Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2025;50(4):1175-1180
DOI: 10.17826/cumj.1821266

RESEARCH

Impact of preoperative embolization on operative and postoperative outcomes in juvenile nasopharyngeal angiofibroma patients

Preoperatif embolizasyonun juvenil nazofaringeal anjiyofibroma hastalarında ameliyat ve ameliyat sonrası sonuçlarına etkisi

Elvan Onan[1], Çağlar Eker[1], İlda Tanrısever Pehlivan[1], Bilen Onan[1], Muhammed Dağkıran[1], Özgur Sürmelioğlu[1], Süleyman Özdemir[1], Özgür Tarkan[1], Mustafa Mete Kıroğlu[1]

[1]Çukurova University, Adana, Türkiye

Abstract

Purpose: This study assessed the influence of external carotid artery (ECA) versus combined ECA and internal carotid artery (ICA) supply on surgical outcomes of Juvenile nasopharyngeal angiofibroma (JNA).

Materials and Methods: This retrospective observational study included patients with juvenile nasopharyngeal angiofibroma who underwent preoperative transarterial embolization followed by endoscopic resection between 2007 and 2025. Patients were stratified by vascular supply (ECA-only vs. ECA+ICA) and Andrews–Fisch stage. Demographic data, intraoperative blood loss, and residual tumor status were retrospectively analyzed.

Results: The mean age was 17.7 years (range 9–62). Age and ECA branching patterns did not differ significantly between groups. All stage I–II tumors were supplied exclusively by the ECA, whereas stage III–IV tumors showed both ECA-only and ECA+ICA supply. Mean intraoperative blood loss did not differ significantly between vascular groups but was markedly higher in stage III–IV disease than in compared with stage I–II. Residual tumor occurred only in patients with ECA+ICA supply.

Conclusion: ICA contribution is strongly associated with advanced-stage JNA and increased risk of residual tumor, although it does not significantly elevate intraoperative blood loss. These findings highlight tumor stage as the main predictor of bleeding and completeness of resection.

Keywords:. Internal carotid artery, juvenile nasopharyngeal angiofibroma, preoperative embolization

Öz

Amaç: Bu çalışma, eksternal karotis arter (ECA) ile kombine eksternal ve internal karotis arter (ECA+ICA) beslenmesinin Juvenil nazofaringeal anjiyofibromanın (JNA) cerrahi sonuçları üzerindeki etkisini değerlendirmiştir.

Gereç ve Yöntem: Bu retrospektif gözlemsel çalışma, 2007–2025 yılları arasında endoskopik rezeksiyon öncesinde preoperatif transarteriyel embolizasyon uygulanan juvenil nazofaringeal anjiyofibromlu hastaları içermektedir. Hastalar damar beslenmesine (yalnızca ECA veya ECA+ICA) ve Andrews–Fisch evresine göre sınıflandırıldı. Demografik veriler, intraoperatif kan kaybı ve rezidüel tümör durumu analiz edildi.

Bulgular: Ortalama yaş 17,7 yıldı (9–62). Yaş ve ECA dallanma paternleri gruplar arasında anlamlı farklılık göstermedi. Evre I–II tümörlerin tamamı yalnızca ECA tarafından beslenirken, evre III–IV tümörlerde hem yalnızca ECA hem de ECA+ICA beslenmesi görüldü. Ortalama intraoperatif kan kaybı damar grupları arasında anlamlı farklılık göstermedi), ancak evre III–IV hastalıkta evre I–II'ye kıyasla belirgin şekilde daha yüksekti. Rezidüel tümör yalnızca ECA+ICA beslenmesi olan hastalarda görüldü.

Sonuç: ICA katkısı, ileri evre JNA ve rezidüel tümör riskinin artması ile güçlü şekilde ilişkilidir; ancak intraoperatif kan kaybını anlamlı şekilde artırmamaktadır. Bulgular, tümör evresinin kanama ve tam rezeksiyon başarısının temel belirleyicisi olduğunu göstermektedir.

Anahtar kelimeler: İnternal karotis arter, juvenil nazofaringeal anjiyofibroma, preoperatif embolizasyon

Address for Correspondence: Elvan Onan, Çukurova University, Faculty of Medicine, Department of Otorhinolaryngology, Adana, Türkiye, E-mail: uygurelvan@hotmail.com
Received: 10.11.2025 Accepted: 17.12.2025

INTRODUCTION

Juvenile nasopharyngeal angiofibroma (JNA) is a rare, benign but locally aggressive vascular tumor that typically arises in the nasopharynx of adolescent males. Although it accounts for less than 0.5% of all head and neck tumors, JNA poses significant clinical challenges due to its high vascularity and propensity for local invasion into adjacent anatomical regions, including the paranasal sinuses, pterygopalatine and infratemporal fossae, orbit, and even intracranial compartments.[1-3] Despite its benign nature, the aggressive growth pattern and risk of massive intraoperative hemorrhage make JNA a complex disease to manage.

Endoscopic resection following embolization of the feeding vessels represents the standard therapeutic approach for JNA.[4,5] The risk of significant intraoperative bleeding continues to be a primary concern. Preoperative embolization has become integral to the treatment protocol to minimize intraoperative blood loss. The conventional embolization approach involves selective occlusion of external carotid artery branches (ECA).[6] While embolization of ECA branches is considered safe in most cases, embolization of internal carotid artery (ICA) branches carries considerable risk, is technically challenging with limited success, and is generally avoided.[7]

The vascular supply of JNA most commonly arises from branches of the ECA, particularly the internal maxillary artery (IMA).[8] In some cases, however, additional supply from the ICA or other ECA branches is present, complicating both embolization and surgical resection. The pattern of vascular supply has important implications for surgical outcomes, including blood loss, completeness of resection, and recurrence.

In light of these considerations, we conducted a retrospective analysis of patients with JNA who underwent preoperative embolization followed by endoscopic resection. This study aimed to evaluate the impact of vascular supply patterns—ECA only versus combined ECA+ICA—on operative and postoperative outcomes, with particular attention to tumor staging, intraoperative blood loss, and residual tumor rates.

Although preoperative embolization is a well-established component of juvenile nasopharyngeal angiofibroma management, the clinical implications of different vascular supply patterns remain insufficiently defined. In particular, data comparing surgical outcomes between tumors supplied exclusively by the external carotid artery and those with additional internal carotid artery contribution are limited; therefore, the present study aims to address this gap by analyzing operative and postoperative outcomes in relation to vascular supply patterns.

MATERIALS AND METHODS

Sample

Between January 2007 and January 2025, a total of 29 patients diagnosed with primary JNA who underwent both preoperative transarterial embolization (TAE) and endoscopic resection at the Department of Otorhinolaryngology, Çukurova University Faculty of Medicine, were retrospectively evaluated. Patients with a history of previous surgery or radiotherapy, incomplete clinical data, or insufficient follow-up records were excluded from the study.

Procedure

The study was approved by the Cukurova University ethics committee (Approval No: 157, dated July 18, 2025) and conducted in accordance with the Declaration of Helsinki.

All patients were followed regularly with clinical examination, nasal endoscopy, and radiologic imaging. Residual tumor was defined as persistent tumor detected on early postoperative imaging or endoscopic evaluation without a disease-free interval. Recurrent tumor was defined as newly detected disease occurring after a documented disease-free period during follow-up. Tumor detected within the first 12 months after surgery was classified as residual disease, whereas tumor identified after a documented disease-free interval of more than 12 months during follow-up was defined as recurrent disease.

Data collection

Demographic characteristics (age, sex) and presenting symptoms were retrieved from patient records. Preoperative angiographic images were reviewed in detail, and tumors were classified into two groups based on their vascular supply: those fed exclusively by ECA branches and those with dual supply from both the ICA and ECA branches. Within the ECA-only group, tumors were further

subclassified according to whether they were supplied by unilateral IMA, bilateral IMA, or other ECA branches. All patients were staged according to the Andrews–Fisch[9] classification, which stratifies JNA based on the degree of local invasion, including extension into the paranasal sinuses, pterygopalatine and infratemporal fossae, orbit, and intracranial compartments. Andrews-Fisch stage, tumor vascular supply, estimated intraoperative blood loss, and presence of residual tumor were retrospectively collected from surgical notes, imaging records, and patient files.

Preoperative embolization protocol

All patients underwent selective angiography and transarterial embolization 24–48 hours before surgery. Feeding vessels were identified and selectively embolized using polyvinyl alcohol (PVA) particles and/or microspheres. Particle size ranged from 150-500 μm. In cases with ICA contribution, embolization was limited to safely catheterizable ECA branches with collateral circulation. Following embolization, all patients underwent endoscopic tumor resection during the same hospital admission.

Statistical analysis

Statistical analyses were performed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were presented as numbers and percentages for categorical variables and mean and standard deviation for continuous variables. Comparisons between groups were made using the chi-square test or Fisher's exact test for categorical variables. For continuous variables, comparisons between two groups were conducted with the Student's t-test when the assumption of normal distribution was met, and with the Mann–Whitney U test when the normality assumption was not satisfied. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 17.7 years (range: 9–62 years). No significant difference in mean age was observed between the ECA-only and ECA+ICA groups ($p = 0.939$). Similarly, no significant intergroup difference was found when comparing unilateral versus bilateral ECA supply ($p = 0.642$).

A significant difference was identified regarding Andrews–Fisch staging ($p = 0.023$). All stage I–II cases demonstrated exclusive ECA supply, whereas stage III–IV cases showed a similar distribution of ECA-only and ECA+ICA supply.

Comparison of intraoperative blood loss revealed no significant difference between the groups ($p = 0.385$). In contrast, residual tumor status differed significantly between groups: all patients with residual tumor had ECA+ICA supply, while 81.5% of those without residual tumor demonstrated exclusive ECA supply ($p = 0.013$). (Table 1)

Table 1. Demographic, staging, and surgical outcomes according to tumor vascular supply pattern

Variable	ECA group (median [min–max] / mean ± SD / n [%])	ECA+ICA group (median [min–max] / mean ± SD / n [%])	p-value
Mean age (years)	15 (9–62)	16 (9–26)	0.939
ECA branches			0.642
Unilateral	16 (80%)	4 (20%)	
Bilateral	6 (66.7%)	3 (33.3%)	
Andrews–Fisch stage			0.023
Stage I–II	12 (100%)	0 (0%)	
Stage III–IV	10 (58.8%)	7 (41.2%)	
Intraoperative blood loss (ml)	320.45 ± 395.71	464.28 ± 291.14	0.385
Residual tumor			0.013
Absent	22 (81.5%)	5 (18.5%)	
Present	0 (0%)	2 (100%)	

Table 2. Comparison of vascular supply patterns and intraoperative blood loss according to Andrews–Fisch staging

Variable	Stage I–II (n = 12, 41.4%)	Stage III–IV (n = 17, 58.6%)	p-value
ECA supply			0.043
• Unilateral IMA	11 (55%)	9 (45%)	
• Bilateral IMA	1 (11.1%)	8 (88.9%)	
IMA + other ECA branches			0.703
• Absent	8 (47.1%)	9 (52.9%)	
• Present	4 (33.3%)	8 (66.7%)	
ICA supply			0.023
• Absent	12 (54.5%)	10 (45.5%)	
• Present	0 (0%)	7 (100%)	
Intraoperative blood loss (ml)	129.17 ± 101.04	514.71 ± 414.49	0.002
Residual tumor			0.498
• Absent	12 (44.4%)	15 (55.6%)	
• Present	0 (0%)	2 (100%)	

Patients were stratified according to the Andrews–Fisch classification. Comparison of stage I–II versus stage III–IV groups revealed a significant difference in vascular supply patterns ($p = 0.043$). Most patients with bilateral IMA supply were in the stage III–IV group, whereas those with unilateral IMA supply were distributed similarly. No significant intergroup difference was found for tumors supplied by the IMA in combination with other ECA branches ($p = 0.703$). In contrast, ICA contribution was observed exclusively in stage III–IV patients, while cases without ICA supply were evenly distributed across both staging groups, yielding a significant difference ($p = 0.023$).

Mean intraoperative blood loss was significantly higher in stage III–IV patients than in stage I–II ($p = 0.002$). Detailed comparisons are presented in Table 2.

DISCUSSION

This study evaluated the impact of vascular supply patterns on operative and postoperative outcomes in patients with JNA undergoing preoperative embolization followed by endoscopic resection. The principal findings were that (1) tumors with combined ECA+ICA supply were more frequently associated with advanced stage disease, (2) residual tumor was observed exclusively in patients with ECA+ICA supply, (3) intraoperative blood loss was significantly higher in patients with stage III–IV disease compared with those in stage I–II, and (4) estimated intraoperative blood loss did not differ significantly between patients with and without ICA contribution. These results suggest that tumor stage plays a crucial role in predicting surgical complexity and completeness of resection.

The role of preoperative embolization in JNA surgery is well established, with multiple studies confirming its ability to reduce intraoperative bleeding and improve surgical field visibility.[5,10]

Our findings are consistent with previous reports showing that embolization of ECA branches is safe and effective, whereas ICA contribution presents significant technical and prognostic challenges. The presence of ICA supply not only complicates embolization but also appears to correlate with higher rates of residual tumor, underscoring the importance of preoperative angiographic assessment in surgical planning. The 24–48 hour interval between embolization and surgery is considered optimal to maximize tumor devascularization while minimizing revascularization and inflammatory changes that may complicate surgical dissection. In the present study, adherence to this time window may have contributed to effective intraoperative hemorrhage control.

Our results indicated a strong association between advanced tumor stage and ICA supply, corroborating previous studies.[11] The intricate vascularization patterns observed are consistent with the systematic review by Overdevest et al., which identified ICA feeders in 35.6% of 828 JNA cases.[12] Interestingly, although ICA contribution was strongly associated with advanced tumor stage, it did not correspond to significantly greater intraoperative blood loss than in patients lacking ICA feeders. This may reflect the effectiveness of selective embolization of ECA

branches, even in tumors with partial ICA supply, in controlling intraoperative hemorrhage. However, the increased rate of residual tumor in the ICA group suggests that the main prognostic impact of ICA involvement may be on completeness of resection rather than blood loss. Moreover, the higher incidence of residual tumor observed in the ICA group may also be attributed to the fact that ICA feeders were identified exclusively in advanced-stage disease, where residual tumor is inherently more common.

Although the mean intraoperative blood loss was higher in the ECA+ICA group overall, the difference did not reach statistical significance. In contrast, staging analysis demonstrated a clear and significant difference in blood loss between early- and advanced-stage disease, confirming that tumor extent remains a substantial determinant of intraoperative hemorrhage despite embolization. Similar results have been reported by Nicolai et al. and others, emphasizing that embolization, while valuable, cannot thoroughly neutralize the effect of tumor stage on bleeding risk[13].

Depending on the site of origin of the primary JNA, ICA feeders most commonly arise from the vidian artery and the inferolateral trunk.[14] These vessels are typically narrow, tortuous, and arise at acute angles, which makes superselective catheterization technically challenging. The use of particulate or liquid embolic materials in ICA feeders carries a substantial risk of severe complications, including cerebral infarction and blindness.[15,16] Gargula et al. reported an attempt to embolize ICA feeders in 14 patients with JNA, of which superselective embolization was technically successful in only nine cases using detachable coils. However, this intervention did not result in a significant reduction in intraoperative blood loss when compared with non-embolized patients. [17] Considering both the potential complications of ICA embolization and the absence of a substantial difference in blood loss between the ICA and ECA-only groups in our series, It appears feasible to achieve safe and effective embolization of the ECA and its branches without resorting to superselective ICA embolization. Tumor resection can generally be accomplished with proper embolization of the ECA feeding vessels alone.

One of the significant challenges in the management of advanced JNA is the tendency for residual tumor to remain despite the intraoperative impression of complete excision, particularly when the tumor is removed en bloc. Several authors have documented the propensity of advanced-stage JNA to recur.[18,19] One of the significant causes of residual tumor is extensive invasion of the skull base, most commonly involving the basisphenoid, greater wing of the sphenoid, vidian canal, and pterygoid root.[18,20] Additionally, involvement of the cavernous sinus and the infratemporal fossa, and the presence of ICA supply have been identified as predictive of residual disease. [18,19,21] In our cohort, residual tumor was detected exclusively in patients with ECA+ICA supply. This observation suggests that ICA vascularization may represent an independent risk factor for incomplete resection. Although ICA feeders did not correspond to significantly greater intraoperative blood loss in our series, their presence appears to compromise the ability to achieve radical excision, likely due to the technical limitations of embolizing ICA branches and the anatomic complexity of tumors with ICA contribution. These findings align with prior reports indicating that ICA supply is more frequently encountered in advanced-stage disease and is associated with higher rates of residual tumor. In this context, ICA involvement may not primarily influence intraoperative hemorrhage, but rather the complete surgical resection, thereby serving as an adverse prognostic marker for residual tumor.

The present study has several limitations. Its retrospective design and relatively small sample size limit the generalizability of the findings. In addition, heterogeneity in embolization techniques over the extended study period may have influenced outcomes. Despite these limitations, the study provides valuable insights into the prognostic role of vascular supply patterns in JNA and reinforces the clinical relevance of detailed preoperative angiographic evaluation.

Our findings demonstrate that advanced-stage JNA is strongly associated with bilateral IMA and ICA contribution, which in turn increases the risk of residual tumor despite preoperative embolization. While ICA feeders correlated with advanced-stage disease, they were not associated with significantly higher intraoperative blood loss than patients without ICA contribution. Careful angiographic evaluation of vascular supply patterns is therefore essential in surgical planning. Patients with ICA feeders, in particular, should be considered at higher risk for incomplete resection and adverse outcomes, and may benefit from adjunctive therapeutic strategies or closer postoperative follow-up.

Author Contributions: Concept/Design : EO, MD, BO; Data acquisition: EO, MMK, SO, BO, OT; Data analysis and interpretation: EO, BO, CE, MD, ITP, OS; Drafting manuscript: EO, MD, ITP, BO, CE, OS; Critical revision of manuscript: -; Final approval and accountability: EO, ÇE, İTP, BO, MD, ÖS, SÖ, ÖT, MMT; Technical or material support: -; Supervision: -; Securing funding (if available): n/a.
Ethical Approval: Ethical approval was obtained from the Çukurova University Faculty of Medicine Research Ethics Committee with the decision number 157/44 dated 18.07.2025.
Peer-review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: Authors declared no financial support

REFERENCES

1. Lund VJ, Stammberger H, Nicolai P, Castelnuovo P, Beal T, Beham A et al. European Rhinologic Society Advisory Board on Endoscopic Techniques in the Management of Nose, Paranasal Sinus and Skull Base Tumours. European position paper on endoscopic management of tumours of the nose, paranasal sinuses and skull base. Rhinol Suppl. 2010;22:1-143.
2. Liu Z, Hua W, Zhang H, Wang J, Song X, Hu L et al. The risk factors for residual juvenile nasopharyngeal angiofibroma and the usual residual sites. Am J Otolaryngol. 2019;40:343-6.
3. Lutz J, Holtmannspötter M, Flatz W, Meier-Bender A, Berghaus A, Brückmann H, et al. Preoperative embolization to improve the surgical management and outcome of juvenile nasopharyngeal angiofibroma (JNA) in a single center: 10-year experience. Clin Neuroradiol. 2016;26:405-13.
4. Leong SC. A systematic review of surgical outcomes for advanced juvenile nasopharyngeal angiofibroma with intracranial involvement. Laryngoscope. 2013;123:1125–31.
5. Giorgianni A, Molinaro S, Agosti E, Terrana AV, Vizzari FA, Arosio AD et al. Twenty years of experience in juvenile nasopharyngeal angiofibroma (JNA) preoperative endovascular embolization: an effective procedure with a low complications rate. J Clin Med. 2021;10:3926.
6. Tan G, Ma Z, Long W, Liu L, Zhang B, Chen W et al. Efficacy of preoperative transcatheter arterial embolization for nasopharyngeal angiofibroma: a comparative study. Cardiovasc Intervent Radiol. 2017;40:836-44.
7. Gargula S, Saint-Maurice JP, Labeyrie MA, Eliezer M, Jourdaine C, Kania R et al. Embolization of internal carotid artery branches in juvenile nasopharyngeal angiofibroma. Laryngoscope. 2021;131:775–80.
8. Overdevest JB, Amans MR, Zaki P, Pletcher SD, El-Sayed IH. Patterns of vascularization and surgical morbidity in juvenile nasopharyngeal angiofibroma: A case series, systematic review, and meta-analysis. Head Neck. 2018;40:428-43.
9. Andrews JC, Fisch U, Valavanis A, Aeppli U, Makek MS. The surgical management of extensive nasopharyngeal angiofibromas with the infratemporal fossa approach. Laryngoscope. 1989;99:429-37.
10. Diaz A, Wang E, Bujnowski D, Arimoto R, Armstrong M, Cyberski T et al. Embolization in juvenile nasopharyngeal angiofibroma surgery: a systematic review and meta-analysis. Laryngoscope. 2023;133:1529-39.
11. Mehan R, Rupa V, Lukka VK, Ahmed M, Moses V, Shyam Kumar NK. Association between vascular supply, stage and tumour size of juvenile nasopharyngeal angiofibroma. Eur Arch Otorhinolaryngol. 2016;273:4295-303.
12. Overdevest JB, Amans MR, Zaki P, Pletcher SD, El-Sayed IH. Patterns of vascularization and surgical morbidity in juvenile nasopharyngeal angiofibroma: A case series, systematic review, and meta-analysis. Head Neck. 2018;40:428-43.
13. Nicolai P, Villaret AB, Farina D, Nadeau S, Yakirevitch A, Berlucchi M et al. Endoscopic surgery for juvenile angiofibroma: a critical review of indications after 46 cases. Am J Rhinol Allergy. 2010;24:67-72.
14. Liu Q, Xia Z, Hong R, Pan Y, Xue K, Liu Q, et al. Preoperative embolization of primary juvenile nasopharyngeal angiofibroma: is embolization of internal carotid artery branches necessary? Cardiovasc Intervent Radiol. 2023;46:1038-45.
15. Trivedi M, Desai RJ, Potdar NA, Shinde CA, Ukirde V, Bhuta M et al. Vision loss due to central retinal artery occlusion following embolization in a case of a giant juvenile nasopharyngeal angiofibroma. J Craniofac Surg. 2015;26:451-3.
16. Casasco A, Houdart E, Biondi A, Jhaveri HS, Herbreteau D et al Major complications of percutaneous embolization of skull-base tumors. AJNR Am J Neuroradiol. 1999;20:179-81.
17. Gargula S, Saint-Maurice JP, Labeyrie MA, Eliezer M, Jourdaine C, Kania R et al. Embolization of internal carotid artery branches in juvenile nasopharyngeal angiofibroma. Laryngoscope. 2021;131:775-80.
18. Herman P, Lot G, Chapot R, Salvan D, Huy PT. Long-term follow-up of juvenile nasopharyngeal angiofibromas: analysis of recurrences. Laryngoscope. 1999;109:140-7.
19. Snyderman CH, Pant H, Carrau RL, Gardner P. A new endoscopic staging system for angiofibromas. Arch Otolaryngol Head Neck Surg. 2010;136:588-94.
20. Onerci TM, Yücel OT, Oğretmenoğlu O. Endoscopic surgery in treatment of juvenile nasopharyngeal angiofibroma. Int J Pediatr Otorhinolaryngol. 2003;67:1219-25.
21. Ballah D, Rabinowitz D, Vossough A, Rickert S, Dunham B, Kazahaya K et al. Preoperative angiography and external carotid artery embolization of juvenile nasopharyngeal angiofibromas in a tertiary referral paediatric centre. Clin Radiol. 2013;68:1097-106.