ORIGINAL RESEARCH

Secondary Hyperparathyroidism: Clinical Exploration of Endoscopic Total Parathyroidectomy Using the Oral Vestibular Approach with Forearm Autotransplantation

Fei Xu, MD; Xiurong Zhang, BS; Zicong Liao, BS; Jianping Zhou, BS; Zhiping Tang, MD

ABSTRACT

Context • For secondary hyperparathyroidism (SHPT), physicians prefer conservative treatments, and surgical intervention has proven to be the best solution for some patients. Among the surgical interventions, total parathyroidectomy plus autotransplantation (TPTX+AT), using the forearm, is the major effective treatment. TPTX+AT, in conjunction with transoral endoscopic thyroidectomy vestibular approach (TOETVA), includes many advantages.

Objective • The study intended to evaluate the clinical value of performing an endoscopic total parathyroidectomy TPTX+AT in conjunction with TOETVA in treating SHPT and to summarize and share the clinical experience.

Design • The research team performed a prospective controlled study.

Setting • The study took place at the Zhongshan Boai Hospital affiliated with Southern Medical University in Zhong Shan, Guangdong, China.

Participants • Participants were 97 SHPT patients who were admitted to the hospital between March 2020 and March 2022.

Intervention • The intervention group included 47 SHPT patients who received endoscopic TPTX+AT combined with the TOETVA, and the control group included 50 SHPT patients who received routine TPTX+AT.

Outcome Measures • The research team performed comparisons between the groups regarding: (1) operating conditions, including intraoperative blood loss, operating time, and number of parathyroid glands detected intraoperatively; (2) clinical efficacy, (3) postoperative complications, (4) parathyroid hormone (PTH) and calcium (Ca) levels, (5) psychological status using the Hamilton Anxiety (HAMA) and the Hamilton Depression Scale (HAMD), and (9) life quality using the 36-Item Short Form Health Survey (SF-36).

Results • The intervention group had significantly longer operation times and significantly greater intraoperative blood loss than the control group did, but the intervention group had fewer complications, lower PTH and Ca levels, and a higher efficacy ($P<.05$). The intervention group also had a significantly better psychological state and prognostic quality of life than the control group did ($P<.05$).

Conclusions • Endoscopic treatment of SHPT using TPTX+AT in combination with TOETVA can significantly relieve clinical symptoms and lower serum PTH and Ca levels. The results suggest that the operation is safe and effective. (*Altern Ther Health Med.* 2023;29(1):216-223).

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Secondary hyperparathyroidism (SHPT) is one of the most commonly seen complications in patients with chronic renal failure (CRF), renal insufficiency, and renal tubular acidosis (RTA) and in pregnant women, with a high incidence worldwide. According to the survey, the number of new SHPT cases worldwide in 2019 exceeded 200 000, and the risk of SHPT has increased about 6 times from the rate a decade ago.[1]

In the course of the disease, SHPT can not only increase the occurrence of musculoskeletal complications but also can cause cardiovascular and cerebrovascular events, which can be life-threatening in severe cases.[2] At present, approximately 80 000 patients worldwide die each year due to SHPT.[3]

For SHPT, physicians prefer conservative treatments clinically, and surgical intervention has proven to be the best solution for patients with refractory and progressive SHPT when other medical treatments have been ineffective.[4] Among those surgical interventions, total parathyroidectomy plus autotransplantation (TPTX+AT), using the forearm, is the major effective treatment for SHPT, with well-documented efficacy.[5,6] The main content of TPTX+AT is to re-implant a small part of the excised parathyroid slices into the body when the hyperparathyroidism needs to be surgically removed to prevent postoperative hypoparathyroidism.

Endoscopy

Since 1996, when Gagner[7] successfully performed the first endoscopic parathyroidectomy, medical practitioners have widely applied endoscopy clinically because it is safe and effective, provides a larger visual field during an operation, and leaves a less noticeable scar. With the development of endoscopic techniques and equipment, medical practitioners have rapidly developed a variety of endoscopic approaches for parathyroidectomy.[8-10]

In recent years, as endoscopy technology and equipment have advanced and research have gradually revealed the advantages of the technology's minimally invasive methods, medical practitioners have used endoscopy more and more for TPTX+AT and have rapidly developed a variety of surgical approaches, with significant application results.[11-13] Because of this, surgeons have increasingly accepted the concept of performing endoscopic thyroidectomy through the natural cavity, which has become the preferred option in TPTX+AT.[14]

It's difficult to identify and resect the parathyroid tissue during the operation.[15] The combined procedure, TPTX+AT, in conjunction with transoral endoscopic thyroidectomy vestibular approach (TOETVA), includes many advantages:[16,17] (1) it makes the best use of the advantages of natural orifice transluminal endoscopic surgery (NOTES), which avoids leaving noticeable scars; (2) it avoids the inconvenience of operation and the difficulty of exposing the lower pole caused by a block of the clavicle in the breast-breast approach, and it provides better surgical accuracy; (3) it offers a good overhead view, making it easy to resection the substernal parathyroid tissues, and it can handle the ectopic substernal parathyroid; and (4) it significantly reduces subcutaneous dissection compared with other methods.

Current Study

Due to the difficulty of the operation on the parathyroid gland, endoscopic surgery hasn't been used extensively for SHPT in modern medicine. Therefore, summarizing the experience of endoscopic thyroidectomy through TOETVA is of great reference significance for the future clinical mastery of endoscopic TPTX+AT.

The current study intended to evaluate the clinical value of performing an endoscopic total parathyroidectomy using TPTX+AT in conjunction with TOETVA in treating SHPT and to summarize and share the clinical experience.

METHODS

Participants

The research team performed a prospective controlled study. The study took place at the Zhongshan Boai Hospital affiliated with Southern Medical University in Zhong Shan, Guangdong, China. Participants were SHPT patients who were admitted to the hospital between March 2020 and March 2022. All SHPT patients routinely underwent hemodialysis treatments and had symptoms of bone pain, itching skin on the lower limbs, and dark skin. When a patient enters the hospital for treatment, as long as he meets the inclusion and exclusion criteria of this study, we will ask him if he is willing to participate in this study. If the patient agrees, the information will be tracked and recorded in real time by the members of the research group. This study strictly followed the Declaration of Helsinki and was approved by the Ethics Committee of our hospital, and all patients signed the informed consent.

Procedures

Groups. The intervention group included patients who underwent endoscopic TPTX+AT combined with TOETVA, and the control group included patients who underwent routine TPTX+AT.

Preoperative procedures. Preoperative x-ray examinations showed osteoporotic changes in all SHPT participants' long bones, and ultrasound and computed tomography (CT) scans of the neck showed enlargement of the parathyroid gland.

Preoperative CT and B-ultrasound to locate the parathyroid gland are very important for the operation. They can show the position and size of the gland and its anatomical relationship to the surrounding area as well as the ectopic parathyroid gland behind the sternum, in the glandular embedding and tracheoesophageal groove. Medical practitioners can evaluate the parathyroid glands based on the information from preoperative localization and on the common anatomical site, appearance and texture of the glands.

Patients with SHPT have a complete and smooth capsule, with many small blood vessels on the capsule's surface and with the capsules being brown and yellow in color and slightly hard in texture. These capsules need to be distinguished from lymph nodes, fat granules, and ectopic thymus.[18]

AT. The surgeries of both the intervention group and the control group included AT. The graft sites include the subcutaneous part of the forearm on the non-fistula side, the intramuscular part of the forearm on the non-fistula side, the sternocleidomastoid muscle, and the abdominal subcutaneous and subcutaneous parts of the manubrium, deltoid, and trapezius.

The advantage of selecting the forearm limb as the graft site is that it's easy to monitor the graft survival rate and recurrence by comparing the serum parathyroid hormone (PTH) levels of both upper arms, and a surgeon can remove the graft under local anesthesia if recurrence happens.[19]

Exposure of the parathyroid gland using TOETVA. The exposure of the parathyroid gland during the operation is essential to a good outcome. TOETVA provides an alternative "From head side to foot side" anatomical method,[18] helping in the exposure of the inferior parathyroid gland and of the parathyroid gland behind the sternum. When dealing with the parathyroid gland's upper pole, the surgeon must sever part of the thyrohyoid muscle and pull out the upper pole.

The surgeon dissects the parathyroid gland's lateral capsule to turn the gland up to the opposite side and expose the dorsal parathyroid gland. However, the blood vessels of the upper pole and middle pole can influence the release of fixation when the surgeon exposes the thyroid gland when performing an operation using TOETVA. It's necessary to sever the blood vessels during operation and remove the soft-tissue fixation.[20]

Postoperative management. The medical team suggests that patients assume a semireclining position after awakening. The postoperative management of patients includes: (1) continuously observing the patient's vital signs, any swallowing and hoarseness to prevent aspiration and cough, neck drainage volume, and color; (2) continuously observing levels of PTH and blood calcium (Ca), which are re-checked often to give Ca-supplement treatments if necessary: oral caltrate, calcitriol + intravenous calcium infusion of 4-9 g per day at the early stage; and (3) performing maintenance hemodialysis 1-2 days after the operation. Then the patient receives heparin-free hemodialysis at one week after the operation.

Outcome measures. The research team compared demographic and clinical data at baseline, such as ages, genders, and family histories of illness, between the groups. For both groups, the research team measured: (1) operating conditions; (2) clinical efficacy; (3) the occurrence of postoperative complications; (4) levels of PTH and Ca; (5) psychological states using scores on the Hamilton Anxiety Scale (HAMA) and the Hamilton Depression Scale (HAMD)[21]; and (6) prognostic quality of life using the Short-Form 36 Item Health Survey (SF-36).[22] The research team followed up with participants by telephone and hospital visits, with an interval of no more than 3 months between contacts and a duration of 12 months.

Intervention

Intervention group. Patients receive heparin-free hemodialysis on the day before the surgery and perform a povidone iodine gargle on the morning of the day before surgery and on the day of the surgery. Before the surgery, the nephrology, anesthesiology, and hemodialysis departments coordinated the development of a perioperative diagnosis and treatment plan. The medical team of one of the members of the research team performed the surgery, and the team used intraoperative prophylactic use of second-generation cephalosporins.

For the surgery, the medical team: (1) asks the patient to lie in supine position, with his or her shoulder and back raised and neck tilted back; (2) disinfects the patient's face and mouth thoroughly; (3) using the endoscope (Fiegert, Tuttlingen, Germany), makes a 10-mm incision in the middle of the central incisor that starting 0.5 cm from the root of the vestibular gingiva down to the periosteum of the mandible; (4) cuts the connective tissue of the mental protuberance and separated the submaxillary and anterior cervical flaps, using a separator stick placed against the skin to create operating space; (5) puts a 10-mm trocar (Fiegert) against the periosteum of the mandible to puncture it from the anterior middle cervical platysma to the thyroid cartilage; and (6) places the endoscope, injected CO_2, and applied pressure at 3 mmHg.

The medical team then: (1) inserts a 5-mm trocar (Fiegert) from the bilateral mandibular first premolars along the oral vestibular isthmus and mandibular periosteum to subcutaneously puncture the anterior midline of the neck to enter the operating space (Figure 1A); (2) dissociates subcutaneous space below the level of the thyroid cartilage up to the sternum, using the electric hook and ultrasonic knife, the subcutaneous part below the thyroid cartilage to the sternum and the lateral border of the sternocleidomastoid muscle (Figure 1B); (3) prevents injury to the anterior jugular vein and cut the linea alba cervicalis longitudinally; (4) uses the thyroid retractor to pull the anterior cervical muscles to both sides (Figure 1C); (5) separates the thyroid's lateral capsule, removes the soft fixation, and rolls up the thyroid to the opposite side (Figure 1D); (6) severs the pulling blood vessels of the thyroid during exposure if necessary; (7) with the underside of the thyroid fully exposed, searches all the parathyroid glands and excises lesions according to the CT results and parathyroid anatomy (Figure 1E); (8) places the remaining tissue in normal saline for transplantation. Figure 1F shows the appearance of the neck on the fourth day after the operation.

The medical team then: (1) at 30 minutes after removal of all the parathyroid glands, samples the patient's blood every 15 minutes to detect the parathyroid hormone (PTH) level during the operation, and (2) while waiting for the results, sutures the linea alba cervicalis, places the drainage tube in the glandular fossa, and drains the fluid from the puncture hole in the chest wall.

Participants in the intervention group received forearm autotransplantation. The medical team implanted 10-15 pieces of parathyroid tissue (1 mm × 1 mm × 1 mm), about 30 mg in total, subcutaneously 4-cm deep into the radial forearm, without arteriovenous fistula operation. The team used nonabsorbable sutures to mark the graft site and sutured the subcutaneous tissue and skin after hemostasis. A PTH value of <100pg/mL during the operation indicated that the operation had been effective. The team performed no

Figure 1. The Surgical Procedure of Endoscopic Total Parathyroidectomy Plus Autotransplantation TPTX+AT, Using the Forearm, combined with the transoral endoscopic thyroidectomy vestibular approach (TOETVA). Figure 1A shows the surgical posture and each trocar position; Figure 1B shows the create anterior neck space; Figure 1C shows the pulling of the anterior cervical muscles to both sides; Figure 1D shows the cutting and dissociation of the lateral capsule of the thyroid gland; Figure 1E shows the exposure and resection of the parathyroid gland; and Figure 1F shows the appearance of the neck on the fourth day after the operation.

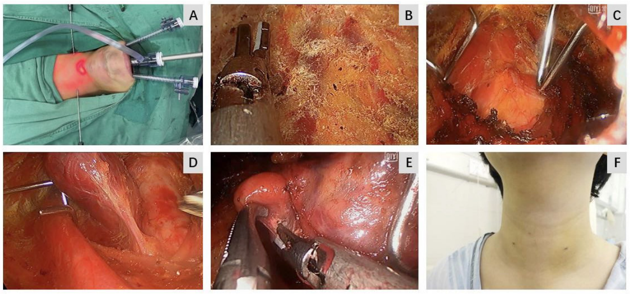


Table 1. Comparison of Demographic and Clinical Data at Baseline (N = 97)

	Control Group n = 50 Mean ± SD n (%)	Intervention Group n = 47 Mean ± SD n (%)	t/χ²	*P* value
Age	56.82 ± 10.01	56.23 ± 10.87	0.278	.781
Gender			0.075	.784
Male	14 (28.00)	12 (25.53)		
Female	36 (72.00)	35 (74.47)		
Family History of Illness			0.595	.440
Yes	4 (8.00)	6 (12.77)		
No	46 (92.00)	41 (87.23)		
Smoking			0.048	.827
Yes	17 (34.00)	15 (31.91)		
No	33 (66.00)	32 (68.09)		
Drinking			0.177	.674
Yes	14 (28.00)	15 (31.91)		
No	36 (72.00)	32 (68.09)		
Insomnia			0.167	.683
Yes	39 (78.00)	35 (74.47)		
No	11 (22.00)	12 (25.53)		
Place of Residence			0.014	.907
Urban	24 (48.00)	22 (46.81)		
Rural	26 (52.00)	25 (53.19)		

further explorations and sutured the oral vestibular mucosa incision at the end of the operation (Figure 1F).

Control group. Patients in the control group received only TPTX and no AT. The operation is the same as above.

Outcome Measures

Operating conditions. The research team measured: (1) intraoperative blood loss, operating time, and number of parathyroid glands detected intraoperatively. The lower the intraoperative blood loss and operating time, the higher the safety of the surgery, and the higher the number of parathyroid glands detected intraoperatively, the better the effect of surgery on SHPT.

Clinical efficacy. The research team measured clinical efficacy postintervention at three months after surgery at discharge, evaluating the efficacy as follows: (1) markedly effective = the lesion cleared without hoarseness or recurrent laryngeal nerve injury; (2) effective = improvement in a participant's clinical symptoms and condition; and (3) ineffective = failure to meet the criteria for markedly effective or effective.

Postoperative complications. The research team determined if participants experienced postoperative complications, including hemorrhage, hoarseness, choking, and wound infection.

PTH and Ca levels. The research team measured the levels at baseline, at one week postoperatively, at one month postoperatively, and postintervention at 3 months after surgery. Elevated PTH and Ca indicate hyperthyroidism, while lower PTH and Ca indicate hypothyroidism.

Psychological status.[21] Postintervention at 3 months after surgery at discharge, the research team assessed participant's psychological status using the HAMA and the HAMD. The HAMA and HAMD scales are recognized emotional evaluation scales. The higher the score, the more severe the patient's anxiety and depression.

Prognostic follow-up. At the last follow-up at 12 months after surgery, the team assessed participant's life quality using the Short-Form 36 Item Health Survey (SF-36),[22] with higher scores indicating better life quality on the following subscales: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and Mental Health (MH). The SF-36 was developed by a team at the American Academy of Medicine, and higher scores on each dimension indicate better patient status in this area. That is, an increase in the overall score indicates an excellent quality of life.

Statistical Analysis

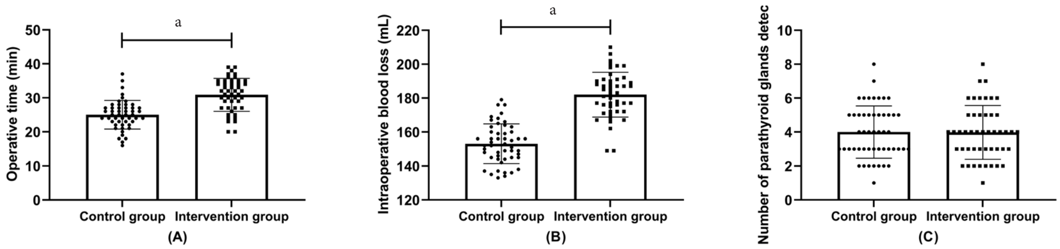
The research team employed the SPSS 26.0 (IBM, Armonk, NY, USA) for statistical analysis. The team analyzed: (1) measurement data, statistically expressing the data as means ± standard deviations (SDs), using the independent samples *t* test; (2) multi-time-point comparisons using repeated analysis of variance (ANOVA) and the LSD post-hoc test; and (3) count data, recorded as percentages, using the chi-square test. $P < .05$ indicates significant differences.

RESULTS

Demographic and Clinical Data at Baseline

The research team included 97 SHPT patients in the study and analyzed their data, 47 in the intervention group and 50 in the control group (Table 1). No significant differences existed between the groups at baseline ($P > .05$), indicating comparability.

Figure 2. Comparisons of Surgical Conditions for the Intervention and Control Groups. Figure 2A shows operative time; Figure 2B, shows intraoperative blood loss; and Figure 2C shows the number of parathyroid glands detected.



[a]$P < .05$, indicating that the intervention group's intraoperative blood loss and operating time were significantly higher than those of the control group

Operating Conditions

All participants successfully completed the operation without the need to convert to open surgery. One patient in the intervention group underwent the surgery in combination with the thoracic-breast approach because medical team couldn't expose the parathyroid gland's left upper pole.

The intervention group's intraoperative blood loss ranged from 20 to 39mL, with a mean of 30.89 ± 4.86 mL, and the group's operating time ranged from 149 to 210 min, with a mean of 182.00 ± 13.18 min (data not shown). The medical team found 173 yellowish-brown parathyroid glands in the group.

In the control group, the intraoperative blood loss ranged from 16 to 37 mL, with a mean of 25.02 ± 4.21 mL, and the group's operating time ranged from 133 to179 min, with a mean of 153.10 ± 11.67 min (data not shown). The medical team found 185 parathyroid glands in the group.

Figure 2A shows that the groups had no significant difference in the number of parathyroid glands detected ($P > .05$,), while Figures 2B and 2C show that the intervention group's intraoperative blood loss and operating time were significantly greater than those of the control group.

Clinical Efficacy

For the intervention group, 78.72% of the procedures were significantly effective, 17.02% were effective, and 4.26% were ineffective (Table 2). In the control group, 60.00% of the procedures were markedly effective, 34% were effective, and 6.00% were ineffective.

No statistically significant differences existed between the groups in the number of participants with effective and ineffective treatments ($P > .05$). However, the number of participants with markedly effective treatments was significantly higher in the intervention group than in the control group ($P < .05$). Both methods can significantly improve SHPT, with a significant therapeutic effect in the intervention group.

Postoperative Complications

At one week after surgery, the intervention group's symptoms of bone pain and pruritus had significantly decreased (data not shown), and no postoperative complications, hemorrhage, hoarseness, or choking had occurred (Table 3). In the control group, one participant developed a hemorrhage, two had hoarseness, and two experienced choking, with a complication rate of 10.00%.

The intervention group had a significantly lower rate of postoperative complications than that of the control group ($P < .05$), suggesting that the surgery method used in the intervention group contributed to higher patient safety.

Table 2. Comparison of the Clinical Effects for the Intervention and Control Groups

	Markedly Effective n (%)	Significantly Effective n (%)	Ineffective n (%)
Control group, n = 50	30(60.00)	17(34.00)	3(6.00)
Intervention group, n = 47	37(78.72)	8(17.02)	2(4.26)
χ^2	3.976	3.651	0.151
P value	0.046[a]	0.056	0.698

[a]$P < .05$, indicating that the number of participants with markedly effective treatments was significantly higher in the intervention group than in the control group

Table 3. Comparison of Postoperative Complications for the Intervention and Control Groups

	Hemorrhage n (%)	Hoarseness n (%)	Choking n (%)	Complication Rate n (%)
Control group, n=50	1(2.00)	2(4.00)	2(4.00)	5 (10.00)
Intervention group, n=47	0(0.0)	0(0.0)	0(0.0)	0 (0.0)
χ^2				4.955
P value				.026[a]

[a]$P < .05$, indicating that the intervention group had a significantly lower rate of postoperative complications than the control group did

PTH and Ca Levels

Table 4 shows that the level of PTH in both groups at one week postoperatively was significantly lower than that at

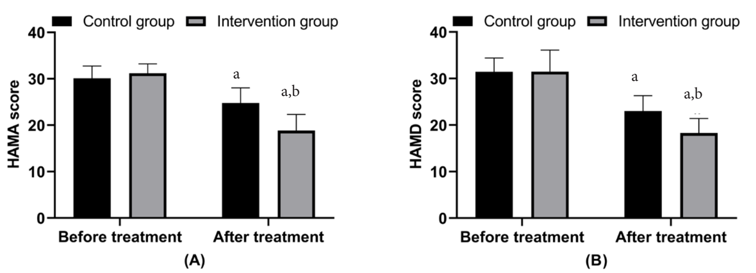
Table 4. Comparison of PTH and Ca Levels for the Intervention and Control Groups

		Control Group n = 50 Mean ± SD	Intervention Group (n = 47) Mean ± SD	*t*	*P* Value
PTH, pg/mL	Baseline	2137.77 ± 528.14	2142.06 ± 528.65	0.040	.968
	One week after surgery	5.93 ± 1.90[a,b]	4.22 ± 2.00[a]	4.318	<.001
	One month after surgery	19.84 ± 7.80[a,b]	15.26 ± 6.95[a,b]	3.046	<.001
	Postintervention at three months after surgery	40.83 ± 18.28	41.77 ± 22.86[b]	0.224	.823
Ca, mmol/L	Baseline	3.42 ± 0.29	3.39 ± 0.25	0.544	.588
	One week after surgery	2.42 ± 0.26[b,c]	2.01 ± 0.20[b,c]	8.665	<.001
	One month after surgery	2.02 ± 0.19	2.02 ± 0.18	0.000	-
	Postintervention at three months after surgery	2.00 ± 0.22	2.02 ± 0.21	0.457	.648

[a]*P* < .05, indicating that the PTH significantly decreased for both the intervention and the control group between baseline and one week postoperatively, but that level had significantly increased between one week and one month postoperatively, and continued to increase, but not significantly, until postintervention at 3 months after surgery
[b]*P* < .05, indicating that the intervention group's levels of PTH at one week and one month postoperatively and of Ca at one week postoperatively were significantly lower than those of the control group
[c]*P* < .05, indicating that the Ca level in both groups was significantly lower at one week postoperatively than at baseline

Abbreviations: Ca, calcium; PTH, parathyroid hormone.

Figure 3. Comparisons of Psychological States for the Intervention and Control groups. Figure 3A shows the HAMA scores, and Figure 3B shows the HAMD score.



[a]*P* < .05, indicating that the intervention group and the control group both had significantly lower HAMA and HAMD scores postintervention at three months after surgery than at baseline
[b]*P* < .05, indicating that the intervention group had significantly lower HAMA and HAMD scores postintervention at three months after surgery than the control group did

Abbreviations: HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale.

baseline (*P* < .001) and that the level had significantly increased between one week and one month postoperatively for both groups (*P* < .001) and continued to increase, but not significantly, between one month postoperatively postintervention at 3 months after surgery (*P* < .05).

The Ca level in both groups was also significantly lower at one week postoperatively than at baseline (*P* < .05). Those levels remained in a relatively stable state for both groups, with no significant changes from one week postoperatively to postintervention at 3 months after surgery (*P* > .05).

The intergroup comparisons revealed no significant differences in PTH or Ca between the groups at baseline or postintervention at 3 months after surgery (*P* > .05), but the intervention group's levels of PTH at one week and one month postoperatively and of Ca at one week postoperatively were significantly lower than those of the control group (*P* < .05).

Psychological States

No significant differences existed between the groups in the HAMA and HAMD scores at baseline (*P* > .05). Postintervention at 3 months after surgery, the HAMA scores of the intervention group and the control group were 18.85 ± 3.48 and 24.78 ± 3.28 (data not shown), respectively, and were significantly lower than their scores at baseline (Figure 3A). The postintervention HAMA score was significantly lower in the intervention group than in the control group (*P* < .05).

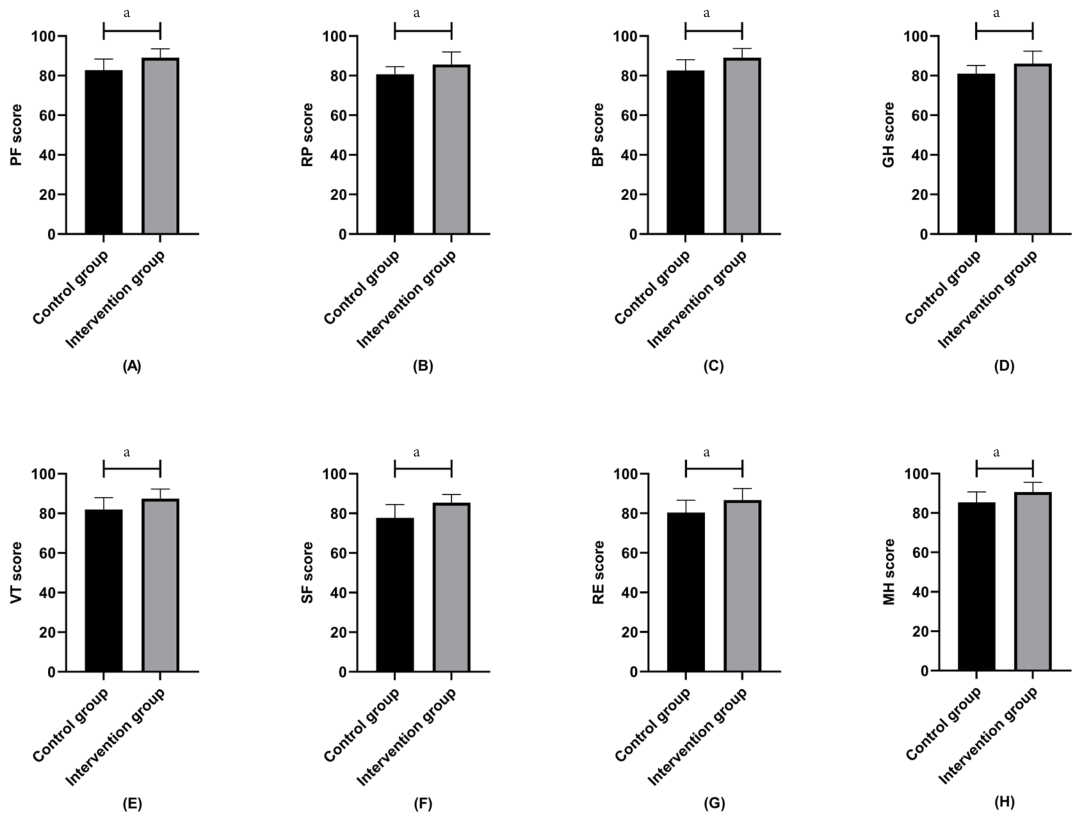
Figure 3B shows that the HAMD scores significantly decreased between baseline and postintervention (*P* < .05) to 18.28 ± 3.15 and 23.02 ± 3.29 in the intervention and control groups, respectively, with a significantly lower score in the intervention group postintervention than in the control group (*P* < .05). This suggests a better psychological state in the intervention group after treatment.

Patients' Prognosis

The research team successfully tracked all participants in the intervention and control groups during the follow-up. At 12 months after surgery, the intervention group had significantly higher scores for PF (Figure 4A), RP (Figure 4B), BP (Figure 4C), GH (Figure 4D), VT (Figure 4E), SF (Figure 4F), RE (Figure 4G) and MH (Figure 4H) than the control group did.

This finding indicates a significantly better prognostic quality of life for the intervention group, which again verifies the excellent results of endoscopic TPTX+AT combined with TOETVA.

Figure 4. Comparisons of Prognostic Quality of Life (SF-36) Scores for the Intervention and Control Groups at 12 Months After Surgery. Figure 4A shows the PF score; Figure 4B shows the RP score; Figure 4C shows the BP score; Figure 4D shows the GH score; Figure 4E shows the VT score; Figure 4F shows the SF score; Figure 4G shows the RE score; and Figure 4H shows the MH score.



[a]$P < .05$, indicating that the intervention group had significantly higher PF, RP, BP, GH, VT, SF, RE, and MH scores postintervention than at baseline

Abbreviations: BP, bodily pain; GH, general health; MH, mental health; PF, physical functioning; RE, role emotional; RP, role physical; SF, social functioning; VT, vitality.

DISCUSSION

In the current study, the research team found through intergroup comparisons that endoscopic TPTX+AT combined with TOETVA had a longer operating time and more surgical blood loss than conventional total parathyroidectomy; however, it contributed to significantly better clinical effects and a more stable postoperative thyroid function in the participants. In addition, the intervention group had fewer complications and a better treatment experience.

The current research team had learned a lot from past experience with TPTX+AT combined with TOETVA,[23] including that a patient's neck shouldn't tilt back too much, that the flap at the mental protuberance needs to be broad enough, that the bilateral 5-mm trocar can be punctured on the fourth side of the lip and this puncture can be avoided by working across the second cusp's lateral side, and that the mandible needs to rotate to help the forceps to cross the blocking from the trachea and Adam's apple. This experience can help the exposure and precise resection of the parathyroid gland.

The current research team usually transplants the thyroid tissue into the subcutaneous part of the forearm on the non-fistula side.

The present study had some limitations. The number of participants was small, and a possibility exists of chance in the statistical calculations of some results. In addition, due to the short trial period, the research team was still unable to evaluate SHPT patients' long-term prognosis after endoscopic TPTX+AT combined with TOETVA. The team plans to resolve these limitations in a follow-up study, to provide more reliable experimental results for clinical use.

CONCLUSIONS

Endoscopic treatment of SHPT using TPTX+AT in combination with TOETVA can significantly relieve clinical symptoms and lower serum PTH and Ca levels. The results suggest that the operation is safe and effective.

AUTHOR CONTRIBUTIONS

Fei Xu and Xiurong Zhang have contributed equally to this work

AUTHORS' DISCLOSURE STATEMENT

The authors declare that they have no competing interests.

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