 2017;120:1238–1244)**

The main characterizations of myocardial infarction (MI) are based on Q waves and ST segment changes at electrocardiogram,[1–3] thus distinguishing Q-wave versus non-Q-wave MI and ST elevation MI (STEMI) versus non-ST elevation MI (NSTEMI)[2–5]. Improvements in MI prevention and treatment have reduced its incidence, lead to fewer STEMI, and globally improved its prognosis. Yet an aging population with frequent co-morbidities implies that MI will remain a common condition. Temporal trends in MI are well established, but there are no precise data on temporal changes of myocardial ischemia or necrosis after MI. This is at odds with details on myocardial ischemia in naïve patients[6]. Awareness of trends in myocardial ischemia and necrosis in stable patients after MI would prove important to appraise the impact of current management strategies and plan treatment and rehabilitation.

Methods

This is a sub-analysis of an ongoing retrospective study based on our administrative myocardial perfusion imaging (MPI) database, whose details have been already provided elsewhere[6, 7]. Patients provided written informed consent for data collection and analysis, and the main retrospective study was approved by the competent review board.

Patients undergoing MPI since 2004 for the diagnostic or prognostic work-up of coronary artery disease and reporting MI (defined as the presence of clinical symptoms or signs of myocardial ischemia, associated with increased cardiac biomarkers, pathologic Q waves at the electrocardiogram, akinesis or dyskinesis at left ventricle imaging studies) occurring 6 months or more before MPI were identified, excluding those aged <18 years. Stress testing was based on bicycle stress or dipyridamole. ^{201}Thallium (IBA Molecular Italy, Monza, Italy)

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was used for peak and rest single-photon emission computed tomography. A dual-head gamma camera (Millennium MG or Millennium MyoSIGHT, GE Healthcare, Milan, Italy) was used for imaging.

Semiquantitative interpretation of stress or rest images was performed based on a 7-region model, finally obtaining for each region a 5-point scoring system (from 0 [normal uptake] to 4 [severely reduced or absent uptake]). This score directly yielded 5 classes of maximal ischemia score, with the final maximal ischemia score strictly depending on the worst region of perfusion. Similarly, a maximal necrosis score was computed, distinguishing 5 classes (from 0 [no necrosis] to 4 [severe necrosis]). Gated single-photon emission computed tomography was used to appraise regional contractility distinguishing 4 separate classes (0—normokinesis; 1—hypokinesis; 2—akinesis; 3—dyskinesis)[7, 8].

Continuous variables are reported as mean ± standard deviation. Categorical variables are reported as n (%). After distinguishing patients in 5 groups according to the period in which myocardial perfusion scintigraphy had been performed (2004 to 2005, 2006 to 2007, 2008 to 2009, 2010 to 2011, 2012 to 2013). Bivariate analyses were performed using analysis of variance and Cuzick tests for continuous variables and chi-square test for trend for categorical variables. To adjust for baseline confounders, we computed a propensity score for the 2004 to 2005 and 2012 to 2013 groups, and matched patients 1:1 with a 0.001 propensity caliper. Then, we performed unpaired *t* tests and chi-square tests on propensity-matched patients. Statistical significance was set at the 2-tailed 0.05 level, and p values unadjusted for multiplicity are reported throughout. Computations were performed with Stata 13 (StataCorp, College Station, TX).

Results

A total of 10,476 patients were included in the analysis: 3,279 (31.3%) undergoing myocardial perfusion scintigraphy in 2004 to 2005, 2,385 (22.8%) in 2006 to 2007, 1,863 (17.8%) in 2008 to 2009, 1,613 (15.4%) in 2010 to 2011, and 1,336 (12.8%) in 2012 to 2013 (Table 1). Trend analysis highlighted several important temporal changes in baseline and procedural features. Overall, these changes suggested a significant worsening in the global risk profile of the patients, together with a shift toward more percutaneous

Table 1
Patient characteristics

Characteristic	Period					Total (n = 10,476)	Overall p	p for trend
	2004-5 (n = 3279)	2006-7 (n = 2385)	2008-9 (n = 1863)	2010-11 (n = 1613)	2012-13 (n = 1336)			
Age (years)	63.7 ± 9.8	63.7 ± 10.2	64.6 ± 10.3	64.9 ± 10.3	66.1 ± 10.2	64.3 ± 10.1	<0.001	<0.001
Women	581 (17.7%)	424 (17.8%)	337 (18.1%)	307 (19.0%)	231 (17.3%)	1880 (18.0%)	0.760	0.730
Height (cm)	169.0 ± 7.6	169.1 ± 7.9	169.2 ± 7.9	169.5 ± 8.1	169.8 ± 8.0	169.3 ± 7.9	0.009	<0.001
Weight (kg)	77.7 ± 12.4	78.5 ± 12.9	79.2 ± 12.9	79.0 ± 13.5	79.6 ± 13.4	78.6 ± 13.0	<0.001	<0.001
Body surface area (m2)	1.90 ± 0.20	1.91 ± 0.20	1.92 ± 0.19	1.92 ± 0.20	1.93 ± 0.21	1.91 ± 0.20	<0.001	<0.001
Body mass index (kg/m2)	27.2 ± 3.6	27.4 ± 3.8	27.6 ± 3.9	27.4 ± 3.9	27.6 ± 3.9	27.4 ± 3.8	<0.001	0.002
Family history of CAD	1440 (43.9%)	1150 (48.2%)	971 (52.1%)	844 (52.4%)	716 (53.7%)	5121 (48.9%)	<0.001	<0.001
Smokers							0.020	0.028
Never	865 (26.4%)	564 (23.7%)	477 (25.6%)	396 (25.6%)	334 (25.0%)	2636 (25.2%)		
Former	1854 (56.5%)	1433 (60.1%)	1057 (56.7%)	908 (56.3%)	738 (55.2%)	5990 (57.2%)		
Current	560 (17.1%)	387 (16.2%)	329 (17.7%)	309 (19.2%)	264 (19.8%)	1849 (17.7%)		
Dyslipidemia	2006 (61.2%)	1554 (65.2%)	1161 (62.3%)	1010 (62.6%)	840 (62.9%)	6571 (62.7%)	0.049	0.508
Diabetes mellitus							<0.001	<0.001
None	2393 (73.0%)	1713 (71.9%)	1275 (68.4%)	1070 (66.3%)	868 (65.0%)	7319 (70.0%)		
Diet therapy	140 (4.3%)	139 (5.8%)	141 (7.6%)	106 (6.6%)	108 (8.1%)	634 (6.1%)		
Oral hypoglycemic agents	609 (18.6%)	434 (18.2%)	341 (18.3%)	339 (21.0%)	281 (21.0%)	2004 (19.1%)		
Insulin	135 (4.1%)	98 (4.1%)	106 (5.7%)	98 (6.1%)	79 (5.9%)	516 (4.9%)		
Prior percutaneous coronary intervention	1591 (48.5%)	1362 (57.1%)	1207 (64.8%)	1123 (69.6%)	974 (72.9%)	6257 (59.7%)	<0.001	<0.001
Prior coronary artery bypass grafting	747 (22.8%)	496 (20.8%)	355 (19.1%)	305 (18.9%)	226 (16.9%)	2129 (20.3%)	<0.001	<0.001
Rest electrocardiogram								
Q waves	510 (15.6%)	524 (22.0%)	398 (21.4%)	300 (18.6%)	300 (22.5%)	2032 (19.4%)	<0.001	<0.001
ST abnormalities	1134 (34.6%)	1088 (45.6%)	1078 (57.9%)	1058 (65.6%)	842 (63.0%)	5200 (49.6%)	<0.001	<0.001
T abnormalities	253 (7.7%)	177 (7.4%)	137 (7.4%)	112 (6.9%)	102 (7.6%)	781 (7.5%)	0.905	0.599
Medical Rx								
ACE inhibitor or AII blocker	2118 (64.6%)	1630 (68.3%)	1333 (71.6%)	1185 (73.5%)	951 (71.2%)	7217 (68.9%)	<0.001	<0.001
Antiplatelet agent	2805 (85.5%)	2134 (89.5%)	1685 (90.5%)	1459 (90.5%)	1197 (89.6%)	9280 (88.6%)	<0.001	<0.001
Beta-blocker	1834 (55.9%)	1485 (62.3%)	1232 (66.1%)	1137 (70.5%)	899 (67.3%)	6587 (62.9%)	<0.001	<0.001
Calcium-channel antagonist	914 (27.9%)	600 (25.2%)	399 (21.4%)	297 (18.4%)	276 (20.7%)	2486 (23.7%)	<0.001	<0.001
Nitrate	1312 (40.0%)	764 (32.0%)	517 (27.8%)	357 (22.1%)	244 (18.3%)	3194 (30.5%)	<0.001	<0.001
Statin	2215 (67.6%)	1796 (75.3%)	1437 (77.1%)	1311 (81.3%)	1097 (82.1%)	7856 (75.0%)	<0.001	<0.001

ACEi = angiotensinogen converting enzyme; AII = angiotensin II; CAD = coronary artery disease.

Table 2
Stress and global myocardial perfusion imaging characteristics

Characteristic	Period					Total (n = 10,476)	Overall p	p for trend
	2004-5 (n = 3279)	2006-7 (n = 2385)	2008-9 (n = 1863)	2010-11 (n = 1613)	2012-13 (n = 1336)			
Exercise stress	2765 (84.3%)	2119 (88.9%)	1623 (87.1%)	1363 (84.5%)	1116 (83.5%)	8986 (85.8%)	<0.001	0.241
Anginal pain during stress	371 (11.3%)	373 (15.6%)	364 (19.5%)	384 (23.8%)	385 (28.8%)	1877 (17.9%)	<0.001	<0.001
% of predicted maximum heart rate	88.6 ± 7.8	87.7 ± 7.7	85.7 ± 8.1	88.0 ± 7.8	90.0 ± 7.8	88.0 ± 7.9	<0.001	0.096
Workload (Watt)	96.7 ± 37.5	99.2 ± 40.4	101.1 ± 38.5	107.3 ± 41.3	100.2 ± 38.7	100.2 ± 39.2	<0.001	<0.001
Metabolic equivalents of task	12.6 ± 4.6	12.8 ± 4.9	13.0 ± 4.7	13.8 ± 5.1	12.8 ± 4.7	12.9 ± 4.8	<0.001	<0.001
ST-segment deviation (mm)	1.86 ± 1.92	1.73 ± 2.02	1.65 ± 2.01	1.43 ± 1.99	1.31 ± 1.85	1.62 ± 1.96	<0.001	<0.001
Left ventricular ejection fraction (%)	50.0 ± 12.1	53.7 ± 12.4	54.7 ± 13.0	57.2 ± 14.1	56.1 ± 13.2	53.6 ± 13.1	<0.001	<0.001
End-diastolic volume index (mm/m2)	97.6 ± 48.7	88.3 ± 46.8	83.9 ± 44.9	77.7 ± 43.5	77.3 ± 40.9	87.1 ± 46.4	<0.001	<0.001
Myocardial perfusion scintigraphy								
Overall test results							<0.001	<0.001
Normal	552 (16.8%)	450 (18.9%)	272 (14.6%)	228 (14.1%)	182 (13.6%)	1684 (16.1%)		
Ischemic	1166 (35.6%)	812 (34.1%)	661 (35.5%)	583 (36.1%)	438 (32.8%)	3660 (34.9%)		
Ischemic and necrotic	392 (12.0%)	283 (11.9%)	256 (13.7%)	210 (13.0%)	170 (12.7%)	1311 (12.5%)		
Necrotic	1169 (35.7%)	840 (35.2%)	674 (36.2%)	592 (36.7%)	546 (40.9%)	3821 (36.5%)		
Maximal ischemia score							<0.001	<0.001
No ischemia	1721 (52.5%)	1290 (54.1%)	946 (50.8%)	820 (50.8%)	728 (54.5%)	5505 (52.6%)		
Minimal ischemia	195 (6.0%)	182 (7.6%)	193 (10.4%)	214 (13.3%)	151 (11.3%)	935 (8.9%)		
Mild ischemia	469 (14.3%)	387 (16.2%)	362 (19.4%)	360 (22.3%)	274 (20.5%)	1852 (17.7%)		
Moderate ischemia	521 (15.9%)	411 (17.2%)	314 (16.9%)	193 (12.0%)	157 (11.8%)	1596 (15.2%)		
Severe ischemia	373 (11.4%)	115 (4.8%)	48 (2.6%)	26 (1.6%)	26 (2.0%)	588 (5.6%)		
Maximal necrosis score							<0.001	0.028
No necrosis	1718 (52.4%)	1262 (52.9%)	933 (50.1%)	811 (50.3%)	620 (46.4%)	5344 (51.0%)		
Minimal necrosis	233 (7.1%)	204 (8.6%)	187 (10.0%)	203 (12.6%)	234 (17.5%)	1061 (10.1%)		
Mild necrosis	399 (12.2%)	380 (15.9%)	348 (18.7%)	302 (18.7%)	269 (20.1%)	1698 (16.2%)		
Moderate necrosis	279 (8.5%)	208 (8.7%)	145 (7.8%)	127 (7.9%)	104 (7.8%)	863 (8.2%)		
Severe necrosis	650 (19.8%)	331 (13.9%)	250 (13.4%)	170 (10.5%)	109 (8.2%)	1510 (14.4%)		

revascularizations, less surgical revascularizations, and comprehensive improvements in medical therapy. Temporal changes in baseline features were mirrored by temporal differences in stress features (Table 2).

Analysis of temporal trends in MPI showed over the years a lower prevalence of normal MPI (from 16.8% to 13.6%) and ischemic MPI (from 35.6% to 32.8%), and a higher prevalence of ischemic and necrotic MPI (from 12.0% to 12.7%) or solely necrotic MPI (from 35.7% to 40.9%, p <0.001) (Figure 1). Notably, the prevalence of severe ischemia decreased over time from 11.4% to 2.0%, with a similar trend for moderate ischemia (from 15.9% to 11.8%) (Figure 2). Similarly, favorable results for changes in the prevalence of severe necrosis (from 19.8% to 8.2%) and moderate necrosis (from 8.5% to 7.8%, p = 0.028) (Figure 3).

Moving from the patient to the regional level of analysis (Table 3) showed a progressive increase in the prevalence of apical, inferior, posterior, and lateral ischemia (all p <0.05). Necrosis was more common over the years in the anterior proximal-mid, septal, inferior, and posterior regions (all p <0.001). Finally, regional akinesis or dyskinesis appeared less common over time in the apical regions, but more common in the septal and lateral regions (all p <0.05).

Discussion

Coronary artery disease continues to carry a substantial morbidity and mortality burden[1]. Acutely, the risk of arrhythmias or mechanical complications remains important, whereas, chronically, the adverse effect on myocardial function continues to impact even on stable patients. Yet there have been dramatic changes in the way MI presents and is approached over the years[2–4]. Physicians have modified substantially their definitions and classifications, moving progressively toward more sensitive albeit potentially less specific ones[4]. Incidence rates have also changed substantially, and overall age- and sex-adjusted rates have declined, with an accompanying shift toward more NSTEMI than STEMI[5]. In addition, short- and long-term prognoses of MI have significantly improved. Several factors play a role, on top of population trends and patient features, including prevention, treatment, and rehabilitation strategies. For instance, mechanical reperfusion of STEMI and invasive management for NSTEMI have become commonplace. Indeed, this is well shown locally, as our center serves a large catchment area in the Lazio region in Italy. Corresponding figures for the uptake of primary or rescue percutaneous coronary intervention (PCI) or any PCI for our period of interest highlight that in our region of more than 5 million inhabitants, there were 1,428 primary or rescue PCI and 8,428 any PCI in 2004, in comparison with as many as 2,648 and 11,002, respectively, in 2013.[9] Adjusting for changes in the population size, this amounts to a ratio of primary or rescue PCI per 10,000 inhabitants*year of 2.7 in 2004 and 4.5 in 2013, whereas the ratio for any PCI went from 16.0 to 18.7. Although the successes of our fight against MI are many, we continue to face the growing epidemic of patients with heart failure, who feature, at least in part, some of the very acute MI patients

Table 3
Regional myocardial perfusion imaging characteristics

Characteristic	Period					Total (n = 10,476)	Overall p	p for trend
	2004-5 (n = 3279)	2006-7 (n = 2385)	2008-9 (n = 1863)	2010-11 (n = 1613)	2012-13 (n = 1336)			
Regional ischemia								
Apical	452 (13.8%)	315 (13.2%)	342 (18.4%)	276 (17.1%)	181 (13.6%)	1566 (15.0%)	<0.001	0.024
Anterior distal	204 (6.2%)	112 (4.7%)	90 (4.8%)	70 (4.3%)	73 (5.5%)	549 (5.2%)	0.025	0.060
Anterior proximal-mid	177 (5.4%)	109 (4.6%)	82 (4.4%)	80 (5.0%)	86 (6.4%)	534 (5.1%)	0.064	0.400
Septal	129 (3.9%)	47 (2.0%)	42 (2.3%)	41 (2.5%)	45 (3.4%)	304 (2.9%)	<0.001	0.105
Inferior	808 (24.6%)	554 (23.2%)	475 (25.5%)	426 (26.4%)	377 (28.2%)	2640 (25.2%)	0.010	0.003
Posterior	670 (20.4%)	433 (18.2%)	482 (25.9%)	380 (23.6%)	264 (19.8%)	2229 (21.3%)	<0.001	0.031
Lateral	339 (10.3%)	271 (11.4%)	190 (10.2%)	152 (9.4%)	111 (8.3%)	1063 (10.2%)	0.042	0.018
Regional necrosis								
Apical	851 (26.0%)	604 (25.3%)	504 (27.1%)	437 (27.1%)	365 (27.3%)	2761 (26.4%)	0.535	0.159
Anterior distal	475 (14.5%)	329 (13.8%)	284 (15.2%)	239 (14.8%)	174 (13.0%)	1501 (14.3%)	0.398	0.623
Anterior proximal-mid	183 (5.6%)	114 (4.8%)	114 (6.1%)	125 (7.8%)	115 (8.6%)	651 (6.2%)	<0.001	<0.001
Septal	231 (7.0%)	152 (6.4%)	156 (8.4%)	141 (8.7%)	123 (9.2%)	803 (7.7%)	0.003	<0.001
Inferior	492 (15.0%)	373 (15.6%)	336 (18.0%)	296 (18.4%)	286 (21.4%)	1783 (17.0%)	<0.001	<0.001
Posterior	414 (12.6%)	302 (12.7%)	338 (18.1%)	282 (17.5%)	251 (18.8%)	1587 (15.2%)	<0.001	<0.001
Lateral	227 (6.9%)	178 (7.5%)	132 (7.1%)	109 (6.8%)	89 (6.7%)	735 (7.0%)	0.876	0.618
Regional akinesis or dyskinesis*								
Apical	365 (22.6%)	450 (19.2%)	349 (18.9%)	292 (18.2%)	249 (18.7%)	1705 (19.5%)	0.013	0.007
Anterior distal	95 (5.9%)	124 (5.3%)	107 (5.8%)	104 (6.5%)	92 (6.9%)	522 (6.0%)	0.294	0.078
Anterior proximal-mid	11 (0.7%)	12 (0.5%)	2 (0.1%)	14 (0.9%)	19 (1.4%)	58 (0.7%)	<0.001	0.008
Septal	87 (5.4%)	101 (4.3%)	140 (7.6%)	134 (8.4%)	115 (8.6%)	577 (6.6%)	<0.001	<0.001
Inferior	137 (8.5%)	102 (4.4%)	99 (5.4%)	118 (7.4%)	92 (6.9%)	548 (6.3%)	<0.001	0.794
Posterior	117 (7.3%)	88 (3.8%)	94 (5.1%)	98 (6.1%)	85 (6.4%)	482 (5.5%)	<0.001	0.526
Lateral	10 (0.6%)	31 (1.3%)	32 (1.7%)	38 (2.4%)	32 (2.4%)	143 (1.6%)	<0.001	<0.001

* Regional wall motion analysis available in a total of 8,744 patients (respectively 1,616, 2,345, 1,848, 1,604, and 1,331).

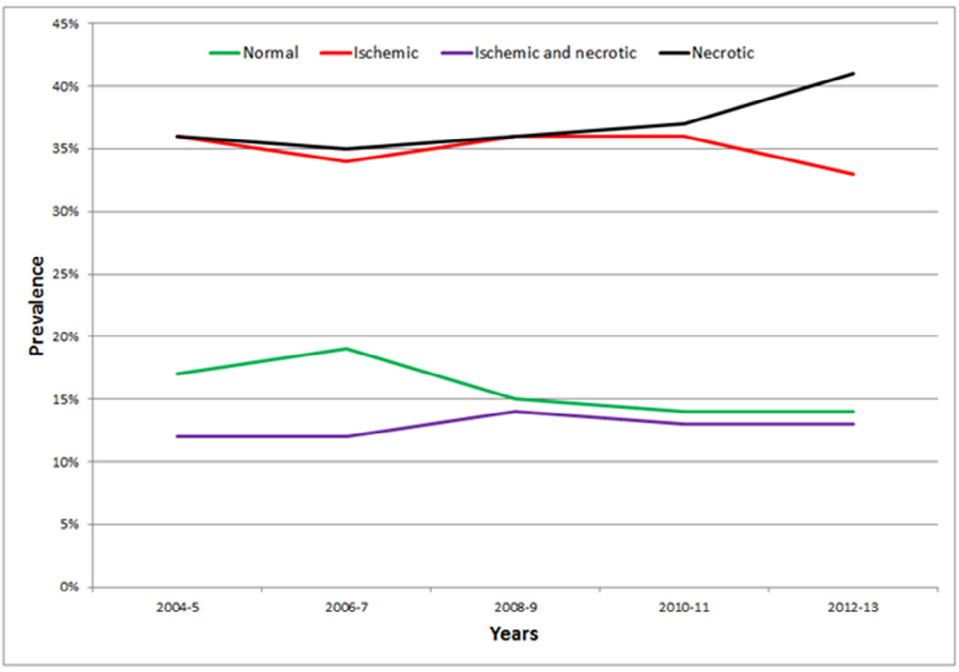

Figure 1. Temporal trends in overall results of myocardial perfusion imaging in patients with a clinical history of myocardial infarction.

we have saved from death in the first place but who will end up developing chronic complications of MI.

Temporal trends in stable naïve patients undergoing MPI have already been analyzed in detail, highlighting an increase in the prevalence of normal scans and an overall improvement in the ischemic outlook[6, 10, 11]. Yet there are no studies to date focusing specifically on temporal trends in myocardial ischemia and necrosis (or viability) in stable patients

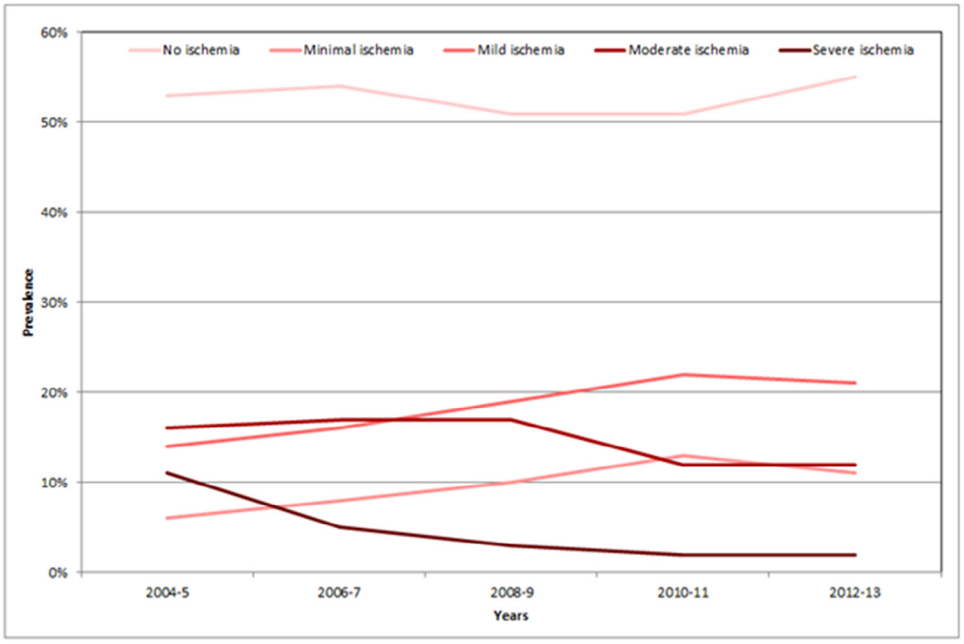

Figure 2. Temporal trends in maximal ischemia score (MIS) at myocardial perfusion imaging in patients with a clinical history of myocardial infarction.

Table 4
Patient characteristics in propensity-matched patients from 2004 to 2005 and from 2012 to 2013

	Period		p
	2004-5 (n = 853)	2012-13 (n = 853)	
Age (years)	65.1 ± 9.2	65.0 ± 10.3	0.732
Female gender	147 (17.2%)	148 (17.4%)	0.949
Height (cm)	169.6 ± 7.6	169.4 ± 7.8	0.538
Weight (kg)	79.2 ± 12.9	78.7 ± 12.8	0.419
Body surface area (m2)	1.93 ± 1.84	1.92 ± 1.88	0.369
Body mass index (kg/m2)	27.5 ± 3.8	27.4 ± 3.7	0.508
Family history of CAD	424 (49.7%)	432 (50.6%)	0.698
Smoking history			0.898
Never	213 (25.0%)	221 (25.9%)	
Former	479 (56.2%)	471 (55.2%)	
Current	161 (18.9%)	161 (18.9%)	
Dyslipidemia	545 (63.9%)	538 (63.1%)	0.725
Diabetes mellitus			0.461
None	583 (68.4%)	594 (69.6%)	
Diet therapy	54 (6.3%)	58 (6.8%)	
Oral hypoglycemic agents	176 (20.6%)	153 (17.9%)	
Insulin	40 (4.7%)	48 (5.6%)	
Prior percutaneous coronary intervention	563 (66.0%)	568 (66.6%)	0.798
Prior coronary artery bypass grafting	169 (19.8%)	165 (19.3%)	0.807
Rest electrocardiogram			
Q waves	170 (19.9%)	184 (21.6%)	0.403
ST abnormalities	452 (53.0%)	453 (53.1%)	0.961
T abnormalities	67 (7.9%)	67 (7.9%)	1
Medical Rx			
ACE inhibitor or AII blocker	575 (67.4%)	590 (69.2%)	0.435
Antiplatelet agent	754 (88.4%)	755 (88.5%)	0.940
Beta-blocker	555 (65.1%)	551 (64.6%)	0.839
Calcium-channel antagonist	188 (22.0%)	200 (23.5%)	0.488
Nitrate	222 (26.0%)	203 (23.8%)	0.288
Statin	682 (80.0%)	673 (78.9%)	0.590

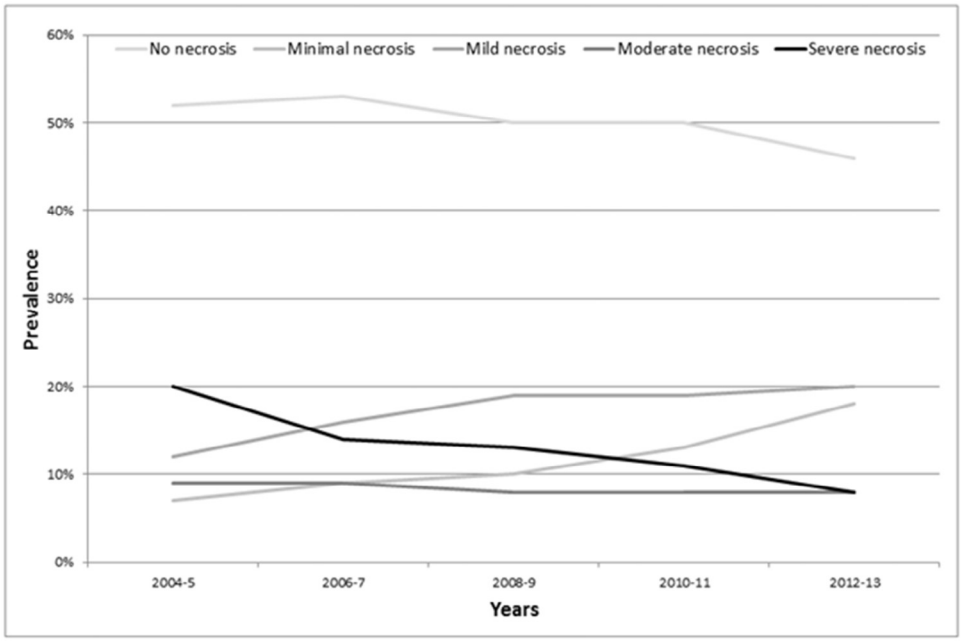

Figure 3. Temporal trends in maximal necrosis score (MNS) at myocardial perfusion imaging in patients with a clinical history of myocardial infarction.

Table 5
Stress and global myocardial perfusion imaging characteristics in propensity-matched patients from 2004 to 2005 and from 2012 to 2013

Characteristic	Period		p
	2004-5 (n = 853)	2012-13 (n = 853)	
Exercise stress	722 (84.6%)	717 (84.1%)	0.739
Anginal pain during stress	118 (13.8%)	234 (27.4%)	<0.001
% of predicted maximum heart rate	88.5 ± 7.6	90.1 ± 7.7	<0.001
Workload (Watt)	93.5 ± 37.1	102.9 ± 38.1	<0.001
Metabolic equivalents of task	11.9 ± 4.5	13.2 ± 4.6	<0.001
ST-segment deviation (mm)	2.18 ± 1.94	1.21 ± 1.81	<0.001
Left ventricular ejection fraction (%)	48.8 ± 11.9	57.0 ± 13.2	<0.001
End-diastolic volume index (mm/m2)	101.3 ± 49.8	75.1 ± 38.6	<0.001
Myocardial perfusion scintigraphy			
Overall test results			0.425
Normal	109 (12.8%)	133 (15.6%)	
Ischemic	288 (33.8%)	281 (32.9%)	
Ischemic and necrotic	118 (13.8%)	113 (13.3%)	
Necrotic	338 (39.6%)	326 (38.2%)	
Maximal ischemia score			<0.001
No ischemia	447 (52.4%)	459 (53.8%)	
Minimal ischemia	39 (4.6%)	100 (11.7%)	
Mild ischemia	133 (15.6%)	176 (20.6%)	
Moderate ischemia	136 (15.9%)	100 (11.7%)	
Severe ischemia	98 (11.5%)	18 (2.1%)	
Maximal necrosis score			<0.001
No necrosis	397 (46.5%)	414 (48.5%)	
Minimal necrosis	64 (7.5%)	143 (16.8%)	
Mild necrosis	122 (14.3%)	166 (19.5%)	
Moderate necrosis	83 (9.7%)	63 (7.4%)	
Severe necrosis	187 (21.9%)	67 (7.9%)	

Table 6
Regional myocardial perfusion imaging characteristics in propensity-matched patients

Characteristic	Period		p
	2004-5 (n = 853)	2012-13 (n = 853)	
Regional ischemia			
Apical	114 (13.4%)	120 (14.1%)	0.673
Anterior distal	50 (5.9%)	47 (5.5%)	0.754
Anterior proximal-mid	47 (5.5%)	57 (6.7%)	0.312
Septal	33 (3.9%)	35 (4.1%)	0.805
Inferior	205 (24.0%)	244 (28.6%)	0.032
Posterior	175 (20.5%)	161 (18.9%)	0.394
Lateral	98 (11.5%)	69 (8.1%)	0.018
Regional necrosis			
Apical	246 (28.8%)	233 (27.3%)	0.484
Anterior distal	140 (16.4%)	110 (12.9%)	0.040
Anterior proximal-mid	53 (6.2%)	72 (8.4%)	0.078
Septal	76 (8.9%)	73 (8.6%)	0.797
Inferior	147 (17.2%)	163 (19.1%)	0.315
Posterior	143 (16.8%)	146 (17.1%)	0.846
Lateral	64 (7.5%)	52 (6.1%)	0.248
Regional akinesis or dyskinesis*			
Apical	123 (26.7%)	157 (18.5%)	0.001
Anterior distal	33 (7.2%)	58 (6.8%)	0.824
Anterior proximal-mid	4 (0.9%)	7 (0.8%)	0.935
Septal	35 (7.6%)	74 (8.7%)	0.482
Inferior	52 (11.3%)	57 (6.7%)	0.004
Posterior	41 (8.9%)	49 (5.8%)	0.033
Lateral	4 (0.9%)	17 (2.0%)	0.118

* Regional wall motion analysis available in a total of 1,310 patients (respectively 461 and 849).

with clinical MI. The present study aimed indeed to address this issue. We found that, despite a worsening baseline profile and an increase in the prevalence of abnormal scans, the severity of myocardial necrosis and myocardial ischemia improved over time, in keeping with similar favorable trends on left ventricle dimension and systolic function. These results confirm that our ongoing preventive, therapeutic, and rehabilitative efforts appear to have, at least in part, succeeded in improving the outlook of patients with MI as far as ischemic and necrotic burden are concerned. Yet several unmet needs remain, and it should be borne in mind that even minor areas of necrosis may still impact detrimentally on patient symptoms, signs, or prognosis (e.g., by promoting arrhythmias or unfavorable remodeling).

This work has several limitations, including the retrospective design, the single-center setting, and the use of administrative data. In addition, we relied on clinical history and patient documents to define a clinical MI, and thus we cannot exclude the impact of information bias, on top of selection and referral bias. Another limitation is the lack of ancillary testing modalities, including fractional flow reserve (invasive or noninvasive) and coronary flow reserve (invasive or noninvasive), which could have proven important for both diagnostic and prognostic characterization of the patients[12]. Finally, complete revascularization during or after MI can also impact on subsequent MPI results, but this detailed analysis was beyond the scope of our work[13].

In conclusion, the outlook of stable patients with previous MI has substantially improved in the last decade, with a decrease in the severity of residual myocardial and necrosis, despite an apparent worsening in baseline features (Tables 4–6).

Disclosures

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