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ORIGINAL ARTICLE
CAROTID DISEASE

EDITOR'S CHOICE

Twelve years of experience in carotid endarterectomy with general anesthesia and preserved consciousness

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ABSTRACT

Background: Carotid endarterectomy (CEA) can be performed both under general anesthesia (GA) or local anesthesia (LA) with good results. General anesthesia with preserved consciousness (GAPC) using remifentanil infusion has been already reported in literature and could potentially merge the advantages of GA and LA overcoming the disadvantages of this last technique. Although the good results of GAPC reported in literature, this technique is not widespread in clinical practice. The aim of this study was to report the perioperative results of CEA under GAPC in a large series of consecutive patients.

Methods: This is a retrospective, single center, observational study including all patients treated for CEA under GAPC in our institution between January 2008 and October 2019. Primary endpoints were neurological complications rate, mortality rate in the perioperative period, need to GAPC conversion to GA during surgery and evaluation of the technique with a specific questionnaire regarding patients' satisfaction. Secondary endpoints were myocardial infarction (MI) rate, other perioperative complications rate, rate of intraoperative shunting and need of reintervention in the perioperative period.

Results: In the considered period 1290 CEA under GAPC were performed and included in this study. Neurological complications rate was 2.01%, mortality rate in the perioperative period was 0.07%, need of GAPC conversion to GA rate during surgery was 0.46% and patients satisfaction regarding the technique were high with a mean vote of 9.1 in a 0 to 10 scale. In the perioperative period MI rate was 0.23%, other perioperative complications rate was 1.39%, intraoperative shunting rate was 7.1% and reintervention rate after surgery was 2.4%.

Conclusions: CEA under GAPC may combine the advantages of LA and GA, with a very low rate of conversion to GA during surgery and good patients' satisfaction. Moreover, it does not increase neurological, cardiologic and systemic complications. For these reasons CEA under GAPC could represents a valid alternative to GA or LA.

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Key words: Carotid arteries; Surgery, Endarterectomy, carotid; Anesthesia, general; Remifentanil.

Carotid endarterectomy (CEA) is, at present, the first-choice treatment for patients with symptomatic and asymptomatic severe carotid stenosis.[1] Although CEA is a safe procedure allowing good results both in the postoperative period and in long-term follow-up,[2] perioperative neurological complications are reported in literature between 1-7%.[3-5] Several techniques have been proposed from both a surgical[6] and anesthetic point of view to reduce the rate of perioperative complications and death, that should be nowadays documented <3% for average surgical risk patients.[1] CEA can be performed both under general anesthesia (GA) and local anesthesia (LA).[1]The choice for the anesthetic protocol is nowadays based on surgeons preferences and centers experience,[1] as no definitive data supports the superiority of a technique over the other. GA offers better patient control and stability during the intervention; but neurological monitoring can be carried out only with indirect methods (*e.g.* NIRS, stump pressure, evoked potentials, electroencephalography [EEG], transcranial Doppler)[7, 8] and is burdened by a higher rate of perioperative complications and mortality according to large meta-analysis reported in literature.[9] On the other hand, LA is a less invasive option allowing direct monitoring of the neurological status and a lower perioperative myocardial infarction rate compared to GA.[10] Despite these advantages, LA may be less comfortable for patients and surgeons during the intervention with occasional risk of conversion to GA. The conversion from LA to GA entails potentially dangerous maneuvers in urgent setting and could be stressful for physicians and patients. Many studies compared GA and LA during CEA, with no definitive evidence of the superiority of one technique over the other.[11]

General anesthesia with preserved consciousness (GAPC) with remifentanil infusion for CEA was first described in 2001 with good results.[12] GAPC using remifentanil infusion allows direct neurological monitoring during surgery and prompt and safe conversion to GA in case of patients' intolerance. GAPC is been reported in literature as an effective anesthetic technique for CEA, combining the advantages of GA and LA, however GAPC is not widespread in daily clinical practice.[8, 13-17]

The aim of this study was to report the perioperative results of CEA under GAPC in a single center and with a large series of patients.

Materials and methods

Study design

This is a single center, retrospective, observational study. All patients consecutively treated for CEA with GAPC in our institution between January 2008 and October 2019 were enrolled.

CEA was performed in symptomatic patients with stable symptoms and a carotid stenosis >50% (North American Symptomatic Carotid Endarterectomy Trial [NASCET]) and in asymptomatic patients with carotid stenosis >70% (NASCET).[1] For symptomatic patients, treatment was planned according to international guidelines in force during years.[1, 18, 19]

All patients provided written informed consent for surgical treatment.

The study was approved by local ethical committee with protocol AGCC-1 (N. 35880).

Data collection

All data were collected in a dedicated database and analyzed. Demographics collected data were age and sex. Comorbidities collected data were: hypertension (defined as systolic blood pressure >140 mmHg or need for specific drugs to maintain pressure control), dyslipidemia (defined as total blood cholesterol level >200mg/dL or need for statin therapy for cholesterol control), diabetes (defined as need of hypoglycemic drugs for control of glucose blood level), coronary artery disease (defined as previous myocardial revascularization or history of myocardial infarction), chronic obstructive pulmonary disease (COPD) (defined as FEV/FVC<70%), tobacco use history (actual or former smoker), renal dysfunction (defined as GFR<60 mL/h estimated with MDRD),[20] previous carotid revascularization (surgical or endovascular), contralateral internal carotid artery (ICA) occlusion, and acute brain lesions showed by brain computed tomography (CT) in symptomatic patients.

Patients were considered symptomatic when neurological symptoms compatible with stroke, transient ischemic attack (TIA) of the congruous hemisphere or ipsilateral amaurosis fugax were present in the last 6 months.[1] Neurological assessment by a specialist was performed in all symptomatic patients or in doubtful cases.

Anatomical collected data regarded the characteristics of the plaque (calcific, fibrous, lipid, ulcerated) and the severity of the stenosis (NASCET). Anesthesiologic collected data regarded American Society of Anesthesiologist Physical Status Classification (ASA status) and conversion from GAPC to GA (due to patient tolerance).

Surgical collected data were: 1) type of CEA (patching, eversion, direct suture); 2) total duration of surgical intervention; and 3) intra-operative complications.

Preoperative assessment

All asymptomatic patients underwent brain CT and Doppler ultrasound (DUS). Before 2015, supraortic trunk (SAT) computed tomography angiography (CTA) was performed only in selected cases. After 2015 all asymptomatic patients underwent routinely SAT CTA.

All symptomatic patients underwent brain CT at symptoms onset and after 24 h, associated with DUS and SAT CTA. After brain imaging, a neurologist's assessment was carried out in all cases.

All symptomatic patients under dual antiplatelet therapy for neurological indication or patients with absolute cardiologic indications (recent endovascular myocardial revascularization) continued treatment until surgery. All other patients underwent treatment under single antiplatelet therapy. Patients under oral anticoagulant therapy (OAT) switched to low molecular weight heparin (LMWH) at least 5 days before surgery.

Patients with anatomical contraindications, such as plaque extension over the mandibular angle, previous neck irradiation, restenosis after CEA, and hostile neck were considered for CAS.

Anesthetic protocol and surgical treatment

As first step, vocal cord anesthesia with lidocaine spray 4% (5 cc) was carried out in all patients. After GAPC induction with intravenous bolus of propofol (2 mg/kg), tracheal intubation was performed and remifentanil infusion (0.025 γ.kg/min) alone was started to maintain patient sedation. After these maneuvers, a superficial cervical plexus block was performed in all patients with naropine 0.37% (10 cc) and lidocaine 2% (5 cc) for optimal pain control during surgery. During surgery, the remifentanil infusion was modulated to modify the consciousness status of the patient during different surgical phases.

After administration of intravenous bolus of non-fractioned heparin (100 UI/Kg), the CCA was first dissected and then clamped (Figure 1). After CCA control, neurological tolerance test (NTT) was carried out by squeezing a soft toy for 2 consecutive minutes. After CCA control, ECA and ICA were separately dissected and cross-clamped. After ICA clamping another 1-minute NTT was carried out. In all cases, if the NTT revealed symptoms compatible with brain hypo-perfusion ICA temporary shunting was positioned. Shunt was positioned immediately after arterial section and after new NTT to confirm the resolution of neurological symptoms, the CEA was performed. Selective shunting policy was applied both in symptomatic and asymptomatic patients.

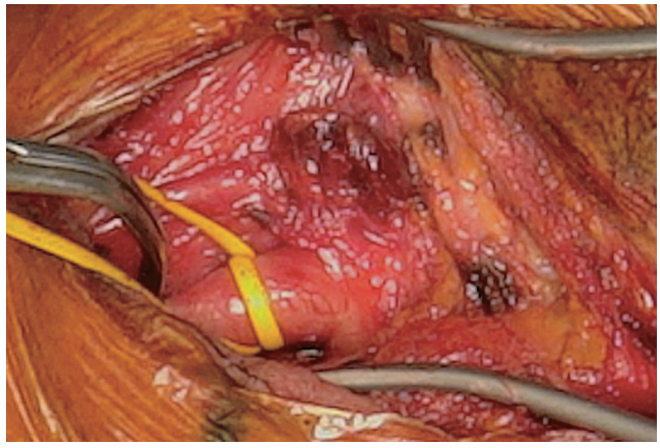

Figure 1.—CCA dissected and cross-clamped before ICA and ECA dissection.

If the NTT was negative, the remifentanil infusion was increased, and the CEA was performed without shunt. The surgical technique for CEA was chosen according to carotid anatomy and surgeon's preference. After declamping, NTT was newly performed to rule out the occurrence of early neurological complications.

Only selected patients at high risk for surgery needed intensive care unit (ICU) after surgery.

Endpoints

Primary endpoints were: 1) neurological complications rate; 2) mortality rate in the perioperative period; 3) need to GAPC conversion to GA during surgery; and 4) evaluation of the technique with a specific questionnaire regarding patients' satisfaction.

Neurological complications were defined as TIA or stroke congruous with the surgical site occurred in the first 30 days after surgery. Need of GAPC conversion was defined as need of patient sedation during the awake phase for seizure, discomfort or pain that affect NTT evaluation. The patient's evaluation of the technique was carried out by a written questionnaire that was proposed to all patients by two different surgeons (AU, RMD) on first postoperative day, after drainage removal. The questionnaire was structured according to previous experiences reported in literature[16] and the first postoperative day was chosen to allow reliable intervention recollection by the patients. We started to administer the questionnaire since January 2018, so this analysis concerns only a limited sample of patients in the series. Data re-

garding the administered questionnaires are reported in Table I.

Secondary endpoints were: 1) myocardial infarction (MI) rate; 2) other perioperative complications rate; 3) rate of intraoperative shunting; and 4) need of reintervention in the perioperative period.

Myocardial infarction was defined as association of at least two of the following events in the first 30 days after surgery: typical clinical presentations, suggestive ECG changing, significant elevation in troponin I level after surgery and kinetic changes at echocardiography analysis. Other complications were defined as cardiologic (non-ischemic), respiratory or systemic complications.

Statistical analysis

Quantitative data are given as mean±standard deviation, while categorical data are presented as counts and percentage. χ^2 test was employed in order to analyze both comparison between symptomatic and asymptomatic patients in term of shunting rate and patients under anticoagulant therapy in term of postoperative reintervention for neck hematoma. Statistical significance was considered for P value<0.05. All statistical analyses were performed using SPSS software (version 20.0; SPSS Inc., Chicago, IL).

TABLE I.—*Items evaluated by questionnaires.*

Do you have auditive memories of the intervention?	Yes/No
Voices	Yes/no
Sounds	Yes/no
Conversations	Yes/no
Orders	Yes/no
Do you have visual memories of the intervention?	Yes/No
Lights	Yes/no
Dark	Yes/no
Shadows	Yes/no
Faces	Yes/no
Did you experience pain during the intervention?	
No pain	Yes/no
Moderate pain	Yes/no
Severe pain	Yes/no
Pain localization	Descriptive
Which type of personal feeling did you experienced during the intervention?	
Afraid	Yes/no
Weak	Yes/no
Anxious	Yes/no
Stifled	Yes/no
Panic	Yes/no
Do you remember the intervention as real event or dream?	Dream/real
How would you rate your satisfaction regarding the intervention?	From 0 to 10

Each item reported in the table was asked to the patient.

Results

Population

A total of 1137 consecutive patients (male 65.8%, mean age 73.6±7.9 years) underwent 1290 CEA under GAPC. In 293 patients (22.7%) CEA was carried out for symptomatic stenosis. Twenty-six patients (2.3%) treated with CEA had a contralateral ICA occlusion. Detailed data regarding anamnestic and clinical patients' characteristics are reported in Table II.

Anesthetic and surgical results

CEA was performed under single antiplatelet therapy, double antiplatelet therapy and under anticoagulant therapy in 1156 patients (89.6%), 129 patients (10%) and 84 patients (6.5%), respectively.

CEA was performed with ICA patching using a dacron patch (hemocarotid patch, Maquet, Rastatt, Germany) or a biological patch (XenoSure® biologic vascular patch, Burlington, MA, USA) in the majority of cases (834 patients, 64.5%). Detailed data regarding surgical technique are reported in Table III. Mean intervention duration was 97±28.4 minutes and mean clamping time was 51.4±14.2 minutes.

Intra-operative complications occurred in 3 cases (0.23%): one patient presented symptoms consistent with acute coronary syndrome and a NSTEMI was found in the postoperative period; the patient underwent medical treatment with dual antiplatelet therapy. One patient presented the same symptoms during surgery but, in the immediate postoperative period, a STEMI was found, and the patient was treated in emergent setting with PTCA of the left coronary artery. One patient presented new onset of atrial fibrillation treated with anticoagulation in the postoperative period. No intra-operative death occurred. Fifteen patients (1.16%) were transferred to ICU after surgery.

Mean hospital stay was 3.3±1.6 days.

Endpoints

In the perioperative period 8 TIA (0.62%), 8 minor strokes (0.62%) and 10 major strokes (0.76%) occurred. Perioperative stroke rate was 1.4% (18 cases) and perioperative TIA rate was 0.62% (8 cases). Thus, the global rate of neurological events in the perioperative period was 2.01% (26 events). All patients with neurological complications underwent emergent brain CT, DUS analysis or SAT CTA (if DUS results were unclear).

Considering the 26 patients with neurological complications, 8 patients (0.62%) were shunted for positive NTT

TABLE II.—*Anamnestic and clinical data.*

Total patients sample 1137	Tot. N. (%)
Hypertension	1118 (98.3)
Dyslipidemia	876 (77)
Diabetes	397 (34.9)
Active smoker	270 (23.7)
Former smoker	383 (33.7)
CAD	257 (22.6)
COPD	232 (20.4)
CKD	136 (11.9)
Hemodialysis	4 (0.35)
ASA classification 2	524 (40.6)
ASA 3 classification	747 (57.9)
ASA 4 classification	19 (1.5)
Single antiplatelet therapy	1156 (89.6)
Double antiplatelet therapy	129 (10)
LMWH	84 (6.5)
Statin	908 (70.4)
Symptomatic	293 (22.7)
TIA	125 (42.7)
Stroke	140 (47.8)
Amaurosis	28 (9.5)

CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; CKD: chronic kidney disease; ASA: American Society of Anesthesiology; LMWH: light molecular weighted heparin; TIA: transient ischemic attack.

TABLE III.—*Plaque's characteristics and surgical data.*

Total CEA 1290	Tot. N. (%)
Fibrolipidic plaque	785 (60.8)
Calcific plaque	435 (33.7)
Ulcerated plaque	68 (5.3)
ICA stenosis 50-70%	67 (5.2)
ICA stenosis 70-80%	534 (41.4)
ICA stenosis 80-90%	434 (33.6)
ICA stenosis >90%	255 (19.8)
Contralateral ICA occlusion	26 (2.3)
CEA and patching	834 (64.5)
Eversion	422 (32.7)
Semieversion	21 (1.6)
Direct suture	14 (1.1)
Shunting	92 (7.1)
Shunting for positive NTT	86 (93.5)
Shunting for patients' intolerance	6 (6.5)

NTT: neurological tolerance test.

during surgery while the remaining patients had normal NTT.

Among the 26 patients with neurological complications, 7 (2.4%) of these were treated for symptomatic carotid stenosis while 19 (1.9%) were treated for asymptomatic carotid stenosis.

Three patients (0.23%) with major stroke presented an ICA thrombosis in the immediate postoperative period. Two of these patients underwent medical therapy, while one patient was treated with venous ICA bypass. One patient (0.07%) with major stroke presented a residual intimal flap in the ICA and underwent reintervention.

One out of 26 patients (3.8%), treated for symptomatic stenosis, presented a hemorrhagic stroke after surgery.

Among the patients with neurological complications, 9 (0.69%) had an intraoperative stroke. One patient had intra-operative stroke due to residual intimal flap and underwent reintervention (previously described). Considering the remaining 8 cases, 6 patients requested shunt positioning for positive NTT.

One perioperative death occurred (0.07%) in an asymptomatic patient with acute ICA thrombosis determining major stroke in the postoperative period. The patient was transferred to ICU and died on 7th postoperative day.

CEA under GAPC was well tolerated in all but 6 patients, determining a GA conversion rate of 0.46%. These patients presented severe agitation and seizure during NTT and, after remifentanil infusion increase to obtain sedation a carotid shunt was employed in all cases without perioperative complications.

Over the entire patients' sample, 157 questionnaires (12.2%) were disposable for analysis. The majority of patients reported auditive memory (135 case, 86%) of the operation and 70 patients (44.4%) reported visual memory. Only 5 patients (3.2%) reported incomplete pain suppression in the neck region during surgery and 130 patients (82.8%) reported to feel comfortable during intervention. Twenty-seven patients (17.2%) reported anxious feeling during the awake phase. The majority of patients (129-82.2%) described the intervention as a "real experience" while the remaining described the procedure as a "dream." The mean vote assigned by the patients regarding the general satisfaction about the technique was 9.1.

In the perioperative period, 3 myocardial infarctions (0.23%) occurred. All patients presented NSTEMI and were transferred to the Department of Cardiologic for therapy. Considering also the intra-operative MI previously reported, the global MI rate in the postoperative period was 0.38% (5 cases).

The rate of other complications in the perioperative period was 1.39% (18 cases). The most frequent perioperative complication was the onset of atrial fibrillation (11 case, 61.1%). Four patients (22.2%) presented respiratory insufficiency: 3 patients were found to have a pneumonia treated with intravenous antibiotic therapy and 1 COPD patient presented respiratory distress treated with CPAP for 2 days, with complete symptoms resolution. Three patients (6.2%)

presented dyspnea for congestive heart failure after surgery, successfully treated in all cases with diuretic therapy.

The intra-operative ICA shunting rate during surgery was 7.1% (92 cases), with 86 shunts positioned for positive NTT and 6 shunts positioned for GAPC intolerance. The rate of ICA shunting was significantly higher in patients treated for symptomatic carotid stenosis (P=0.0001).

Reintervention in the perioperative period was necessary in 31 patients (2.4%): the majority of reinterventions were performed for neck hematoma on first postoperative day (29 cases, 93.5%), 2 patients (6.5%) underwent reintervention for ICA acute thrombosis or residual flap after CEA respectively. Among the 29 patients who underwent neck hematoma drainage, only 4 (13.8) were under anticoagulant therapy, with no significance differences (P=0.084).

Discussion

In our experience, CEA under GAPC appeared a safe procedure, with low rate of neurological complications (2.01%) and MI rate (0.23%) in the perioperative period, low rate of perioperative death (0.07%), good tolerance by the patients, as demonstrated by the administered questionnaires and low rate of conversion to GA. GAPC allowed direct neurological monitoring during ICA cross-clamping and allows easy conversion to GA if necessary. To the best of our knowledge, this is the largest series reported in literature regarding CEA under GAPC.

Nowadays, CEA is equally performed both under GA and LA.[1] LA for CEA has been largely reported in literature, with comparable results to GA in term of neurological complications and perioperative death.[10, 11, 21] In a recent meta-analysis, Hajibandeh *et al*.[9] considering over 53,000 patients, reported a significant higher rate of postoperative TIA and stroke for GA (P=0.0001). In the same meta-analysis, also perioperative death (P=0.01) and MI rate (P=0.0002) resulted significantly higher for CEA under GA. The authors concluded that CEA under LA represents a less invasive option than GA, with significative reduction of neurologic complications, cardiologic complications and perioperative death.[9]

GAPC, despite tracheal intubation, allows similar impact of LA over patients in our experience, with a very low rate of postoperative death, postoperative MI and other complications in the perioperative period. Results regarding CEA under LA are reported in large patients' cohort, with a postoperative stroke rate between 1.4% and 3.2%, postoperative MI rate between 0.6% and 0.9% and perioperative death of 0.9%.[9, 21] The results of our experience are satisfactory considering that 57.9% of CEA were performed in ASA 3 patients and 1.5% in ASA 4 patients.

Recently CEA under LA has shown lower risk of silent postoperative ischemic brain lesion on MRI diffusion-weighed respect to GA, in a prospective randomized study.[22] Although silent ischemic lesions are silent with no impact on perioperative neurological outcomes, these types of lesions could affect cognitive functions in the long-term follow-up. The authors analyzed also the type of lesions according to Szabo classification[23] showing that patient with higher rate of shunting presented higher rate of Szabo type IV lesion, due to embolic events. The authors concluded that intra-operative shunting could entails higher risk of intra-operative embolic events.[22]

The most critical aspect of CEA under LA is patients' compliance during surgery. If the patient became restless, presents seizure, respiratory distress or agitation, conversion from LA to GA requires prompt tracheal intubation during surgery.

This maneuver, frequently performed in an uncontrolled way, could lead to brain hypo-perfusion secondary to hypotensive condition, due to anesthesia and also airways damage. In the GALA trial the reported rate of conversion from LA to GA was 1.4% (69 patients) and the majority of conversions (53 cases) were performed after the start of surgery mostly for patients' discomfort and restlessness.[11] GAPC allows a better patient's control in this situation, allowing sedation with increase in remifentanil infusion and ICA temporary shunting. In our experience this maneuver was necessary in 6 patients (0.46%). None of these patients reported complications in the perioperative period. In order to really understand patients' tolerance to GAPC, since 2018 we started to administer to the patient a questionnaire to evaluate intraoperative phase.

Both LA and GAPC allows direct neurological monitoring during surgery, leading to a lower rate of ICA shunting compared to CEA under GA.[8, 9, 21] Temporary shunt insertions during CEA, although largely employed, could lead to additional risks such as arterial wall dissection, plaque's debris embolization during the maneuver and extension of surgery duration. For these reasons, a selective shunting policy during CEA is our standard approach. Selective shunting needs a neurological status assessment during the intervention with either direct or indirect methods. Direct neurological status monitoring is considered the most reliable technique to assess brain hypo-perfusion during surgery, allowing very selective shunting during CEA.[11, 21] GA needs an indirect neurological monitoring during surgery such as stump pressure, EEG, NIRS or TCD.[24] All

these methods provide incomplete information about the neurological status and often leads to higher shunting rate if compared with direct monitoring.[8] In our experience CEA under GAPC allowed strictly selective shunting, with a low rate of intra-operative shunting.

Our results are aligned with other experiences regarding CEA under GAPC reported in literature.[13-17] All these experiences underlined the advantages of this technique, allowing prompt conversion to GA when necessary in 0.9-1.1% of cases, and high patients satisfaction (98.8-100%) evaluated with a questionnaire. Although the good results already reported in literature, our experience considers the largest sample size of consecutive patients treated with GAPC allowing the evaluations of this technique in a "real world" population.

A potential disadvantage of LA is the need for deep cervical plexus block for pain control during surgery. This maneuver is not riskless and could lead to neck anatomical structure damage during injection (intravascular-injection, neck hematoma, CNS complications and respiratory distress due to diaphragmatic or vocal cord paralysis) and present a higher rate of conversion to GA respect of superficial plexus block.[25] During GAPC a superficial plexus block is sufficient for pain control, avoiding the potential complications arising from deep cervical plexus block.

Patients' satisfaction about the technique was high. Although the majority of patients reported the surgical intervention as a "real event" with auditive and visual memory, very few cases of anxiety or uncomfortable feeling were reported. None of the patients reported respiratory distress due to tracheal intubation.

Uncontrolled pain was reported in 3.2% of the analyzed cases showing the effectiveness of both remifentanil and superficial plexus block in obtaining good analgesia, with no need for more invasive procedures like deep cervical plexus block. The patients' tolerance of the technique has a crucial value for the evaluation of GAPC for CEA, as this technique offers a comfortable solution both for physicians and patients, limiting some stressful situation during the intra-operative phase, like conversion to GA.

Despite all the potential advantages of GAPC, this technique is still poorly employed in daily clinical practice. A possible reason for this aspect is that GAPC is technically demanding from the anesthetic point of view, requiring both experience in remifentanil dosage and perfect knowledge of surgical procedure by the anesthetic team in order to obtain optimal timing for the awake phase. In our experience the technical aspects are counterbalanced by a fast learning curve by the anesthesiologists and by several advantages in term of selective shunting, low neurological and cardiologic complications and both patients and surgeons' satisfaction.

Limitations of the study

This study presents some limitations due to the retrospective analysis, monocentric experience and absence of control group. The questionnaire for patients 'evaluation of the technique, although was administered in a good sample size, was not disposable for all patients, making the analysis of patient's satisfaction weak. Furthermore, the questionnaire administered to the patients was based on other experiences reported in literature but is not a validated questionnaire.

Conclusions

GAPC combines the advantages of both GA and LA, allowing direct neurological monitoring, patient's stability during surgery and easy conversion to GA. Considering our experience, postoperative neurological complications, MI rate, mortality rate and systemic complications are comparable to LA and GA in literature data. Patient satisfaction in our experience was extremely high, underling the importance of airways control for patient's management during surgery. We think that GAPC represents a valid alternative to LA or GA for CEA, but more and specific studies are needed to compare the outcomes of these different techniques and draw firm conclusions.

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