RESEARCH ARTICLE

Influence of obesity on in-hospital clinical outcomes after recanalization of chronic total occlusions

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OBJECTIVES: Recanalization of chronic total occlusions (CTOs) in interventional cardiology is one of the most challenging and complex procedures. Currently, no data is available about the impact of BMI on success rates among CTO patients undergoing percutaneous coronary intervention. The aim of this study was to investigate the impact that BMI has on success rates, complications and procedure characteristics among a large group of CTO patients that underwent percutaneous coronary intervention.

METHODS: The present study retrospectively included 420 patients who underwent percutaneous coronary intervention for at least one chronic total occlusion in the Hospital of Lithuanian University of Health sciences clinics of Kaunas. All patients were grouped by the BMI level based on the World Health Organization classification. Statistical analyses were performed using the SPSS 20.0 software. The value of $p<0.05$ was considered as statistically significant.

RESULTS: Positive correlations were detected between body mass index level and cardiovascular risk factors, as well as the duration of the procedure, fluoroscopy time, likewise amount of used contrast increased with the increase of BMI ($p<0.05$). Nevertheless, there was no statistical significant difference across all body mass index categories in terms of procedure success, complication rates, and outcomes ($p>0.05$).

CONCLUSION: This retrospective study indicates that BMI has no impact on in-hospital outcomes in patients with chronic total occlusion after percutaneous coronary intervention.

Key Words: *Obesity; Chronic total occlusion; Percutaneous coronary intervention; Coronary artery disease*

INTRODUCTION

Recanalization of chronic total occlusions (CTOs) in interventional cardiology is one of the most challenging and complex procedures [1]. Coronary artery CTOs can be identified in around one in every five patients that show clinical indications for coronary angiography [2]. Recanalization of CTOs is indicated in cases of progressing angina symptoms, with evidence of significant myocardial ischemia [3]. After recanalization in these patients, an increase in left ventricular function can be expected [4]. Due to the emerging methods in interventional cardiology and the use of new CTO equipment's, CTO recanalization success rates have increased steadily in recent years [5]. Moreover, coronary artery bypass grafts (CABG) can be avoided which can result in lower complication rates [6].

Worldwide obesity levels have increased over recent decades [7]. Obesity in particular, severe obesity are linked to a heightened risk of cardiovascular disease (CVD) as BMI is a strong predictor of cardiovascular mortality [8,9].

Despite the heightened risks, the in-hospital outcomes after CTO percutaneous coronary interventions (PCI) remain unstudied in this population. Accordingly, this study retrospectively evaluates the impact of BMI on success and complication rates, as well as procedure characteristics among a large group of CTO patients undergoing PCI.

METHODS AND MATERIALS

Study population

A total of 420 patients that underwent CTO-PCI at the Lithuanian University of health and science clinics of Kaunas were included in this study. Criteria for inclusion were a positive test for angina pectoris and/or positive result for functional ischemia from a stress echocardiography or magnetic resonance imaging test. Patients were subdivided into groups according to their BMI. BMI groups were based on the World Health Organization's definitions [10]

- From 18.5 to 24.9 kg/m^2=Normal weight
- From 25 to 29.9 kg/m^2=Overweight
- From 30 to 34.9 kg/m^2=Obesity
- Greater than or equal to 35 kg/m^{2-}Very obese

CTO-PCI procedure

Either radial or femoral access was chosen according to operator choice. The diameter of guiding catheters was either 6 or 7F. Heparin was administered at the start of interventions, guided by a clotting time of greater than 300 seconds, in order to prevent thromboembolic complications. All PCIs were performed via anterograde approach. In most cases, dual injections were made to define the length of the lesion and for the conformation that PCI guide wire is in the true lumen. In case of femoral access, the puncture site was sealed using manual compression or various vascular closure devices.

Coronary wires ranged from tapered polymer soft-tip guide wires at the start to super-stiff guide wires at the end. In almost all cases, drug-eluting stents were implanted in the occluded segments. Stent apposition and expansion was optimized by post-dilatation.

In order to subdivide the patients according to the complexity of the CTO-PCI, the Japanese-CTO (J-CTO) score was used prior to the interventions [11]. This combined the following parameters:

- Lesion classification degree.
- Bending in excess of 45 degrees in the CTO segment.
- Blunt proximal cap.
- Occluded segment length (>20 mm).
- Previously failed recanalization.

The definition of success in the procedure was a restoration of TIMI grade 3 flow and recanalization of CTO. Each patient undergoing the procedure had a composite safety endpoint evaluation. This summarized severe complications including stroke, cardiac tamponade, vascular complications or in-hospital death.

STATISTICAL ANALYSIS

Continuous variables are shown as median; mean ± standard deviation and minimum maximum. Category variables are presented as percentages and frequencies. Normal distribution was tested for using the 'Shapiro: Wilk' test. 'Mann: Whitney U' test or the 'Kruskal: Wallis' test was used as appropriate for continuous variables and the Fisher exact test for categorical variables.

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This study was given approval by the Research Ethics Committee of the Government of Kaunas (Lithuania). The study complies with the principles laid down in the Declaration of Helsinki, adopted by the 18th World Medical Assembly, Helsinki, Finland, June 1964, and recently amended at the 59th World Medical Assembly, Seoul, Korea, October 2008.

RESULTS

Demographics

Males (62%) made up the majority of patients with a mean age of 68 years (± 5.4 years). Male patients were younger than female (67 ± 7.1 years vs. 72.2 ± 4.4 years; p<0.001). Mean BMI was 26.8 kg/m^2 (±6.5 kg/m^2). From the 420 patients the following BMIs were recorded:

- Normal weight – 42 (10%)
- Overweight - 252 (60%)
- Obese - 100 (23.8%)
- Very obese - 26 (6.2%)

Risk factors

There was a positive correlation between rising BMI categories and the cardiovascular risk elements such as arterial hypertension, diabetes mellitus and family history of coronary artery disease. Compared to patients with a BMI greater than 25 kg/m^2, patients with normal weight showed higher HDL cholesterol (p<0.05) and lower triglycerides (p<0.05). Very obese patients had a higher incidence of diabetes mellitus compared to other subgroups (p=0.015). Overweight patients had a higher rate of chronic obstructive pulmonary disease and lower peripheral arterial disease prevalence.

Procedural characteristics

Procedural and CTO characteristics are displayed in Table 1. All BMI categories had a similar J-CTO score (p>0.05). The amount of contrast medium used increased as BMI increased (p=0.012). The fluoroscopy time tended to increase proportionally with rising BMI (p=0.03). Procedure duration of normal patients was lower as compared to patients with non-normal BMIs (p=0.024). Success rates were similar across all BMI categories (p=0.622; Figure 1).

TABLE 1

Procedural and angiographic characteristics

Variables	Normal	Overweight	Obese	Very obese	P-value
CTO in LAD	28.6% (12)	28.6% (72)	32% (32)	34% (9)	0.65
CTO in LCX	23.8% (10)	31.7% (80)	18% (18)	27% (7)	
CTO in RCA	47.6% (20)	39.7% (100)	50% (50)	38.5% (10)	
1 vessel disease	26.2% (11)	20.7% (52)	35% (35)	26.9% (7)	0.84
2 vessel disease	28.6% (12)	31.7% (80)	29% (29)	26.9% (7)	
3 vessel disease	45.2% (19)	47.6% (120)	36% (36)	46.2% (12)	
J-CTO score ≥ 3	59.5% (25)	65% (164)	63% (63)	57.7% (15)	0.58
Amount of contrast (ml)	220 (80-320)	260 (100-500)	290 (120-650)	350 (200-800)	0.012
Procedure Time (min)	60.5 (30-109)	126.1 (60-190)	160.7 (60-230)	190.2 (90-260)	0.024
Fluoroscopy time (min)	25.6 (6-40)	30.1 (12-60)	35.4 (15-94)	40.2 (20-95)	0.03

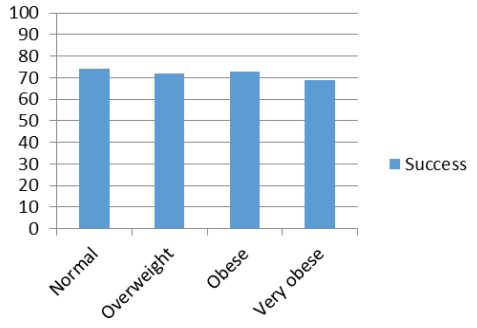

Figure 1) *Percentage of success depending on BMI*

Complication rates

There was no statistically significant difference in procedural complications, which rarely occurred (p=0.12). There were no acute skin lesions witnessed as radiation doses increased with higher BMI categories (p<0.001). Complications that did occur were mostly vascular. In three cases cardiac tamponade occurred. Similarly, three patients were diagnosed with acute stroke after CTO-PCI. No in-hospital deaths were recorded (Figure 2).

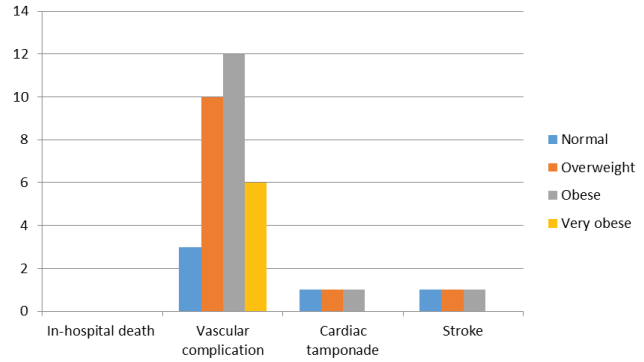

Figure 2) *In-hospital outcomes*

DISCUSSION

The study highlights some important aspects. Firstly, successful procedures and complications in the hospital proved to be independent from BMI categories. This finding seems quite remarkable, given that we already are aware of overweight and obese patients from Western countries having a higher likelihood of getting a wound infection following CABG [12]. This suggests that CTO-PCIs might be a safer alternative to CABG in very obese patients.

Secondly, patients in higher BMI categories had an increase in prevalence of cardiovascular risk factors, such as arterial hypertension, diabetes mellitus, dyslipidemia, triglyceride and HDL-cholesterol levels. These co-morbidities are related to the metabolic syndrome and are in line with current literature on the subject [13].

Thirdly, there was a significant difference in procedure duration, volume of used contrast medium and other procedural characteristics in higher BMI categories. Obese patients had higher doses of radiation (p<0.001) and longer procedure times (p=0.026). Dermal ulcerations could be a serious consequence of such procedures, although there is no supporting data from our study due to the short follow-up period. Nevertheless, it has been proved by Lia et al. that dermal ulcerations can occur during PCIs, especially in CTO's as there is an increase of these lesions with higher radiation doses [14]. Thus, given a longer follow-up period, higher radiation-associated complication rates could be expected in obese patients.

There are divergent opinions on the relationship between BMI and outcomes in CAD patients. The 'obesity paradox' is that despite obesity being a strong CVD development risk factor, mortality rates for obese and very obese patients are low. One possible reason for this paradox is that obese patients may be observed more and therefore receive faster medical intervention. Also, obese patients tend to be younger when the acute cardiovascular event occurs. This could imply that there is benefit regarding age [15].

A Korean study published in 2012 revealed that the relation between BMI and mortality was U-shaped, with the nadir among overweight or obese patients and underweight and normal-weight patients having the highest risk [16]. Their definition of obese, however, was a BMI greater than 25 kg/m^2, not 30, as in our study. Also, half of patients in their study had 1st generation drug-eluting stents (DES) implanted. In the long term, overweight patients, particularly men, had a reduced mortality rate after CTO-PCI, according to a study conducted in USA in 2010 [17]. The patients in their study, however, were older than those in our study.

Contrasting trials, in line with our own, have failed to indicate a relationship between BMI and PCI survival. For instance, data presented from over 5000 patients led to Diletti et al.'s conclusion that, following coronary artery interventions, BMI had no impact on the long-term clinical outcomes [18].

Another method of treatment considered as a substitute for CTO patients could be CABG. Some data indicates that mortality was not increased by obesity in short term perspective; however, this is associated with an increase in late mortality rates. [19].

We can demonstrate that there is no dependence between in-hospital clinical events and BMI. This is in contrast with the previous data that suggested that very obese and lean patients are at greater risk following PCI [20].

CONCLUSION

Our ex-post facto study indicates that obesity have no impact on in-hospital outcomes in CTO-PCI patients. This retrospective study indicates that BMI has no impact on in-hospital outcomes in patients with chronic total occlusion after percutaneous coronary intervention.

CONFLICT OF INTEREST

No conflict of interest.

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