Minimally invasive direct coronary artery bypass (MIDCAB) – safety assessment in own material

Małoinwazyjne pomostowanie naczyn wieńcowych (MIDCAB) – ocena bezpieczeństwa w materiale własnym

Introduction: Minimally invasive direct coronary artery bypass (MIDCAB) allows achieving similar safety and efficacy, with markedly reduced post-operative length of stay when compared to conventional surgical revascularization. Despite promising results, a small number of minimally invasive procedures are performed in Poland. The aim of the study is to assess short- and long-term outcome of MIDCAB revascularization in order to evaluate the safety of the procedure.

Material and Methods: Retrospective observational study analyzing 38 consecutive patients who underwent MIDCAB procedure between 2014 to 2016 in the Department of Cardiovascular Surgery and Transplantology at the John Paul II Hospital, Kraków. Perioperative data was obtained from patient medical records and the median follow-up period valued 17.3 months.

Results: No postoperative deaths and only 1 case of postoperative myocardial infarction were observed. Throughout the follow-up period, the survival rate and freedom from MACCE rate valued 100%, with only 1 case of repeated revascularization.

Conclusions: Minimally invasive revascularization is a safe procedure which can be performed with excellent short- and long-term outcome in low-risk patients.

According to the European Society of Cardiology (ESC) Guidelines, revascularization in stable CAD with proximal left anterior descending (LAD) artery involvement is recommended as the best treatment option, and coronary artery bypass grafting (CABG) proves to be beneficial over percutaneous coronary intervention (PCI) in terms of recurrent angina and repeat revascularization [5-7]. Nevertheless, although the prevalence of cardiovascular diseases accrues with age, an increasing number of young patients suffering from CAD is being observed worldwide [8,9]. These individuals are in...
need of minimally invasive procedures which represent an attractive alternative to a sternotomy and at the same time provide better life quality and ease quick rehabilitation [10,11]. Similar safety and efficacy, and markedly reduced post-operative length of stay when compared to conventional on- and off-pump CABG are very promising. However, increased post-operative pain that results from spreading of the ribs may require more aggressive pain management in early postoperative period [12-14].

Despite promising results, a small number of minimally invasive and conventional off-pump procedures (reaching 2.2 and 7.8% in 2015 respectively) are being performed at our Institution.

The aim of the study is to assess short- and long-term outcome of Minimally Invasive Direct Coronary Artery Bypass (MID-CAB) revascularization in order to evaluate the safety of the procedure.

**Material and Methods**

In a retrospective observational study we analyzed 38 consecutive patients who underwent MIDCAB procedure between 2014 to 2016 in the Department of Cardiovascular Surgery and Transplantology at the John Paul II Hospital, Kraków. Data was obtained from patient medical records. Follow-up data were obtained as a part of outpatient clinic appointment.

Most of the operated patients were males (62.4%), and the mean age in the study cohort was 63 yo. Nearly all of the individuals suffered from hypertension (92.1%). However, other comorbidities were not observed with such a high incidence - i.e. hyperlipidemia (36.8%), diabetes (26.3%), peripheral artery disease (PAD) (7.9%). Moreover, none of the individuals suffered from chronic obstructive pulmonary disease (COPD) or chronic kidney disease (CKD). Patients usually had preserved left ventricular ejection fraction (LVEF, median 55%), and the risk assessed preoperatively was usually low (median EuroSCORE II 0.73%) (Tab. I).

All surgeries were performed through a left anterolateral minithoracotomy. After making a 5- to 6-cm skin incision in the fifth intercostal space, the pectoralis muscle was displaced bluntly with minimal division following the muscle fiber orientation. Left Internal Mammary Artery (liMA) harvesting was then performed under direct vision, and anastomoses were performed with a use of vacuum stabilizer. Nearly all of the individuals were operated electively (97.4%) and the median procedure time valued 177.5 (75-215) minutes. liMA was used in nearly all cases (97.4%) and riMA was harvested and implanted in one patient.

Postoperative complications were assessed, including death from cardiac and non-cardiac causes, MACCE (defined as any postoperative MI, death from cardiac causes and acute stroke), prolonged mechanical ventilation (>48 hours), excessive bleeding requiring rethoracotomy, need for blood products transfusions, deep wound infection. Moreover, ICU and overall hospitalization time were also analyzed.

Follow-up questionnaire included current CCS class, MACCE, hospitalization due to cardiac causes, requirement for repeated revascularization, and death from cardiac and non-cardiac causes.

**Results**

Within perioperative period, no deaths before discharge were reported and only 1 case of postoperative MI was observed. In this individual, subsequent bypass angiography was performed and early graft failure was diagnosed.

Prolonged mechanical ventilation was observed in 2 individuals (5.3%), and 2 other patients required rethoracotomy (5.3%). Both of these procedures were performed through previous incision, and in one case pleural hematoma was evacuated and in another bleeding from the incision was supplied. No other post-operative complications were observed (Tab. II).

**Table I**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Analyzed population, n=38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>62.9 (±9.9)</td>
</tr>
<tr>
<td>Male sex, n (%)</td>
<td>26 (68.4)</td>
</tr>
<tr>
<td>Diabetes, n (%)</td>
<td>10 (26.3)</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>35 (92.1)</td>
</tr>
<tr>
<td>Hyperlipidemia, n (%)</td>
<td>14 (36.8)</td>
</tr>
<tr>
<td>PAD, n (%)</td>
<td>3 (7.9)</td>
</tr>
<tr>
<td>CCS, class</td>
<td>2 (2-3)</td>
</tr>
<tr>
<td>LVEF, %</td>
<td>55 (50-60)</td>
</tr>
<tr>
<td>EuroSCORE II, %</td>
<td>0.73 (0.61-0.95)</td>
</tr>
</tbody>
</table>

Data shown as mean ± SD or as median (IQR), or number (percentage). Abbreviations: PAD, Peripheral Artery Disease; CCS, Canadian Cardiovascular Society; LVEF, Left Ventricle Ejection Fraction

**Table II**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Analyzed population, n=38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>MACCE, n (%)</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Cardiac death, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>MI, n (%)</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Acute stroke, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Prolonged mechanical ventilation, n (%)</td>
<td>2 (5.3)</td>
</tr>
<tr>
<td>Rethoracotomy, n (%)</td>
<td>2 (5.3)</td>
</tr>
<tr>
<td>Deep wound infection, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>ICU stay, days</td>
<td>1 (1-1)</td>
</tr>
<tr>
<td>Hospitalization time, days</td>
<td>8 (7-9)</td>
</tr>
<tr>
<td>Blood products transfusions, n (%)</td>
<td>6 (21.2)</td>
</tr>
</tbody>
</table>

Data shown as mean ± SD or as median (IQR), or number (percentage). Abbreviations: MACCE, Major Adverse Cardiac and Cerebrovascular Event; MI, Myocardial Infarction; ICU, Intensive Care Unit

![Figure 1](image)

**Figure 1**

Freedom from hospitalization from cardiac causes.

Krzywa Kaplana-Meiera dla zgonów z przyczyn sercowych.
Moreover, there were only 8 (21.2%) individuals who required blood products transfusion. In 6 (75%) cases, only 1 unit of any blood product was transfused - 2 patients received 1 unit of Packed red blood Cells (PrbC), 4 received 1 unit of Fresh Frozen Plasma (FFP).

The median ICU length of stay was 1 day and patients were usually discharged at day 8 post-surgery.

Follow-up data were obtained from 32 (84.2%) of the patients. The median follow-up period was 17.3 (8.3-25.3) months. From hospital discharge to follow-up appointment, the survival rate and freedom from MACCE rate valued 100%. Moreover, only 1 (3.1%) case of repeated revascularization and 3 (9.4%) cases of hospitalization due to cardiac causes were reported (Fig. 1,2). The statistically significant improvement in angina symptoms, defined by CCS class, was also observed (2 (2-3) vs 1 (1-1); p<0.01) (Fig. 3).

Discussion

Despite improved techniques and experience, part of the morbidity related to CABG is due to extracorporeal circulation. Two large international randomized trials have recently shown no difference in 30-day or 1-year clinical outcomes between on- and off-pump surgery when performed by experienced surgeons [15-17]. Therefore, MIDCAB procedures have found a widespread application since its introduction in the mid-1990s. The minimally invasive approach combines the benefits of postoperative complications reduction and the use of the arterial graft that is known of its great long-term patency (over 80% 10-15 yrs post-surgery) [18].

However, the greatest issue aside from the surgeon’s experience remains the management of general anesthesia. Since the minimally invasive approach requires single-lung ventilation (via a double-lumen tube), patients suffering from COPD and other pulmonary diseases cannot benefit from this technique. Moreover, another contraindication to MIDCAB is obesity. Although the LIMA harvesting is technically possible in obese patients, the pressure placed on the wound edges by the retractor can lead to tissue necrosis and wound infections. Similarly, female patients with large breasts are at increased risk of wound complications [19].

Nevertheless, the outcome of MIDCAB procedures presented in the literature is excellent and most of the studies report low in-hospital mortality (usually below 1%), and low postoperative complications incidence (i.e. chest wound complications value approximately 2-3%, and bleeding requiring rethoracotomy 1-3%) [20]. Few reported major complications included the one case of the LIMA graft rupture 6 weeks post-surgery, and 1.8% incidence of incisional hernias which required operative repair was observed in another study [21,22]. However, the general incidence of complications which result from operative technique is low and the possibility of eliminating sternal dehiscence and deep wound infection, which undoubtedly worsen the outcome and increase the hospitalization costs, is warrantable and would be beneficial especially for elderly patients [23,24].

In the study cohort, the incidence of postoperative complications was low, and observed mortality rate with no deaths reported is very satisfactory, especially in a center with moderate experience with minimally invasive revascularization. On the other hand, beneficial results may be caused by the fact that the cohort comprised mostly of low-risk patients with preserved left ventricular function and therefore no direct conclusions regarding the use of technique in general may be drawn. However, achieved low incidence of blood products transfusions and ICU length of stay should be emphasized. These results allow not only to diminish the risk of worse outcome but also to decrease the costs of hospitalization [25,26].

The beneficial or non-inferior long-term outcomes have been reported when
compared to DES implantation and conventional off- and on-pump CABG [27-29]. Similar promising results regarding freedom from MACCE and repeated revascularization were also observed in the study cohort. However, reports considering and comparing the long-term outcome and graft patency after minimally invasive revascularization are still lacking and warrantable. Nevertheless, great experience with LIMA graft patency and its influence on long-term freedom from MACCE, repeated revascularization, and death, allow optimism and patient benefits seem to outweigh the difficulties involved with complex intubation and surgical technique.

Conclusions
Minimally invasive revascularization is a safe procedure which can be performed with excellent short- and long-term outcome in low-risk patients. The obtained results are very promising. However, the patient selection for the procedure should be performed carefully.

References