Our Anaesthetic Experiences in Patients Undergoing Percutaneous Mitraclip Implantation

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Objective: Percutaneous mitraclip implantation system, is a new technique developed for patients with high surgical risks. It is generally performed in a catheterization laboratory with the guidance of fluoroscopy and transesophageal echocardiography. In this study, we aimed to share our experiences on anaesthetic in patients undergoing mitraclip implantation under general anaesthesia.

Methods: Eighty four patients with severe, symptomatic mitral insufficiency, who had undergone MitraClip implantation under general anaesthesia between July 2012 and March 2015 (54 male, 30 female; mean age: 68.5±10.2 years) were retrospectively investigated in terms of anaesthetic management.

Results: Of the 84 patients undergoing percutaneous mitraclip implantation under general anaesthesia, 84.5% had sodium thiopental and 75% had midazolam for anaesthesia induction. For the maintenance of anaesthesia, 57% of the patients were reported to have sevoflurane, whereas the rest had desflurane. The mean duration of the procedure and anaesthesia was 140.9±48.2 mins and 165.7±50.6 min, respectively. Seventy seven patients were transported to the intensive care unit and intubated after the procedure. The median extubation time was 3 h. Length of stay in the intensive care unit was 2 days, whereas it was 4 days for hospital stay. One patient died during the procedure and six patients died after the procedure.

Conclusion: Percutaneous mitraclip implantation procedure is quite difficult for anaesthesiologists because of the procedure itself and the population on which the procedure is performed. The primary aim of anaesthesia management is to provide haemodynamic stability. The preoperative preparation and anaesthesia methods should be the same as for patients undergoing cardiac surgery. It is reported that as the experience regarding this subject increases, success of the procedure increases, with better protected haemodynamic stability, less inotropic and vasopressor requirement and shorter length of hospital stay.

Keywords: Percutaneous mitraclip implantation, mitral regurgitation, general anaesthesia

Abstract

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Introduction

Mitral regurgitation (MR) can be caused by functional or structural abnormalities in one or more components of the mitral apparatus (leaflets, annulus, chordae tendineae, papillary muscles and left ventricle) (1). While degenerative MR involves the primary abnormalities of leaflets, the leaflets are usually normal in secondary or functional MR, and the reason for regurgitation is the remodelling of the left ventricle, papillary muscle displacement and annular dilatation. The mortality rate is less than 1% in degenerative MR, which can be surgically treated (2). Annuloplasty is a widely used surgical method in which the annulus is surrounded by a restrictive ring (3). Recurrence is seen in 25–30% patients after the surgery of functional MR (3, 4). Its precise prognostic benefit could not be demonstrated in comparison to optimal medical therapy (5). The ‘edge-to-edge’ technique including subvalvular apparatus is employed in order to reduce the growth rate of recurrent MR in patients with severe regurgitation (6).

In recent years, percutaneous MitraClip implantation procedure (Abbott Vascular, Menlo Park, CA, USA) has emerged as an alternative approach for patients having contraindication for surgery or for high-risk patients only if it is anatomically suitable (7). The procedure is usually carried out in the catheterization laboratory under fluoroscopy under the guidance of transesophageal echocardiography (TEE) (8).

Anaesthesia methods applied during MitraClip implantation vary among centres (9, 10). This procedure can be performed under deep sedation and general anaesthesia (11). For patients considered to be at high risk during anaesthesia, determining
the appropriate approach is important (10). However, no guidance has been created related to anaesthesia during MitraClip implantation procedure yet. There are a small number of publications on this subject in the literature, too. Patients for whom this procedure is planned may have many accompanying problems in addition to advanced MR. Furthermore, intensive care is required after the procedure in a large number of patients.

In this study, we have aimed to share our experience of anaesthesia in the patient group for which we planned MitraClip implantation procedure in our hospital.

Methods

With the approval received from the Clinical Research Ethics Committee of the Faculty of Medicine of Yıldırım Beyazıt University, 84 patients (54 males and 30 females) who underwent MitraClip implantation procedure due to symptomatic and severe MR were retrospectively evaluated according to the procedure dates of the patients: here, forms for preoperative evaluation, perioperative anaesthesia and intensive care follow-up were used for patients admitted to the Ankara Ataturk Training and Research Hospital between July 2012 and March 2015. By using the patient files, the following were recorded: demographic data of patients (age, gender, body mass index (BMI)), coexisting diseases, preoperative ejection fraction (EF%), values of pulmonary artery pressure (PAP), duration of operation and anaesthesia, anaesthetic agents used, measurements of activated coagulation time (ACT), patients’ conditions when transferred to the postoperative coronary intensive care unit (CICU), extubation and duration of stay in the ICU, duration of hospital stay after the procedure and complications developing during and after the procedure.

Patient preparation

All the procedures applied to these patients were performed in the cardiac catheterization unit of our hospital. Heated blankets were placed on the operating tables of the patients. Routine dual-channel ECG (DII, V5), pulse oximetry (SpO2), body temperature using a nasopharyngeal temperature probe and non-invasive arterial blood pressure monitoring were performed, and the concomitant measurements were recorded. Two wide peripheral vascular accesses were established in patients. By applying local anaesthesia in the right or left radial artery, cannulation was performed for invasive arterial blood pressure monitoring. Initial blood samples were taken for arterial blood gas and ACT measurements. Central venous or pulmonary artery catheterization was not performed in these patients. The extension line of the femoral venous catheter was used as the central vascular access, and the relative measurements of the central venous pressure were obtained through this line.

Anaesthesia management

Anaesthesia was administered without premedication to all the patients by using different hypnotic agents according to the preferences of the anaesthesiologist who applied general anaesthesia. According to this preference, intravenous (IV) lidocaine (1 mg kg\(^{-1}\)) was used to suppress the haemodynamic responses in anaesthesia induction. A single dose of fentanyl (2 µg kg\(^{-1}\)) was administered to the patients. Remifentanil infusion (0.02–2 µg kg\(^{-1}\) min\(^{-1}\)) was preferred in some patients according to the anaesthetist’s preference. Rocuronium bromide (0.6 mg kg\(^{-1}\)) was used as a muscle relaxant. Orotracheal intubation was performed on all the patients; they were ventilated mechanically at 6–8 mL kg\(^{-1}\) tidal volume and a breathing frequency of 12–16 min\(^{-1}\), and the end-tidal CO\(_2\) concentration was maintained at 30–35 mmHg. After administering anaesthesia, a TEE probe was inserted.

Sevoflurane (0.8–1.1%) or desflurane (5–6%) was administered through an oxygen/air mixture (FiO\(_2\)=50%) for anaesthesia maintenance. During the procedure, additional doses of fentanyl were intravenously administered when needed. After the guide catheter was passed through the interatrial septum, an additional dose in the form of 5000 units of heparin was intravenously administered so as to maintain the ACT > 250 s when necessary. During the process, the mean arterial pressure was maintained ≥65 mmHg. Hypovolaemia (determined by TEE), arterial hypotension (that may developing correspondingly) and arterial hypotension (that may develop at the moment when the MitraClip passes the mitral valve) were corrected and raised by primarily using IV crystalloids and then, if necessary, by bolus ephedrine (5 mg), epinephrine (5 mg) and/or norepinephrine (0.03–0.06 µg kg\(^{-1}\) d\(^{-1}\)) infusions. The presence of residual MR and the requirement of a second clip were decided at this stage. At the end of this process, IV protamine was administered to terminate the anticoagulation.

MitraClip implantation procedure

Three-axe catheter system (Evalve Inc., Menlo Park, California, USA) was used for the implantation of the MitraClip. With the guidance of fluoroscopy and TEE, the tip of the outer guide catheter was brought to the left atrium through the guide wire and the dilator by using the standard trans-septal approach. The clip delivery system was advanced into the left atrium via the guide catheter and the clip was placed on the source of the regurgitant jet orthogonally to the three surfaces of the mitral valve. The guide catheter was advanced to the middle of the left atrium and the clip to the left atrial cavity. After MR was sufficiently reduced, the clip was separated from the clip delivery system. The clip delivery system and the guide catheter were retreated. Haemodynamic, angiographic and echocardiographic assessments were repeated (12).

If arterial hypotension was seen during the transition of the MitraClip through the mitral valve, the arterial blood pressure was raised using vasopressor agents (ephedrine, norepinephrine, dopamine or dobutamine) (9). While placing the MitraClip, breathing was temporarily stopped for its correct placement.
Postoperative management

At the end of the procedure, after haemodynamically stable patients were awakened and extubated, hemodynamically unstable patients were taken to the CICU without being extubated.

Statistical analysis

The patients were grouped according to their clinical and demographic characteristics, namely, ASA (III–IV), gender (male–female), drugs used in anaesthesia, the use of vasopressors (used–unused) and the condition at the transfer to the CICU (intubated–extubated). Self-comparison was done for each group in terms of numerical values such as age, BMI, preoperative PAP, EF, anaesthesia duration, duration of procedure, duration of remaining intubated, length of stay in the ICU and length of hospital stay. Kolmogorov–Smirnov test was used for evaluating the distribution of numerical data. Data with two independent groups that fit a normal distribution were analysed with the Student’s t-test and the data that did not fit were evaluated with the Mann–Whitney U test. Cross-data were created by using categorical data such as ASA, gender, anaesthetic agents used in the maintenance and the condition of intubated/extubated transfer to the ICU; these data were evaluated using the chi-square test. Here p<0.05 has been considered to be significant in all the statistical calculations.

Results

In this study, the mean age of 84 patients (54 males and 30 females) who underwent the MitraClip implantation under general anaesthesia was determined as 68.5±10.2 years. Demographic characteristics of the patients are listed in Table 1 and the comorbidities are listed in Table 2. When the patients grouped according to the ASA, sex, vasopressor use, anaesthesia drugs and condition at transfer to the ICU were compared in terms of age, BMI, preoperative PAP, EF, anaesthesia duration, duration of MitraClip implantation, duration of remaining intubated, the length of stay in the ICU and the length of hospital stay, no statistically significant differences were found between the groups (p>0.05). Similarly, when the groups formed according to ASA, gender and agents used in anaesthesia maintenance were compared in terms of intubated/extubated transfer to the ICU, no significant differences were found. For the induction of anaesthesia, sodium thiopental was used in 84.5% patients and propofol in 9.6% patients. For administering anaesthesia, drugs were combined with midazolam in 75% patients. Lidocaine was preferred in 52% patients (Table 3). It was found that fentanyl was administered as a bolus once in 80 patients; apart from using fentanyl in anaesthesia, no additional fentanyl use was required in the patients, except for 4 patients for whom remifentanil was preferred. For the maintenance of anaesthesia, it was seen that sevoflurane was used in 57% patients and desflurane was used in the remaining (Table 3). The combinations of drugs used for anaesthesia induction in patients who were screened in this study are listed in Table 4.

For 48% patients, a vasopressor/inotropic was needed, particularly noradrenaline in 39% patients (Table 3). The average duration required for MitraClip implantation was 140.9±48.2 min and the duration of anaesthesia was 165.7±50.6 min. All the patients, except 7, were transferred to the ICU under intubation and were extubated after an average of 3 h. The average lengths of stay in the ICU and hospital were 2 and 4 days, respectively (Table 5). The procedure resulted in failure in 2 patients (MitraClip could not be placed). Postoperatively, acute renal failure occurred in 3 patients and uvula oedema in 2 patients in the first 24 h (Table 6). A total of 7 patients died: 1 died during the procedure, 1 died 3 days after being operated upon by the cardiovascular surgery clinic following the procedure, 4 died due to cardiogenic shock during the follow-up in the ICU after the procedure and 1 died 3 months after the procedure (Table 6).
Because cardiovascular comorbidities that are seen in patients with valvular heart disease along with advanced age and higher mortality rates complicate surgical options, the preference of less invasive treatment methods, such as transcatheter interventions, may be advantageous. Transcatheter interventions ensure the protection of patients from the stress of surgery and the damage caused by open-heart surgery. The treatment of MR is planned according to the severity of the failure as well as the underlying left ventricular function. Because these patients are in the high-risk group in terms of both open surgery and general anaesthesia and they have many comorbid diseases, they should be effectively prepared preoperatively and should be put into operation under optimal conditions in consideration of these problems.

Table 4. Combinations of drugs used in the induction of anaesthesia in patients included in the study*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium thiopental, midazolam, lidocaine, fentanyl</td>
<td>15 (17.9)</td>
</tr>
<tr>
<td>Sodium thiopental, midazolam, lidocaine</td>
<td>16 (19.0)</td>
</tr>
<tr>
<td>Sodium thiopental, midazolam, fentanyl</td>
<td>19 (22.6)</td>
</tr>
<tr>
<td>Sodium thiopental, midazolam</td>
<td>7 (8.3)</td>
</tr>
<tr>
<td>Sodium Thiopental, lidocaine</td>
<td>5 (6.0)</td>
</tr>
<tr>
<td>Propofol, midazolam, lidocaine</td>
<td>4 (4.8)</td>
</tr>
<tr>
<td>Propofol, midazolam, fentanyl</td>
<td>4 (4.8)</td>
</tr>
</tbody>
</table>

*The most common combinations are shown.

Table 5. Postoperative data of patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of remaining intubated (hours)</td>
<td>3 (1–96)</td>
</tr>
<tr>
<td>Length of stay in the intensive care unit (days)</td>
<td>2 (1–15)</td>
</tr>
<tr>
<td>Length of stay in hospital (days)</td>
<td>4 (1–16)</td>
</tr>
</tbody>
</table>

*Values are given as median (minimum-maximum).

Table 6. Perioperative complications observed in patients

<table>
<thead>
<tr>
<th>Complication</th>
<th>Value n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uvula oedema/palatine trauma</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Failure in procedure</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Respiratory arrest</td>
<td>2 (2.4)</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Emergency surgical repair</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Fever</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Death</td>
<td>7 (8.3)</td>
</tr>
</tbody>
</table>

Discussion

Because cardiovascular comorbidities that are seen in patients with valvular heart disease along with advanced age and higher mortality rates complicate surgical options, the preference of less invasive treatment methods, such as transcatheter interventions, may be advantageous. Transcatheter implantation can be performed under deep sedation or general anaesthesia. The choice of anaesthesia technique to be applied in this high-risk group of patients is very important and the success of this procedure is affected by the patient’s medical history, type of monitoring, accompanying haemodynamic problems and experience of the team. It has been reported that deep sedation is safer than general anaesthesia because of the shorter duration of hospitalization and fewer complications after the procedure (11, 13). However, deep sedation is infrequently preferred by the anaesthesiologist and the teams with insufficient experience because of the mandatory application of TEE during the process and the possibility of the patient to move. Teufel et al. (14) reported that the implantation procedure was performed under local anaesthesia in 5 patients sedated with midazolam and propofol. Therefore, they recommend that the procedure can be performed under local anaesthesia and sedation in patients carrying high risk for general anaesthesia. However, the average duration of the procedure is 88 (74–193) min and the duration of TEE use is 64 (59–193) min with this team (14).
In our study, the duration of the procedure was 140.9 ± 48.2 min. We believe that the experience of the team with regard to the procedure is fairly effective in the selection of anaesthesia technique.

General anaesthesia is very advantageous because it affords the possibility of TEE monitoring, effective airway management, prevention of respiratory artefacts and quick initiation of cardiopulmonary bypass, if needed. In particular, keeping the patient motionless, as though holding its breath, is the most important advantage that general anaesthesia provides while placing the MitraClip. However, tachycardia, bradycardia and volume overload should be avoided during general anaesthesia implementations in these patients. Bradycardia further enhances mitral valve insufficiency by increasing the left ventricular end-diastolic volume. Patients with ventricular failure are very sensitive to the depressant effects of volatile anaesthetics. These agents are known to further aggravate the hypotensive effects of hypovolemia (15). Additionally, these agents disrupt the arterial baroreflex function. In particular, during peripheral vasoconstriction and intraoperative hypovolemia, cardiopulmonary baroreceptors primarily can settle in the low-pressure side of circulation, ensuring that the blood pressure is maintained at a certain level by detecting even the slightest reduction in cardiac filling pressures (16). Opioid-based anaesthesia and the combination of inhalation and IV agents with opioids are preferred in such patients. Further, we primarily used opioids in addition to hypnotic agents for anaesthesia induction. Therefore, the use of balanced anaesthesia was aimed to avoid complications such as tachycardia and hypotension that may complicate the implementation of the procedure. It is reported in the retrospective 21-patient study done by Kothandan et al. (9), etomidate was used in 66.7% patients in the induction of anaesthesia and the anaesthesia-induction agents were combined with fentanyl (90.5%). In our study, we found that sodium thiopental at a high rate and propofol at a lower rate were used as anaesthesia-induction agents, and the combination of both agents with midazolam (at the rate of 75%) was preferred. Anaesthesia-induction agents were combined with remifentanil in only 4% patients. In the remaining patients, fentanyl was preferred. The authors reported that they used sevoflurane in 81% and desflurane in 23.8% patients in the same study (9). The use of desflurane was observed to be at a higher rate (43%) in our study as compared to the mentioned study.

Haemodynamic follow-up should be performed effectively in these patients during the procedure. It should be noted that profound hypotension may develop after the induction of anaesthesia and at the moment when the MitraClip passes through the mitral valve (9). Kothandan et al. (9) used phenylephrine in 71%, ephedrine in 24% and noradrenalin in 24% patients. Di Prima et al. (17) reported that 78% patients needed a vasopressor in their 130-patient retrospective study. In our study, it was observed that a vasopressor was needed in 48% patients as a result of arterial hypotension that developed during anaesthesia induction and after MitraClip placement. For this purpose, noradrenaline was used in 39%, dopamine in 7% and dobutamine in 1.2% patients.

The most important problems in these patients are acute complications such as mitral stenosis development or increase in MR depending on the procedure; occurrence of arrhythmias, particularly atrial fibrillation during septostomy; occurrence of atrial septal defect; right or left atrial wall rupture and cardiac tamponade (12).

The patients should be monitored in the ICU due to changing haemodynamics after MitraClip implantation (16). Siegel et al. (18) have found that an acute improvement occurred in stroke volume, cardiac output and left ventricular filling after MitraClip implantation in 107 patients. They reported that low cardiac output that may be seen after open-heart surgery was not observed after MitraClip placement (18). Armoiry et al. (19) have demonstrated that MR fell below the 2nd degree in 88.2% patients after the procedure. Di Prima et al. (17) reported that cardiogenic shock was seen in 10% patients in their retrospective study. They reported that intensive care was needed for only 1 night in MitraClip patients. The medical condition of the patient is shown to be the determinant in this regard before the operation. In our study, all the patients were monitored in the ICU. Except for 7, all the patients were transferred to the ICU under intubation. In another study, the average duration of extubation after the procedure is reported to be 9.8 h (16). Our patients were extubated within an average of 3 h. We determined the average length of stay in the ICU as 2 days. The length of stay in the hospital is reported to be 5–8 days in other retrospective studies (9, 17, 19). The lengths of hospital stay of our patients seem to be a bit shorter than those reported in studies.

Many complications can be seen due to anaesthesia as well as the placement of TEE during and after MitraClip implantation. Armoiry et al. (19) reported that open-heart surgery was required in 2 out of 62 patients, non-mortal complications developed in 7 patients and 2 patients died. When the causes of patient deaths are examined, it is observed that oesophageal complications caused the death of 1 patient and the death of the other patient was caused by increasing insufficiency due to the failure of attaching the MitraClip to the cardiac valve. In another study, it was reported that after the procedure, liver failure developed in 25% patients, kidney failure in 24% patients and cardiogenic shock in 10% patients; 3 patients died (17). In our study, 1 patient died due to ventricular rupture during the procedure and 1 patient died due to cardiogenic shock that developed 3 days after the surgery was undertaken (open mitral valve replacement) by the cardiovascular surgery clinic. Also, 7 patients died: 4 died due to cardiogenic shock during the intensive care follow-up process (on different days after the first 24 h) and 1 patient died 3 months after discharge from the hospital.
Conclusion

Percutaneous MitraClip implantation procedure is challenging for cardiac anaesthesiologists due to the cardiac pathology of patients, complexity of the operation to be performed and difficulty of intraoperative anaesthetic management. Regardless of the anaesthetic technique, we believe that with an adequate preoperative assessment, invasive monitoring, haemodynamic instability stability and early diagnosis as well as treatment in the case of life-threatening cardiovascular complications and knowing and following the details and steps of the implementation can facilitate to achieve successful results desired by cardiac anaesthesiasts cardiac anaesthesiasts achieve successful results.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Yildirim Beyazit University School of Medicine Clinical Trials Ethical Committee (13.04.2016/No: 116).

Peer-review: Externally peer-reviewed.


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