DIFFERENT SURGICAL MODALITIES IN THE MANAGEMENT OF TRIGEMINAL SCHWANNOMAS

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ABSTRACT:

Introduction: *Schwannomas are benign, slow-growing well-encapsulated tumors. Peripheral nerve sheath tumors are those that develop from Schwann cells that surround the peripheral or cranial nerves.*

Aim Of The Work: *To assess the efficacy of various treatment modalities for trigeminal schwannoma.*

Patients and methods: *From 2015 to 2019, 15 patients who had various surgical procedures to treat trigeminal schwannoma at Ain Shams University Hospitals and Nasser Institute Hospital were the subjects of a retrospective research.*

Results: *The tumors were right-sided in 60% of patients and 40% had left-sided tumors. 26.7% of patients had tumor class A, 20% had tumor class B & 53.3% had class C tumors. Retrosigmoid approach was used in 6.7% of patients, Frontotemporo-orbitozygomatic (FTOZ) Dolanc approach was used in 26.7%, FTOZ approach was used in 6.7%, transzygomatic extradural subtemporal approach was used in 6.7%, Dolanc extradural subtemporal approach was used in 26.7%, the extradural subtemporal approach was used in 6.7% & anterior petrosectomy (Kwase) approach was used in 20.0% of our study population. Partial resection was done for 26.7% of patients, Subtotal resection was done for 33.3% of patients, and complete resection was done for 40.0% of patients. The cavernous extension was present in 53.3% of patients, Gamma Knife postoperative was needed in 53.3% of patients & pathology was Trigeminal Schwannoma in 100% of our patients. Regarding Cavernous extension, there was a statistically significant difference between various methods.*

Conclusion: *The optimum therapy for trigeminal schwannoma with a low complication rate may be total excision using the correct method.*

Keywords: *Schwannomas; Trigeminal; Tumors; Surgical modalities.*

INTRODUCTION:

The nerve sheath's well-capsulated, slowly growing tumor known as a schwannoma often behaves benignly[1]. These tumors are peripheral nerve sheath tumors because they develop from Schwann cells that surround the peripheral or cranial nerves[2]. The majority of schwannomas are idiopathic and typically occur between the third and sixth decades of life; nevertheless, they may be linked to hereditary diseases [3]. Trigeminal schwannomas (TS) are the second most common type of intracranial schwannomas, accounting for less than 1% of all intracranial tumors and 0.8–8% of all intracranial Schwannomas[4]. TS are benign, slow-growing, well-circumscribed tumors.

Children and the elderly are also at risk, despite the fact that they are more prevalent in women between the ages of 30 and 50. TS may develop at any point along the the trigeminal nerve (TN) path[1]. Root tumours of the trigeminal ganglion (TG) are located at the cerebellopontine angle, whereas trigeminal ganglion (TG) tumours are located in Meckel's cave and the lateral wall of the cavernous sinus. Schwannomas of the root, ganglion, and peripheral divisions are intradural, interdural, and extradural, respectively; when TSs originate from one of the three branches of the nerve, the orbit, pterygopalatine fossa, and infratemporal fossa are involved [5].

AIM OF THE WORK:

The purpose of the present study was to assess the results of different approaches for surgical treatment of trigeminal Schwannoma on patients at Ain Shams University Hospitals and Nasser Institute Hospital during the period from 2015 to 2019.

PATIENTS AND METHODS:

This was a retrospective study on 15 patients who underwent surgical excision of trigeminal Schwannoma at Ain Shams University Hospitals and Nasser Institute Hospital during the period from 2015 to 2019. While patients undergoing Gamma Knife (GK) radiosurgery and conservative treatment were excluded from the study. First of all, a preoperative evaluation was carried out. Each patient’s data was achieved from database. All patients enrolled in the study underwent preoperative magnetic resonance imaging (MRI) with contrast.

Personal data like name, age, sex, residence, marital state, special habits, occupation and cerebral dominance were obtained from patient’s admission sheet. Complaint: Headache, vomiting, seizures, visual disorders, motor or sensory deficits, facial pain, numbness, ocular movement affection, bulbar symptoms. Present history included onset, course and duration of the complaint are determined from data base. Past history focused on diabetes, hypertension, liver disease, previous surgeries and other medical problems and family history: Similar or related conditions. Patients’ general examinations were obtained from database.

Neurological examination at conscious level was done according to Glasgow Coma Scale (GCS) and the patient activity according to Glasgow outcome scale (GOS). Detailed routine examination of cranial nerves, including pupillary reaction, field of vision and fundus examination were taken from patient’s admission sheet. Power, tone, reflexes, determining the main motor power grade according to Medical Research Council (MRC) grading system. Finally, Superficial, deep and cortical sensations was examined. Table (1) illustrated the categories of Glasgow Outcome Scale (GOS) and results in patients comprised in follow-up study[6&7].

Pre-operative imaging included:

A- Brain CT scan: with/without contrast was done as an initial imaging modality for lesion detection, also to detect a mass effect, hydrocephalus, calcifications, intratumoral hemorrhage, or bone abnormalities such as destruction, erosion, infiltration, and hyperostosis.

B- Brain MRI with contrast: imaging method of choice: Each patient had a brain MRI with contrast for tumor location in relation to side, tumor size, and characterization (well or ill-defined edges, solid, cystic or mixed, the pattern of enhancement, presence of calcification, hemorrhage or necrosis, and mass effect).

Pre-operative full routine lab evaluation were confirmed to be within normal values. A proposed medical treatment's nature, consequences, harms, benefits, risks, and alternatives, furthermore, participation in research and possible publications were assured to be involved in the informed consent.

General preoperative medical guidelines including anticonvulsant agents, steroid therapy and prophylaxis of venous thrombo-embolism were revised from the drug sheet of each case. Pre-operative anesthetic evaluation by the assessment of past medical history, and any airway difficulties, any history of drug allergy. Besides standard operative procedures, intraoperative usage of the microscope, Cavitronic Ultrasonic Surgical Aspirator (CUSA), and pneumatic drill.

Intra-operative surgical technique comprised of the data of surgical position and approach, which were selected according to thorough and brief preoperative surgical planning, assessment of the preoperative imaging and functional tests, and anatomic basic knowledge is obtained from the operative sheet. A rigid head fixation with pins (Mayfield, Skull Clamp) used after the administration of a local anesthetic and the surgical approaches used are: Anterior transpetrosal approach, transpetrosal transtentorial approach, lateral suboccipital retrosigmoid approach and modified retrosigmoid, and subtemporal approaches.

Each craniotomy is mentioned with the surgical approach. The microsurgical resections were performed using standard techniques and instruments guided by preoperative MRI. The patient's obtained data shows that neurological evaluation was assessed within the first 24 hours after surgery, before discharge from the hospital, and 3 months later using GOS. Postoperative and preoperative brain MRIs with contrast in all cases were compared to document the extent of resection. The extent of tumor resection (EOR) was graded as follows: gross total resection (GTR) indicates no residual by follow up MRI (more than 95% resection of the enhancing mass), subtotal resection (STR) indicates resection of < 75%, and partial resection (PR) indicates > 65 %.

Neurological, regional, and systemic problems are the three main categories of postoperative complications [8]. Motor, sensory, linguistic, and visual impairments are the primary neurologic postoperative deficits. Regional problems include, for instance, meningitis, cerebritis, hydro-cephalus, wound infections, CSF fistulas, seizures, and brain abscesses. Deep vein thrombosis, pulmonary emboli, myocardial infarction, electrolyte abnormalities, urinary tract infections, pneumonia, and sepsis are a few examples of systemic consequences. Postoperative assessments of neurological outcomes were carried out and documented twice:

1) After the surgery, when the patients could be fully evaluated.
2) At 3-month follow-up examinations.

Statistical Analysis:

The statistical software for the social sciences (SPSS) version 26 was utilized to code and input the data (IBM Corp., Armonk, NY, USA). In terms of quantitative variables, both standard and mean deviation were utilized in order to describe the data, and for categorical variables, frequencies (the number of instances) and relative frequencies (percentages) were used. Using the Chi-square (2) test, categorical data were compared. When the anticipated frequency is less than 5, the exact test was substituted[9]. Statistics were deemed significant for P-values under 0.05.

RESULTS:

The mean age in our study is 35.13 years, the minimum age was 24, and the maximum was 48. The mean preoperative GCS was 15. The immediate postoperative GOS was 5 in

10 patients 66.6% (good outcome), 3 patients 20% were GOS 4 (moderate disability) and 2 patients 13.3% were GOS 2 (intubated and ventilated). 3 months follow up, 14 patients 93.3% were GOS 5 (good outcome), and one patient 6.6% died (GOS 1). The distribution of the studied cases according to Sex was 33.3% male patients to 66.7% female patients. Headache presented in 53.3% of patients, while 66.7% were having facial pain and numbness, and only 20% of the cases had partial Sensorineural hearing loss (SNHL) and tinnitus. According to the side of the lesion, 60% of the studied cases were on the right while 40% of cases were on the left. According to Jefferson classification, 26.7% of the cases were type A, 20% were type B and 53.3% were type C.

Intracavernous extension represented in 53.3% of the cases. Intraoperative temporal lobe contusion represents 26.7% of the cases, while 20% of patients suffer 6th nerve injury from which only one patient improved 3 months later. One patient had a posterior cerebral artery injury that lead to vasospasm of the basilar artery.

3rd nerve paresis presented immediately post-operative in 2 cases that improved within 3 months. CSF collection represents in 2 cases, one of them showed CSF leak and both cases underwent Lumber Drain insertion. Both cases resolved in 3 months follow up. Complete resection of the Schwanomma represented 40% of the patients (6 patients), 33.3% had subtotal resection (5 patients) and partial resection occurred in 26.7% (4 patients). Post-operative GK radiosurgery was done on 53.3% of the study. Facial pain improved post-operatively in 11 patients (73.3%) and remained the same as preoperative in 3 patients (20%). Post-operative pathology of the excised lesions confirms trigeminal Schwanomma in all cases (100%).

A statistically significant difference between methods and cavernous extension was discovered, as the previous table demonstrates. There was no statistically significant difference between techniques with regards of the amount of tissue removed or the need for postoperative GK therapy.

Table (1): Categories of Glasgow Outcome Scale (GOS) and results in patients comprised in follow-up study.

GOS Score	Clinical Meaning	Outcome	Patients, No. (%)
1	Death	Poor	9 (5)
2	Neurovegetative state; patient unresponsive and speechless for weeks or months	Poor	3 (2)
3	Severe disability; patient dependent for daily support	Poor	25 (14)
4	Moderate disability; patients independent in daily life	Poor	31 (18)
5	Good recovery; resumption of normal life with minor neurological and psychological deficits	Favorable	108 (61)

Table (2): Distribution of the studied cases according to the type of approaches.

		No.	%
Approaches	Retrosigmoid	1	6.7%
	FTOZ, Dolanc	4	26.7%
	FTOZ	1	6.7%
	Extradural subtemporal, transzygomatic	1	6.7%
	Extradural subtemporal , Dolanc	4	26.7%
	Extradural subtemporal	1	6.7%
	Anterior petrosectomy(Kwase)	3	20.0%

Table (3): Intraoperative complication.

Complications	**No. (%)**
Temporal lobe contusion	4 (26.66%)
Abducent nerve injury	3 (20%)
Injury to posterior cerebral artery and vasospasm to BA	1 (6.66%)

Table (4): Relation between Approaches and Cavernous extension.

Approaches		**Cavernous extension**		**P-value**
		Yes	**No**	
Retrosigmoid	No.	0	1	**0.002***
FTOZ, Dolanc	No.	4	0	
FTOZ	No.	0	1	
Extradural subtemporal, transzygomatc	No.	0	1	
Extradural subtemporal, Dolanc	No.	4	0	
Extradural subtemporal	No.	0	1	
Anterior petrosectomy (Kwase)	No.	0	3	

*: Chi-square test

DISCUSSION:

A retrospective study aimed to evaluate the result of different approaches for trigeminal Schwannoma and to obtain this aim, we included 15 patients with trigeminal Schwannomas who underwent different surgical modalities in the management. In our study, we noticed that majority of cases were middle-aged females, we analyzed 15 TS cases. Only 5 were males and 10 were females. These findings were comparable with those of Zhang *et al.*,[10], They examined and evaluated 42 TS patients that underwent surgical treatment with a focus on the results of various surgical procedures and the contributions of various operating techniques. There were 24 women and 18 men among them.

Regarding the presenting manifestations among our patients, headache was reported in 53.3% of our patients, SNHL and tinnitus were present in 20% of our patients, facial pain and numbness were present in 66.7%, while seizure, bulbar symptoms, vomiting & ocular movement were not presented among our patients. While the most common preoperative symptom recorded by Park *et al.*,[11]] was dysfunction of trigeminal sensory, that enhanced in 15 of 21 patients (71.4%).

Additionally, Li et al.[12] analyzed vestibular and trigeminal Schwannomas and found that out of 43 TS patients who had surgery, 29 instances (67.4 percent) experienced facial numbness and hypoesthesia as their primary symptoms. Additionally, they discovered that nine instances of trigeminal motor impairment and four cases of normal trigeminal neuralgia (9.3 percent) each (20.9 percent). In addition, Wanibuchi et al.[13] carried out 107 surgeries on 105 patients who had trigeminal Schwannomas and showed that microsurgical therapy could eliminate these tumors with satisfactory outcomes. After surgery, the pain and diplopia were gone, but hypoesthesia usually lingered or even became worse.

In our study, the frontotemporo-orbitozygomatic (FTOZ) and Dolanc approaches were combined in 26.7 percent of patients, the FTOZ approach was used in 6.7 percent of patients, the transzygomatic extradural subtemporal approach was used in 6.7 percent of patients, the extradural subtemporal approach was used in 6.7 percent of patients, and the anterior petrosectomy (Kwase) approach was used in 20.0 percent of patients. However, the skull base technique was used in 22 instances by Zhang et al.[10].

20 percent of our patients had intraoperative 6th nerve affection, 26.6% experienced temporal lobe contusion, and 6.6% experienced posterior cerebral artery damage, all of which contributed to basilar artery vasospasm. In contrast to our finding, 2 (4.7%) of the patients treated by Li et al.,[12] had intra-operative abducens injury. Additionally, vasospasm (n = 1), wound infection (n = 1), and medial gaze palsy (n = 1) were three novel postoperative problems that three patients in Park et al[11] .'s research encountered.

Other common symptoms include those brought on by nearby cranial nerve involvement in the cavernous sinus[13–15]. In our research, 3 patients' face discomfort persisted, whereas it improved in 11 patients (73.3%). (20 percent). On the other hand, Goel et al.[14] observed that whereas 40% of patients saw improvement, 27% experienced deterioration of the preoperative trigeminal sensory deficiency. Chen et al. [16] observed stable face hypesthesia in 72% of cases and improved facial hypesthesia in 28% of cases. Furthermore, 51 percent of patients reported better or stable trigeminal symptoms, although the majority of patients reported increasing facial hypesthesia, according to Jeong et al.[17]. In a recent research including 20 patients, Samii et al.[18] found that all patients' face discomfort and their cerebellar ataxia had improved.

In our study, we identified 5 patients who experienced diplopia due to cranial nerve deficits, either 6th nerve paresis or 3rd nerve paresis, immediately following surgery (33.3%). Three patients experienced improvements (20%) within three months, while two patients continue to experience cranial nerve deficits (13.3 percent). These results were sufficiently similar to those of Al-Mefty et al.[19], who discovered diplopia in 52% of cases (40 percent due to sixth nerve deficit). In addition, Chen et al. [16] observed that diplopia affected 18% of patients (80% owing to a deficit in the abducens nerve and 20% related to the oculomotor nerve), and that diplopia recovered in 70% of patients after surgery.

Additionally, Wanibuchi et al. [13] observed that 20% of patients had diplopia (86 percent due to deficit of the abducens nerve and 14 percent due to deficit of the oculomotor nerve). In Zhang et al[10] .'s research, diplopia caused by cranial nerve deficiencies was improved or remained unaltered following surgery in the majority of individuals; there was no discernible difference between the conventional (76.9 percent) and skull base (87.5 percent) groups (2 = 0.56, $P > 0.05$).

In our analysis, patients had partial resection in 26.7 percent of cases, subtotal resection in 33.3 percent of cases, and full resection in 40.0 percent of cases. However, 57 individuals who had a surgical resection for trigeminal Schwannoma were investigated by Fukaya et al.,[20]. While full tumor excision was performed in 42 of 45 patients (93%) who had skull base surgery, 39 of 57 patients (68%) experienced problems such as cranial neuropathies, brain contusions, or CSF leaking. In Li et al.[12] .'s investigation, the tumor was also completely removed from 39 patients (90.7%), almost completely removed from three patients (7.0%), and partly removed from one patient (2.3%) owing to intraoperative internal carotid artery (ICA) damage.

Gross-total resection (GTR, n = 12) and near-total resection (NTR, n = 7) were accomplished in 19 patients in the Park et al.,[11] investigation (76 percent). For ETOA and EEA, respectively, the GTR/NTR ratios were 81.8 and 69.2 percent. According to the categories, the GTR/NTR rates of ETOA and EEA were 100% and 50% for tumors restricted to the middle cranial fossa, 75% and 33% for dumbbell-shaped tumors situated in the middle and posterior cranial fossae, and 50% and 100% for extracranial tumors. In the research by Wanibuchi et al., [13] entire or almost total removal was carried out in 86 instances (81.9%), and subtotal removal was accomplished in 18 cases (17.1 percent). Entire and almost total resection were accomplished in 100% of instances involving the skull base and 80% of conventional cases in the Zhang et al. [10] research (2 = 4.86, P 0.05). Total resection was accomplished in 40% of instances with cavernous involvement and 81.5 percent of patients without cavernous involvement (2 = 7.47, P 0.05).

Our investigation revealed that 26.7 percent of the cases were Jefferson classification types A, 20 percent were Jefferson classification types B, and 53.3 percent were Jefferson classification types C. Park et al. [11] reported higher numbers, stating that 9 patients (36%) had middle fossa tumors, 8 patients (32%) had dumbbell-shaped tumors in the middle and posterior cerebral fossa, and another 8 patients (32%) had extracranial tumors. Additionally, Wanibuchi et al. [13] explained that 14 tumors (13.1%) were of the peripheral type, 39 (36.4%) were of the ganglion cavernous type, 22 (20.6%) were of the posterior fossa root type, and 32 (30.0%) were of the dumbbell type. Only seven tumors were cystic, whereas 65 were solid and 35 were mixed. 14 of the solid tumors were fibrous, vascular, and attached to nearby structures.

53.3 percent of our patients had cavernous extension, 53.3 percent required GK postoperatively, and 100 percent of our patients had a TS pathology diagnosis. These outcomes were consistent with those of Li et al. [12], who reported that while all four trigeminal neuralgia patients completely recovered after surgery, the facial numbness persisted in 24 individuals (82.8 percent). Only one patient had a tumor return, and this patient had a second procedure, at a median follow-up time of 45.3 25.5 (6-84) months. Additionally, Li et al. [12] came to the conclusion that entire excision using the right strategy might be the best therapy for TS with a minimal risk of complications. However, preoperative symptoms including face numbness and trigeminal motor dysfunction, which seldom improved despite meticulous recognition and preservation of normal fibers throughout the procedure, persisted.

In addition, Park et al. [11] found that expanded endonasal approaches for extracranial tumors and endoscopic trans orbital approaches for trigeminal Schwannomas confined to the dumbbell-shaped tumors located in the posterior and middle fossae or middle fossa both provide adequate access and resectability. In endoscopic surgery, tumors mostly affecting the posterior fossa continue to be difficult. In this investigation, we discovered that there were statistically significant differences between various cavernous extension techniques. In instances with cavernous expansion, FTOZ Dolanc and extradural subtemporal Dolanc were performed (p=0.002). The degree of resection, intraoperative problems, the need for GK therapy postoperatively, and pathology, on the other hand, did not show any statistically significant differences between the various techniques.

These results supported the findings of Zhang et al. [10], who came to the conclusion that the tumor's developmental patterns should be taken into account while choosing an operational strategy. The skull base technique offers greater tumor exposure than the traditional method and boosts the frequency of whole and almost total/partial resections. The main obstacle to the complete excision of the trigeminal Schwannomas was cavernous sinus involvement. Additionally, the goal of therapy is always complete tumor excision; in the majority of instances, cranial nerve function may be preserved or even improved [10].

Conclusion:

We came to the conclusion that the optimal therapy for trigeminal schwannoma with a low complication rate may be entire excision using the correct method. We discovered no statistically significant differences in the outcomes of various therapeutic strategies for trigeminal schwannoma.

Abbreviations:

TS: Trigeminal Schwannoma; TN: Trigeminal Nerve; TG: Trigeminal ganglion; FTOZ: Frontotemporo-orbitozygomatic; GK: Gamma Knife; MRI: Magnetic Resonance Imaging; GCS: Glasgow Coma Scale; GOS: Glasgow Outcome Scale; MRC: Medical Research Council; CT: Computerized Tomography; CUSA: Cavitronic Ultrasonic Surgical Aspirator; EORL: Extent of Tumor Resection; GTR: Gross Total Resection; STR: Subtotal Resection; NTR: Near-total Resection; ETOA: Endoscopic Transorbital Approach; EEA: Endoscopic Endonasal Approach; PR: Partial Resection; CSF: Cerebrospinal Fluid; SNHL: Sensorineural Hearing Loss; ICA: Internal Carotid Artery.

Ethics approval and consent to participate

Ethics approval was obtained by the Research Ethics committee, Faculty of medicine, Ain Shams University, Cairo, Egypt. Also, official approval was received from the General Medical Director of both Ain Shams University and Nasser Institute Hospitals. Each participant was informed about the study's purpose and advantages, and he or she has the ability to withdraw at any moment without penalty. Participants' verbal consent was acquired.

Consent for publication

Not applicable, no individual personal data were included.

Availability of data and material:

Available upon request.

Competing interests:

The corresponding author will provide the utilized and/or analyzed during the present research upon reasonable request.

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المداخل الجراحية المختلفة لعلاج الأورام الشِفانيّة

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المقدمة: تنمو الأورام الشِفانيّة ببطء على هيئة أورام حميدة، وتكون محاطة بكبسولات بشكل جيد. تنشأ هذه الأورام من خلايا شوان التي تُغلف الأعصاب المُحيطية والدماغية؛ وبالتالي فإنّ هذه الأورام هي أورام أغشية الأعصاب المُحيطية.

هدف الدراسة: تم إجراء الدراسة الحالية لتقييم نتائج الأساليب المختلفة للتعامل مع الأورام الشِفانيّة في العصب ثلاثيّ التوائم.

الطريقة: أجريت هذه الدراسة بأثر رجعي على خمسة عشر مريضاً، خضعوا جميعهم لطرق جراحية مختلفة في علاج الأورام الشِفانيّة في العصب ثلاثيّ التوائم في مستشفيات جامعة عين شمس ومستشفى معهد ناصر خلال الفترة من 2015 إلى 2019.

النتائج: وجدنا أنّ حوالي 60٪ من المرضى كانت الأورام لديهم في الجانب الأيمن مقارنةً ب 40٪ مُصابين بأورام في الجانب الأيسر. بالإضافة إلى ما يقرب من 26.7٪ من المرضى لديهم ورم من الفئة A، في حين أنّ 20٪ لديهم ورم من الفئة B، و 53.3٪ منهم مصابون بأورام من الفئة C.

تم استخدام عدة طرق منها الطريقة خَلْفَ السِّينِيّة (Retrosigmoid) في 6.7٪ من الحالات، ونهج Dolanc الجبهي الصدغي الحجاجيّ الوَجنِيّ (FTOZ) في 26.7٪، وطريقة FTOZ في 6.7٪ من المرضى، كما استُخدم النهج تَحْتَ الصُّدْغِيّ خارِجَ الجافِيَة الوجنيّ في 6.7 ٪ من الحالات، ونهج Dolanc تَحْتَ الصُّدْغِيّ خارِجَ الجافِيَة في 26.7 ٪، وأيضاً النهج تَحْتَ الصُّدْغِيّ خارِجَ الجافِيَة في 6.7٪ وأخيراً تم استخدام نهج استئصال صَخْرَةِ الخُشَّاء الأمامية (Kwase) في 20.0 ٪ من إجمالي المرضى محل الدراسة.

بعد ذلك تم إجراء استئصال جزئيّ لـعدد 26.7٪ من المرضى، واستئصال إجمالي جزئي لـ 33.3٪. بينما تم إجراء استئصال كامل لـحوالي 40.0٪ من الحالات موضع الدراسة. ولوحظ وجود الامتداد الكهفيّ في 53.3٪ من الحالات وكانت هناك حاجة إلى استخدام سكين جاما بعد الجراحة في 53.3٪ من المرضى.

كما أوضحت نتائج الفحوص الباثولوجيّة وجود ورم شفانيّ في العصب ثلاثي التوائم في جميع الحالات (100٪) محل الدراسة. وقد تم ملاحظة وجود فرق معنوي إحصائيّ بين الطرق المختلفة فيما يتعلق بالإمتداد الكهفيّ. بينما لم نجد أي فرق ذا دلالة إحصائية بين الطرق المختلفة فيما يتعلق بمدى الاستئصال.

الخلاصة: نستنتج أنّ أفضل علاج للورم الشفانيّ ثلاثي التوائم قد يكون هو الإزالة الكاملة باستخدام الطريقة المناسبة في حالة وجود معدل مضاعفات منخفض.