MÆDICA - a Journal of Clinical Medicine

ORIGINAL PAPERS

Perioperative Management Difficulties in Parathyroidectomy for Primary Versus Secondary and Tertiary Hyperparathyroidism

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Conflict of interests: Data were also presented as a poster at the joint 15th International Congress of Endocrinology and 14th European Congress of Endocrinology, Florence, May 2012

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ABSTRACT

Background: *In patients with hyperparathyroidism, parathyroidectomy is the only curative therapy. Anaesthetic management differs function of etiology (primary vs. secondary or tertiary hyperparathyroidism) and surgical technique (minimally invasive or classic parathyroidectomy).*

Objectives: *To evaluate peri-operative management (focusing on hemodynamic changes, cardiac arrhythmias and patients' awakening quality) in parathyroidectomy for hyperparathyroidism of various etiologies, in a tertiary center.*

Material and methods: *292 patients who underwent surgery for hyperparathyroidism between 2000-2011 were retrospectively reviewed; 96 patients (19M/77F) presented with primary hyperparathyroidism (group A) and 196 (80M/116F) with secondary and tertiary hyperparathyroidism due to renal failure (group B). Biochemical parameters (serum calcium, phosphate, creatinine) were determined by automated standard laboratory methods. Serum intact PTH was measured by ELISA (iPTH - normal range: 15-65 pg/mL).*

Outcomes: *Median surgery duration was 30 minutes in group A (minimally invasive or classic parathyroidectomy) and 75 minutes in group B (total parathyroidectomy and re implantation of a small parathyroid fragment into the sternocleidomastoid muscle). During anaesthesia induction, arterial hypotension developed significantly more frequent in group B (57 out of 196 pts, 29.1%) than in group A (8 out of 96 pts, 8.34%), p<0.0001, especially in patients receiving Fentanyl-Propofol. During surgery and anaesthesia maintenance, bradycardia was significantly more frequent in group A (67 out of 96 pts, 69.8%) than in group B (26 out of 196 pts, 13.3%), p<0.0001, especially during searching of parathy-*

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Article received on the 6th February 2012. Article accepted on the 5th June 2012.

roid glands. By contrary, ventricular premature beats were less frequent in group A (25 out of 96 pts, 25.25%) than in group B (84 out of 196 pts, 42.85%), p=0.003. There were no statistically significant differences between the studied group regarding frequency of arterial hypertension and hypotension, paroxysmal atrial fibrillation.

Conclusions: *anaesthetic management in parathyroid surgery may be difficult because of cardiac arrhythmias (bradycardia in primary hyperparathyroidism and ventricular premature beats in secondary and tertiary hyperparathyroidism, respectively) and arterial hypotension during anaesthesia induction in patients with secondary and tertiary hyperparathyroidism.*

Keywords: hyperparathyroidism, parathyroidectomy, anaesthesia, arrhythmias, arterial hypotension

INTRODUCTION

In patients with hyperparathyroidism, parathyroidectomy is the only curative therapy. Both bilateral and unilateral techniques can be used.

In the largest series of parathyroidectomies published recently (15,000 cases), cure rate was 99.4%; recurrence rate was higher in unilateral techniques: 3-5% at 1 year and up to 4-6% at 10 years (1).

Changes in the management of primary hyperparathyroidism occurred since introducing minimally invasive parathyroidectomy (2). This method can be performed with equal cure rates as standard cervical exploration (up to 97%), with no present evidence of delayed recurrence (3).

However, anaesthetic management of such patients may be difficult because of cardiac arrhythmias and skeletal muscle weakness. Low serum albumin and alteration in the acid base status in the perioperative period can affect the serum calcium level and thus adds to the existing problem (4). Anaesthetic management of patients with secondary and tertiary hyperparathyroidism due to end-stage renal disease is even more difficult, due to their increased risk of cardiovascular comorbidity, increased severity of cardiovascular disease, leading to an adjusted all-cause mortality rate that is 6.4-7.8-fold higher than the general population5. Successful management of these patients requires effective cooperation and communication between anaesthesia, surgical, endocrinology and nephrology staff. ❑

AIM

To evaluate peri-operative management in parathyroidectomy for hyperparathyroidism of various etiologies, in a tertiary center, in order to improve early preoperative medical care of the patient, preoperative risk assessment and for a better selection of anaesthesia type in individualised cases for a better surgical outcome and for a rapid postoperative recovery. ❑

MATERIAL AND METHODS

Patients

Group A consisted of 96 patients (19 M/77 F) with primary hyperparathyroidism due to single parathyroid adenomas. Median age at surgery was 55.7 ± 13.6 years (median: 57 years, range: 20-79 years). Preoperative total calcium levels were 12.5 ± 1.3 mg/dL (median: 12.3 mg/dL, range: 10.06-16.8 mg/dL). Preoperative PTH levels were 557.5 ± 680.9 pg/mL (median: 365.82 pg/mL, range: 84.85-5207.2 pg/mL).

Group B consisted of 196 patients (80M/116F) with secondary and tertiary hyperparathyroidism due to renal failure. Median age at

	Group A (n=96)	Group B (n=196)	P (t test)
Age (years)	55.7 ± 13.6	48.9 ± 11.5	<0.0001
	Median: 57	Median: 50	
	Range: 20-79	Range: 20-87	
Preoperative calcium (mg/dL)	12.5 ± 1.3[&]	10.1 ± 1	<0.0001
	Median: 12.3	Median: 10.1	
	Range: 10.06-16.8	Range: 8-14.25	
Preoperative PTH (pg/mL)	557.5 ± 680.9	1752.6 ± 903.2	<0.0001
	Median: 365.82	Median: 1600	
	Range: 84.85-5207.2	Range: 86-5000	

TABLE 1. Pre-operative biochemical data in patients with hyperparathyroidism undergoing surgery

[&] - Pre-operative calcium was either a spontaneous calcium in patients with mild hypercalcemia or a calcium on various treatments (i.v. hidratation with saline, bisphosphonates, calcitonin, loop diuretics) in patients with moderate and severe hypercalcemia

surgery was 48.9 ± 11.5 years (median: 50 years, range: 20-87 years). Preoperative total calcium levels were 10.1 ± 1 mg/dL (median: 10.1 mg/dL, range: 8-14.25 mg/dL). Preoperative PTH levels were 1752.6±903.2 pg/mL (median: 1600 pg/mL, range: 86-5000 pg/mL).

In group B, from 196 patients, 179 pts underwent hemodialysis for 8.7±4.9 years (median: 8 years, range: 1-26 years) and 17 pts underwent peritoneal dialysis for 4.6±1.9 years (median 4 years, range: 3-8 years).

In group A (primary hyperparathyroidism), 62 patients (64.6%) underwent classical parathyroidectomy (58 with general anaesthesia-endotracheal intubation and 4 with intravenous general anaesthesia) and 34 patients (35.4%) underwent minimally invasive parathyroidectomy (16 with general anaesthesia-endotracheal intubation and 18 with intravenous general anaesthesia).

All group B patients (secondary hyperparathyroidism) underwent classical parathyroidectomy (119 with general anaesthesia-endotracheal intubation and 77 with intravenous general anaesthesia).

Anaesthetic protocol: For general anaesthesia Midazolam, Propofol, Fentanyl, Ketamine, and oxygen administration on nasal mask, 2-3 l/min flow were used. On tegument incision, xyline 1% was administered.

For general anaesthesia with endotracheal intubation Fentanyl, Remifentanyl, Thiopental, Propofol, Suxametonii chloridum, Rocuronium, Vecuronium and volatile gases: Sevofluranum, Izofluranum, Neostigminum, Naloxonum were used.

Mechanic ventilation was controlled either in volume or in pressure, with additional PEEP (positive pressure end-expiratory).

Premedication administered 30 minutes before surgery consisted of i.v. 0.03 mg/kgc midazolam (18 gauge i.v. needle, oposite arm to the arteriovenous fistula). For anaeshesia induction, an opioid was administered (0.2 mg/kgc Fentanyl) together with i.v. hypnotic (either 3 mg/kgc i.v.Thiopental or 1.5 mg/kgc i.v. Propofol). Suxametoniu chloride (succinyl choline, 0.8-1 mg/kgc) was used in patients with primary hyperparathyroidism as muscle relaxant for endotracheal intubation; vecuroniu 0.1 mg/kgc and rocuroniu 0.6 mg/kgc were used in patients with secondary hyperparathyroidism as muscle relaxant for endotracheal intubation. Volume controlled mechanical ventilation (IPPV) or PCV with PEEP was applied, in order to maintain an expired CO_2 pressure around 38-42 mmHg. During anaesthesia maintenance, 0.15 mg/kgc Fentanyl bolus was used for analgesia and 0.1 mg/kgc rocuroniu and 0.03 mg/kgc vecuroniu were used as muscle relaxants. Volatile anaesthetic gas Sevoflurane 1 MAC concentration was added during anaesthesia maintenance. Same doses of anaestethic drugs were used in both groups.

Methods: Biochemical parameters (serum calcium, phosphate, creatinine) were determined by automated standard laboratory methods. Serum intact PTH was measured by ELISA (iPTH - normal range: 15-65 pg/mL).

Patients' surveillance consisted in close monitoring of breathing, heart rate, non-invasive arterial blood pressure, ECG monitoring (DII), pulse oximetry (SaO_2) – Mindray monitor, end expiratory CO_2 concentration- Et CO_2, inspiratory O_2 concentration - FiO_2 monitoring (Dräger Fabius anaesthesia machine). Hemodinamic status was recorded before surgery, during surgical incision, at the end of operation and 10 minutes later.

ASA anaesthetic risk class, surgery and anaesthesia duration, intraoperative and postoperative drug history were also recorded. In the next 2-3 hours post anaesthesia, patients were questioned about presence of abnormal hearing sensations and pain.

Statistics: For the statistical analyses we used the SPSS version 13.0 for Windows. Numerical variables were expressed as mean ± standard deviation. *t test,* Mann-Whitney, chi-square test were used to compare possible differences between the groups. P-value of <0.05 was considered to be statistically significant. ❑

OUTCOMES

Median surgery duration was 30 minutes (range: 25-45 minutes) in group A (minimally invasive or classic parathyroidectomy) and 75 minutes in group B (total parathyroidectomy and re implantation of a small parathyroid fragment into the sternocleidomastoid muscle) – range 60-75 minutes for local anaesthesia and 60-90 minutes for general anaesthesia.

In both groups, a significant number of patients showed co-morbidities (Table 2).

Anemia was present in 14 patients in group A (14.58%) and in 88 patients in group B

(44.9%). Transfusions were required significantly less frequent in patients with primary hyperparathyroidism: in one patient in group A (1.04%) and 17 patients in group B (8.67%), showing moderate anemia (Hb=6-8 g/dL), p=0.0015, χ^2 test.

Pulmonary diseases were present in 6 patients in group A (6.25%) - 2 patients with asthma and 4 with chronic bronchitis - and in 67 patients in group B (69.79%) - notably 27 patients with restrictive chronic respiratory failure due to severe osseous deformations, kyphoscoliosis, pleuritis.

Anaesthetic issues

Regarding American Society of Anaesthesiologists (ASA) physical status classification system, the majority of patients (219 pts., 75%) were classified as ASA 3 (severe systemic disease), 44 patients (15%) as ASA 2 (mild systemic disease) and 29 patients (9.9%) as ASA 4 (severe systemic disease that is a constant threat to life).

Regarding the type of anaesthesia performed, in patients with primary hyperparathyroidism (group A), 74 patients (77.08%) underwent general anaesthesia with endotracheal intubation and 22 patients (22.91%) underwent intravenous general anaesthesia.

In patients with secondary and tertiary hyperparathyroidism due to chronic renal disease (group B), 119 patients (60.71%) underwent general anaesthesia with endotracheal intubation and 77 patients (39.28%) underwent intravenous general anaesthesia.

Anaesthesia induction was performed using fentanyl and thiopental or fentanyl and propofol, respectively (Table 3).

A decrease higher than 25% in arterial blood pressure was considered clinically significant.

	Fentanyl and thiopental	Fentanyl and propofol
Group A (n= 74)	34	40
Group B (n=119)	79	40

TABLE 3. Drugs used for induction of general anaesthesia with endotracheal intubation in studied groups.

Arterial hypotension developed significantly more frequent in group B (57 out of 196 pts, 29.1%) than in group A (8 out of 96 pts, 8.34%), p <0.0001 (χ^2 test), especially in patients receiving Fentanyl-Propofol. Severe hypertension was noticed with equal frequency in group B (109 out of 196 pts, 55.6%) and in group A (52 out of 96 pts, 54.1%), p=ns.

Post-induction hypotension was noticed in 8 patients in group A (8.34%); 4 after fentanyl and thiopental and 4 after fentanyl and propofol.

Clinically significant arterial hypotension was initially treated with 250 ml 0.9% saline solution bolus. If arterial hypotension persisted, ephedrine 5 mg was adminitered in repeated boluses. One patient with primary hyperparathyroidism and preoperative calcium levels 14 mg/dL required pharmaceutical vasoconstriction with ephedrine.

Post-induction hypotension was noticed in 57 patients in group B (29.1%); 19 after fentanyl and thiopental and 38 after fentanyl and propofol. 16 patients with secondary/tertiary hyperparathyroidism required pharmaceutical vasoconstriction with ephedrine.

Regarding muscle relaxation in patients with general anaesthesia-endotracheal intubation, patients from group B required more often reversion of neuro-muscular block (79 out of 119 pts, 66.4%) as compared with patients from group A (32 out of 74 pts, 43.2%), p= 0.0016 (χ^2 test), especially in rocuronium patients – see Table 4. Detailed data on muscle relaxation will be presented in another paper.

During surgery and anaesthesia maintenance, a significant number of events occurred in both groups (Table 5).

Bradycardia was significantly more frequent in group A (67 out of 96 pts, 69.8%) than in group B (26 out of 196 pts, 13.3%), p< 0.0001 (χ^2 test), especially during searching of parathyroid glands. By contrary, ventricular premature beats were less frequent in group A (25 out of 96 pts, 25.25%) than in group B (84 out of 196 pts, 42.85%), p=0.003 (χ^2 test). Ventricular ar-

Co-morbidities	Cardiovascular	Pulmonary	Renal	Osseous	Diabetes mellitus	Gastrointestinal
Group A (n=96)	52	6	54	40	17	27
Group B (n=196)	142	67	196	154	39	83
p (χ^2 test)	0.002	<0.0001	-	<0.0001	ns	0.02

TABLE 2. Co-morbidities in patients with hyperparathyroidism undergoing surgery.

rhythmias were treated with 1% lidocaine and metoprolol.

In patients with heart rate lower than 50 beats/minute, i.v. atropine 0.5 mg/bolus was administered, cumulative dose less than 3 mg; when needed, surgical searching and traction of parathyoid glands was stopped.

There were no statistically significant differences between the studied group regarding frequency of arterial hypertension and hypotension, paroxysmal atrial fibrillation.

Treatment of intra-operative hypertension required intravenous nitroglycerine or enalapril. None of the operated patients associated pheochromocytoma.

In patients with primary hyperparathyroidism, intravenous (i.v.) Nitroglycerine and i.v. enalapril were equally efficient in treatment of intra operative hypertension (78.6% and 94.4%, respectively, p= ns). Four patients unresponsive to initial therapy required combined therapy.

By contrary, in patients with secondary hyperparathyroidsm, i.v. nitroglycerine was more efficient than i.v. enalapril (90.5% vs. 56.8%, p <0.001). Twenty patients unresposive to initial therapy required combined therapy – Table 6.

Extubation was performed when blink and swallowing reflexes were present, conscience was present, and there was a good cardiac and respiratory activity.

Post-surgical complications were presented in Table 7. Angor pectoris occurred more frequent in postoperative period in patients with secondary and tertiary hyperparathyroidism.

From both groups, 7 patients showed transient dysphonia and 2 patients required tracheostoma. Re-operation was necessary in 14 patients: 5 patients for haematomas (2 from group A and 3 from group B), 7 patients for recurrent disease (3 from group A and 4 from group B) and 2 for granulomas (1 patient from each group). ❑

	N (%)	Rocuronium	Vecuronium
Group A	Total n=74	26	48
	Antagonization n=32 (43.2%)	17 (65.4%)	15 (31.3%)
Group B	Total n=119	29	90
	Antagonization n=79 (66.4%)	26 (89.7%)	53 (58.9%)

TABLE 4. Muscle relaxation and required reversion of neuromuscular block in patients with general anaesthesia-endotracheal intubation.

DISCUSSION

As optimal type of anaesthesia in parathyroid surgery is debated, our series focussed on anaesthetic issues in a large series of parathyroidectomies for both primary and secondary/tertiary hyperparthyroidism.

Median surgery duration was 30 minutes in group A (minimally invasive or classic parathyroidectomy) and 75 minutes in group B (total parathyroidectomy and re implantation of a small parathyroid fragment into the sternocleidomastoid muscle).

In a large series of 1112 patients with primary hyperparathyroidism, overall mean operating time was 52.5 ± 30.2 minutes. In this series, choice of anaesthetic approach did not affect the cure or complication rate (6). Operative times significantly decrease with surgeons' experience ans preoperative localization to 22.3 minutes in bilateral techniques and 16.4 minutes in unilateral techniques (1).

In our series, the majority of patients (219 pts., 75%) were classified as ASA, 44 patients (15%) as ASA 2 and 29 patients (9.9%) as ASA

	Arterial hypertension	Arterial hypotension	Bradycardia[&]	Ventricular premature beats[#]	Atrial fibrillation
Group A (n=96)	32	21	67	25	7
Group B (n=196)	79	48	26	84	8
p (χ^2 test)	ns	ns	<0.0001	0.003	ns

TABLE 5. Intra-operative events during parathyroid surgery in studied groups.

		Intra-operative hypertension	i.v. Nitroglycerine	i.v. Enalapril
Group A (n=96)	N	32	14	18
	Efficacy (%)	28/32 (87.5%)	11/14 (78.6%)	17/18 (94.4%)
Group B (n=196)	N	79	42	37
	Efficacy (%)	59/79 (74.7%)	38/42 (90.5%)	21/37 (56.8%)

TABLE 6. Treatment of intra-operative high blood pressure.

	Group A (n=96)	Group B (n=196)	P (*t test*)
Postoperative calcium (mg/dL)	9.1 ± 1.4 Median: 8.94 Range: 3.9-14.8	6.6 ± 1.9 Median: 6.7 Range: 2.8-10.2	<0.0001
Postoperative PTH (pg/mL)	40 ± 33.9 Median: 35.5 Range: 0.92-119.3	78.29 ± 190.5 Median: 80 Range: 43.3-735.5	<0.0001

TABLE 7. Post-operative biochemical data in patients with hyperparathyroidism undergoing surgery.

	Arterial hypertension	Arterial hypotension	Brady cardia	Ventricular premature beats	Atrial fibrillation	Angor pectoris[$]
Group A (n=96)	12	2	1	3	6	17
Group B (n=196)	31	5	4	17	7	64
p (χ^2 test)	ns	ns	ns	ns	ns	0.007

TABLE 8. Post-surgical complications in patients with hyperparathyroidism undergoing surgery.

4. Also the proportion of elderly patients is big (47 out of 96 patients – 48.9% in group A and 32 out of 196 patients 16.3% in group B – were older than 60 years). In a vast series recently published, patients 65-79 and ≥80 years were more likely to have inpatient parathyroidectomies compared with younger patients (42.4%, 46.8% versus 36.0%) and higher ASA classification (42.4%, 59.8% versus 24.2%, all p <0.01) (7).

With high-quality parathyroid adenoma's localization (sestamibi scintigraphy, ultasonography) and intraoperative parathyroid hormone level monitoring, about 60%-70% of all patients would be eligible for minimally invasive parathyroidectomy; this procedure uses both general and local anaesthesia with intravenous sedation (3).

In various series, patients who had parathyroidectomy under local anaesthesia (LA) were older, required less IV narcotic pain mediation, required fewer anti-emetic medications compared to patients on general anaesthesia (8).

In the literature, in a series of 7313 patients with primary hyperparathyroidism, patients ≥80 years were less likely than those 45-64 years to receive general anesthesia (84.9% vs. 89.8%, p <0.01). Patients ≥65 years were more likely to have ≥1 complication (2.2% vs. 1.3%, p <0.01) and respiratory-specific complications compared with younger patients (0.9% vs. 0.3%, p <0.01). Patients 65-79 and ≥80 years were more likely to have extended hospital stays (7.7%, 12.2% vs. 6.5%, p <0.01); mortality rate for patients ≥80 years was higher (0.8% vs. <0.1%, p <0.01). On multivariable analysis, patients ≥65 years had increased risks for overall/respiratory complications and extended hospital stays, (all p <0.01) (7).

Minimally invasive video-assisted parathyroidectomy (MIVAP) conducted under regional anaesthesia (RA) was associated with a shorter overall operating time and a reduced need for postoperative pain relief (ketorolac) as compared to general anaesthesia (GA) in a series of 51 patients with primary hyperparathyroidism (26 RA - bilateral deep cervical block, and local infiltration of the incision site with a mixture of 0.25 per cent lignocaine and 0.15 per cent bupivacaine /25 GA - intravenous administration of propofol, remifentanil and rocuronium bromide) (9).

In our series, arterial hypotension developed significantly more frequent in group B (57 out of 196 pts, 29.1%) than in group A (8 out of 96 pts, 8.34%), p <0.0001 (χ^2 test), especially in patients receiving Fentanyl –Propofol.

There were also concerns that propofol may increase PTH concentrations and/or interfere with PTH assays. However, recent studies found at ten minutes after induction, that PTH concentrations were not influenced by type of anaesthesia (propofol or sevoflurane). There is no evidence to support the avoidance of a propofol anaesthetic for parathyroid surgery (10, 11).

For anaesthesia-induced hypotension, we preffered ephedrine because of it's superiority in maintaining adequate O_2 saturation (12).

There are advantages of local anaesthesia (LA) vs. general anaesthesia (GA), even in the case minimally invasive parathyroidectomy (MIP). In a series a 74 patients with primary hyperparathyroidism undergoing MIP (50 on LA

and 16 on GA), LA confers significantly shorter operative time and hospital stay with no significant difference in subjective postoperative pain, patient satisfaction, overall outcome, or cure rate when compared to GA, in patients with appropriate preoperative localization (13-15).

LA is also an option in patients with secondary/tertiary hyperparathyroidism due to chronic renal disease. The patients with severe cardiorespiratory dysfunction presented very high risk for general anaesthesia (GA). In our series, in group B, 72.45% of patients showed important cardiovascular complications and 69.8% of patients showed respiratory problems. Similarly, in a series of 32 patients with secondary hyperparathyroidism, 50% of patients had severe restrictive lung disease as a result of renal osteodystrophy and the other 50% of patients had poor cardiac status. The post-operative complications were: acute coronary syndrome (n=1) and wound haematoma (n=1), congestive heart failure (n=1). Total parathyroidectomy can be performed safely and successfully under LA, in selected, high-risk patients to minimise the risk of GA (16).

In our series, 8 patients (2.7%) required conversion from local anaesthesia or general intravenous anaesthesia to general anaesthesia with endotracheal intubation. The main causes were prolongation of operatory times due to lack of parathyroid gland localisation (extensive neck exploration required), vicious neck position due to osseous cervical changes and difficulties in monitoring and maintaining normal respiratory function. In the literature, in a series of 441 consecutive patients with primary hyperparathyroidism undergoing minimally invasive parathyroidectomy under cervical block and monitored anaesthesia care using midazolam and narcotics, 47 (10.6%) required conversion to GA: 16 to accomplish simultaneous thyroidectomy, 15 because the intraoperative parathyroid hormone level failed to decrease by at least 50% from the baseline after resection of the incident parathyroid tumor and extensive exploration was required, 8 because of technical difficulties related to ensuring adequate protection of the recurrent laryngeal nerve, 5 to optimize patient comfort, and 2 because of the intraoperative recognition of parathyroid carcinoma (17).

In our series we did not performed cervical plexus block (CBP) during MIP. In centers performing this procedure, superficial CPB has been reported to be easier to perform with similar efficacy and less anaesthesia-related complications than combined deep and superficial CPB. In a series of forty-two patients with primary hyperparathyroidism due to a solitary adenoma, there were no differences in onset of block, pain scores during surgery, or time to first analgesic request between groups. Fentanyl consumption was similar in both groups (18).

Resistance to vecuronium bromide (Vb) induced muscle relaxation for general anaesthesia in a patient with chronic renal failure (CRF) and secondary hyperparathyroidism (HPT) was reported (19).

One limit of our study is lack of intraoperative monitoring of PTH levels (IOPTH). The vast majority of the patients from our series underwent general endotracheal anaesthesia (tracheal intubation). However, it is known PTH secretion is partially regulated by circulating catecholamines and PTH levels are dependent of anaesthetic techniques.

The stress of direct laryngoscopy and passing an endotracheal tube through the vocal cords elicits haemodynamic, metabolic and hormonal changes such as raising blood catecholamine levels and consequently PTH levels. All anaesthetic techniques increased IOPTH levels from preinduction to 3 minutes postinduction, especially general endotracheal anaesthesia (up to 65%), with a peak effect for general anaesthesia at 6 minutes (20). In a series of 72 hyperparathyroid patients undergoing elective parathyroidectomy for primary and secondary hyperparathyroidism, tracheal intubation significantly increased plasma parathyroid hormone levels in both primary and secondary hyperparathyroidism, as well as in patients undergoing thyroidectomy or laparoscopic cholecystectomy under general anaesthesia (21).

In our series we had noticed several postoperative complications. However, postoperative iatrogenic tetraparesis due to prolonged neck extension usually required by this procedure and spinal cord injury was not reported. Mercieri M and coworkers described 2 such cases, on long-term haemodialysis, in whom spinal stenosis associated with chronic renal failure may have made these patients more vulnerable (22). Also pneumotorax was not recorded in our series (23). Some complications, such as dysphonia due to recurrent laryngeal nerve le-

sion can be prevented by intraoperative laryngeal nerve monitoring (24).

Conclusions: anaesthetic management in parathyroid surgery may be difficult because of cardiac arrhythmias (bradycardia in primary hyperparathyroidism and ventricular premature beats in secondary and tertiary hyperparathyroidism, respectively) and arterial hypotension during anaesthesia induction in patients with secondary and tertiary hyperparathyroidism.

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