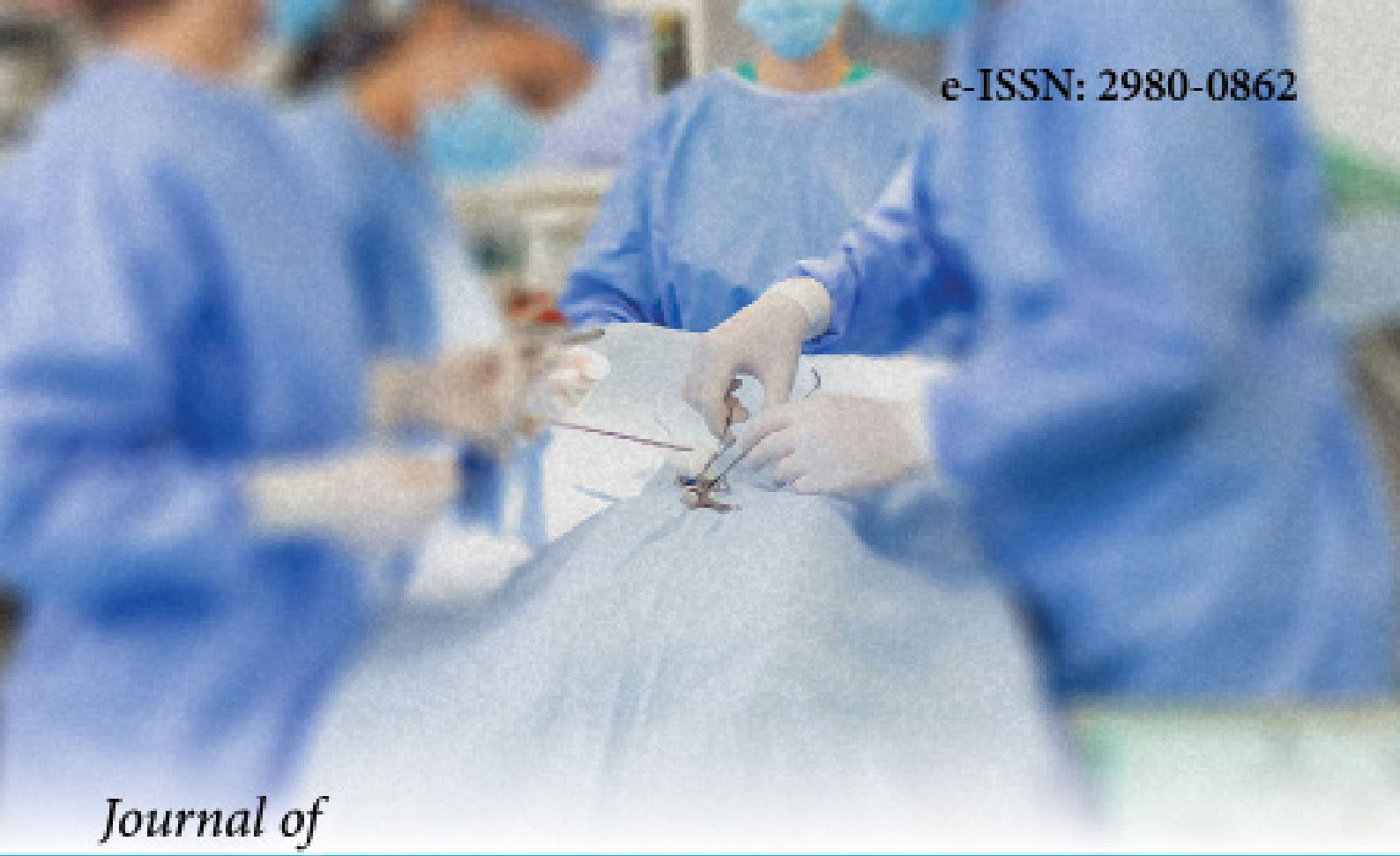


e-ISSN: 2980-0862

Journal of

Comprehensive Surgery

Volume: 2 Issue: 3 Year: 2024

MHA
MEDIHEALTH ACADEMY

EDITOR-IN-CHIEF

ASSOCIATE EDITORS-IN-CHIEF

EDITORIAL BOARD

EDITORIAL BOARD

ENGLISH LANGUAGE EDITOR

STATISTICS EDITOR

DESIGN

Journal of Comprehensive Surgery

CONTENTS

Volume: 2 Issue: 3 Year: 2024

ORIGINAL ARTICLES

REVIEW

CASE REPORT

LETTER TO THE EDITOR

Journal of Comprehensive Surgery

Original Article

DOI: 10.51271/JOCS-0034

Association of serum alpha-fetoprotein (AFP) with indirect prognosis in gastric cancer

Hüseyin Fahri Martlı, Abidin Göktaş, Ahmet Eray Sarı, Mehmet Ali Pak, Sadettin Er, Mesut Tez

Department of General Surgery, Ankara Bilkent City Hospital, Ankara, Turkiye

Cite this article: Martlı HF, Göktaş A, Sarı AE, Pak MA, Er S, Tez M. Association of serum alpha-fetoprotein (AFP) with indirect prognosis in gastric cancer. *J Compr Surg.* 2024;2(3):45-48.

Corresponding Author: Sadettin Er, ersadettin74@gmail.com

Received: 23/05/2024 ◆ **Accepted**: 27/06/2024 ◆ **Published**: 27/08/2024

ABSTRACT

Aims: Alpha-fetoprotein (AFP) is a glycoprotein secreted from the yolk sac and hepatocytes during fetal life. Elevated levels in adults are considered markers for yolk sac tumors, hepatocellular carcinoma and gastric cancer. There is still no consensus on the definition of AFP-secreting gastric cancers, but AFP-secreting gastric cancers have been reported to have a worse prognosis. In this study, AFP levels in gastric cancers with high AFP were compared with pathology results and evaluated in terms of indirect prognosis.

Methods: Patients with gastric cancer operated in the General Surgery Clinic of Ankara Bilkent City Hospital between 2019 and 2023 were retrospectively screened. Among the screened patients, those whose information could not be reached and those with incomplete information were excluded and 126 patients were included in the study. Serum AFP levels of these patients were compared with pathology results, stages and tumor sizes.

Results: The mean age of the patients in our study was 66±11 years, 42 (33.6%) were female and 84 (66.7%) were male. Of the 126 patients analyzed in the study, 107 (84.9%) were AFP-negative and 19 (15.1%) were AFP-positive. There was no significant difference in AFP levels between all patients in terms of liver metastasis, peritoneal metastasis, disease stage, perineural invasion and tumor location. However, serum AFP levels were significantly higher in patients with lymphovascular invasion and lung metastases (p=0.042; p=0.024). In the analysis for serum AFP level in the presence of lymphovascular invasion, ROC value was 2.35 ng/ml, sensitivity 58.2%, specificity 55.9%, area under the curve (AUC) 0.618, 95% confidence interval (95% CI) 0.512-0.723 and p=0.028.

Conclusion: Lymphovascular invasion is a poor prognostic factor in gastric cancer. In this study, a significant correlation was found between serum AFP value and lymphovascular invasion. In gastric cancers without AFP secretion, a serum AFP value above 2.35 ng/ml may be indirectly associated with poor prognosis because it predicts lymphovascular invasion.

Keywords: Gastric cancer, alpha-fetoprotetin, lymphovascular invasion

INTRODUCTION

According to Globacan 2022 data, gastric cancer is both the fifth most common cancer in the world and the fifth most common cause of cancer-related deaths globally.[1] Although gastric cancer can be diagnosed earlier than in the past, the five-year survival rate is 36% for all stages, while this rate is considerably lower for advanced, poorly differentiated and signet ring cell type cancers.[2] Alpha feto-protein (AFP) producing gastric cancer is also associated with poor differentiation, metastasis and poor prognosis.[3]

AFP is secreted from the yolk sac, hepatocytes and some gastrointestinal cells during fetal life. Its secretion in the adult is considered pathologic and is considered a biomarker for yolk sac tumors of gonadal origin, hepatocellular carcinoma and some types of gastric cancer.[4] AFP-producing gastric cancers account for 1.5-15% of all gastric cancers.[5] AFP-producing gastric cancer has been reported to have more liver metastases and lymphovascular invasion than other gastric cancers.[5,6]

Lymphovascular invasion is known to be an independent prognostic factor in malignancies. Lymphovascular invasion means tumoral involvement of microvessels or tumor emboli in the endothelium. This is predictive for lymph node

metastasis and distant organ metastasis.[7] Therefore, adjuvant chemotherapy is recommended for gastric tumors without lymph node metastasis but with lymphovascular invasion due to poor prognosis.[8]

In this study, we aimed to evaluate the predictive value of AFP for lymph node and distant organ metastasis and to compare it with postoperative pathology results based on the knowledge that serum AFP level is an indicator of poor prognosis in patients with gastric cancer.

METHODS

The study was initiated upon receiving approval from the Ankara Bilkent City Hospital Ethics Committee (Date: 22.05.2024, Decision No: TABED1-24-266). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

For the study, 243 patients who underwent surgery for gastric cancer (GC) in the General Surgery Clinic of Ankara Bilkent City Hospital between July 2019 and October 2023 were retrospectively reviewed.

Patients with GC who were under 18 years of age, pregnant women, patients with diseases that may cause high levels of AFP such as chronic liver diseases, cirrhosis, yolk sac tumor, teratoma and hepatocellular carcinoma and whose electronic records could not be accessed, perforation, cases requiring emergency surgery due to bleeding or volvulus (n=18), cases requiring surgery due to pyloric stenosis (n=4), cases with a diagnosis other than gastric adenocarcinoma (neuroendocrine tumor, lymphoma, gastrointestinal stromal tumor) (n=22) were not included in the study.

Demographic (age, gender), laboratory (carcinoembryonic antigen (CEA), Ca 19-9, AFP) and clinicopathological (tumor localization, distant organ metastasis and lymph node metastasis) data were analyzed from the medical records of the remaining 199 patients. Preoperative imaging modalities for staging computed tomography (CT), F18-fluorodeoxyglucose positron emission tomography/computed tomography (PET/CT) and distant organ metastases including liver, lung and peritoneal metastases were determined by reviewing intraoperative operative notes. Pathologic TNM staging (pTNM-AJCC cancer staging manual 8th gastric cancer) was performed from postoperative pathology specimens. Preoperative laboratory parameters of the patients were analyzed and patients with inaccessible CEA, Ca19-9 and AFP levels and patients who could not be clinically evaluated for distant organ metastasis by imaging methods were excluded from the study (n=73) (Figure 1). Serum AFP levels were measured with the ADVIA centaur XPT immuoassay system.

Statistical Analysis

All statistical tests were performed using IBM statistical package for the social sciences (IBM SPSS Corp.; Armonk, NY, USA), version 22 software. Kolmogorov Smirnov and Shapiro-Wilk tests were used to assess the normality of data distribution. Mean±standard deviation (SD) was shown for continuous variables. Differences in continuous variables were analyzed using Mann-Whitney U test or Kruskal-Wallis test. p value <0.05 was considered statistically significant.

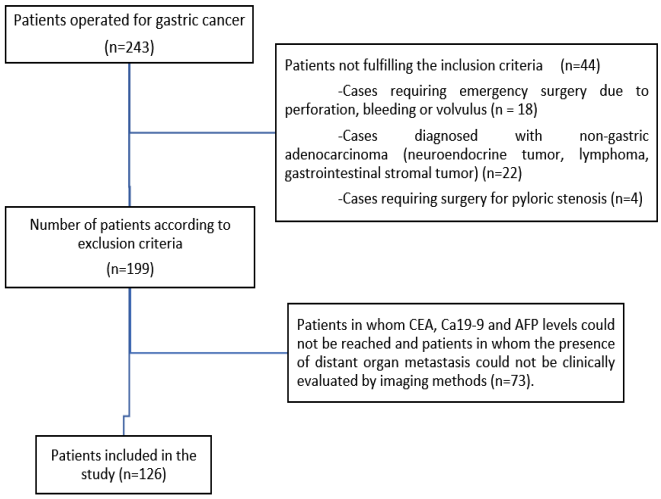


Figure 1. Flowchart of patients included in the study

RESULTS

The mean age of the 126 patients included in the study was 66±11 years, 42 (33.6%) were female and 84 (66.7%) were male, 107 (84.9%) were AFP-negative and 19 (15.1%) were AFP-positive. The clinico-pathologic data of the patients are shown in Table 1.

The median, minimum, and maximum serum AFP levels were 2.6 ng/ml, 1.3 ng/ml and 14.0 ng/ml, respectively. Although there was no significant difference in AFP levels among all patients in terms of liver metastasis, peritoneal metastasis, disease stage, perineural invasion and tumor location, serum AFP levels were significantly higher in patients with lymphovascular invasion and lung metastasis, respectively (p=0.042; p=0.024).

In receiver operating characteristic (ROC) analysis for patients with lymphovascular invasion and lung metastasis, the cut-off values were 2.35 ng/ml and 4.15 ng/ml, respectively. In the analysis performed for serum AFP value in the presence of lung metastasis, sensitivity was 66.7%, specificity 80.5%, area under the curve (AUC) 0.879, 95% confidence interval (95% CI) 0.780-0.979 and p=0.000 (Figure 2, Table 2). In the analysis for serum AFP value in the presence of lymphovascular invasion, sensitivity was 58.2%, specificity was 55.9%, area under the curve (AUC) was 0.618, 95% confidence interval (95% CI) was 0.512-0.723 and p=0.028 (Figure 3, Table 2).

DISCUSSION

In the adult patient, elevated serum AFP primarily suggests hepatocellular carcinoma, other liver diseases and yolk sac tumors of gonadal origin. AFP-secreting gastric cancers have also been described and reported to be a poor prognostic criterion. In this study, we analyzed the serum AFP levels in gastric cancers and found that AFP levels were significantly higher in patients with lung metastases and in patients with lymphovascular invasion.

Lymphovascular invasion is one of the poor prognosis criteria in gastric cancers and it is known that this patient group should be evaluated for adjuvant chemotherapy.[9] Even in early-stage gastric cancers, adjuvant chemotherapy is recommended especially in T2 tumors even in the absence of

Table 1. Demographic data of the patients

	n (%)	Median (min-max)*	p value
Age	126	66±11	
Gender			
Male	84 (66.7)		
Female	42 (33.3)		
Liver			
No	119 (94.6)	2.5 (1.3-938.2)	0.353#
Yes	7 (5.6)	2.7 (1.3-80.6)	
Lung			
No	123 (97.6)	2.5 (1.3-938.2)	0.024#
Yes	3 (2.4)	4.9 (4.0-80.6)	
Peritoneum			
No	123 (97.6)	2.5 (1.3-938.2)	0.693#
Yes	3 (2.4)	3.9 (1.3-4.3)	
Stage			
I-II	49 (38.9)	2.5 (1.3-20.3)	0.542^
III	67 (53.2)	2.5 (1.3-938.2)	
IV	10 (7.9)	3.3 (1.3-80.6)	
Lymph node invasion			
No	36 (28.6)	2.3 (1.3-6.6)	0.060#
Yes	90 (71.4)	2.8 (1.3-938.2)	
Lymphovascular invasion			
No	34 (27.2)	2.3 (1.3-15.1)	0.042#
Yes	91 (72.8)	2.8 (1.3-938.2)	
Perineural invasion			
No	36 (29.3)	2.4 (1.3-20.3)	0.234#
Yes	87 (70.7)	2.7 (1.3-938.2)	
Location of the tumor			
Antrum	39 (31.0)	2.5 (1.3-80.6)	0.262^
Prepiloric	16 (12.7)	2.4 (1.3-15.1)	
Corpus	40 (31.7)	2.6 (1.3-938.2)	
Cardia	14 (11.1)	2.4 (1.3-6.9)	
EGJ	16 (12.7)	3.9 (1.3-177.5)	
Fundus	1 (0.8)	2.3 (2.3-2.3)	
Tumor size (cm)	126	5.6 (0.4-14.0)	
Serum AFP	126	2.6 (1.3-938.2)	

Abbreviations: *(Mean±Standart deviation), ^Kruskal-Wallis Test, #Mann-Whitney U test, Min: Minimum, Max: Maximum, EGJ: Esophagogastric junction, AFP: Alpha feto-protein

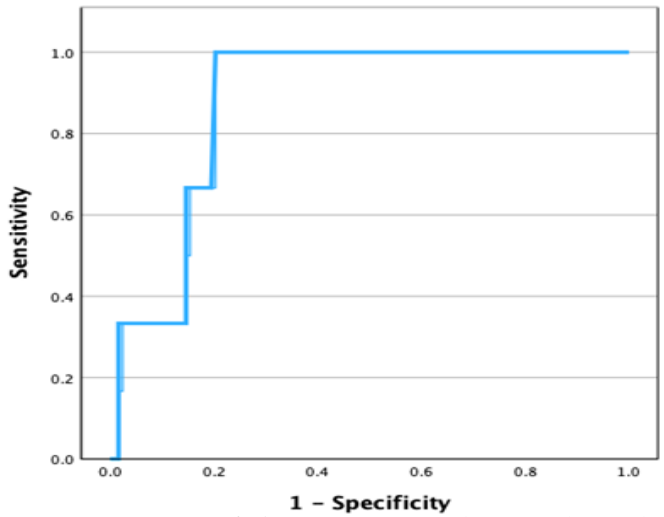


Figure 2. AFP ROC curve for lung metastasis [0.879 (0.780-0.979); p: 0.00)]

AFP: Alpha feto-protein, ROC: Receiver operating characteristic

Table 2. Cut-off for lung metastasis and lymphovascular invasion

Risk factor	AUC (95% CI)	Cutt-uf value	p	Sensitivity	Specifity
Lung metastasis	0.879 (0.780-0.979)	4.15	.000	66.7	80.5
Lymphovascular invasion	0.618 (0.512-0.723)	2.35	.028	58.2	55.9

AUC: Area under the curve

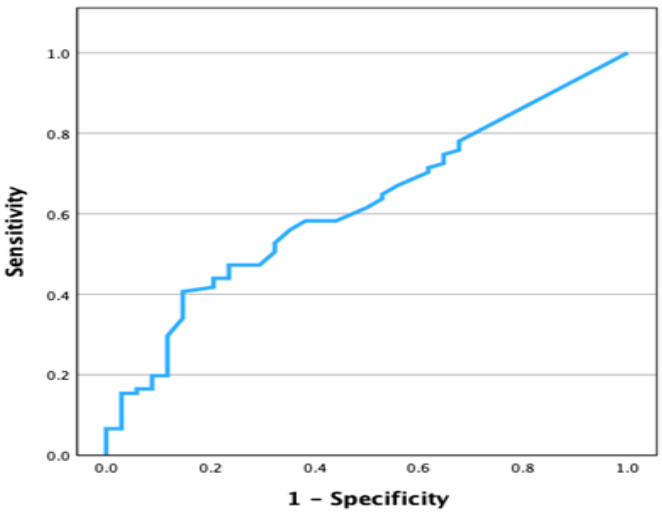


Figure 3. ROC slope for lymphovascular invasion [0.618 (0.512-0.723); p:0.028)]

ROC: Receiver operating characteristic

lymph node positivity.[10] Fujikawa et al.[7] reported pathological T, N and lymphovascular invasion as the most important prognostic indicators in gastric cancers. Lymphovascular invasion is an important risk factor for lymph node metastasis.[11,12] In early-stage gastric cancers, endoscopic mucosal-submucosal dissection can cure the disease. Although the presence of lymphovascular invasion in the pathology of the patient after endoscopic resection does not lead to resective surgery alone, it leads to resective surgery and lymph node dissection when criteria such as border positivity and tumor larger than 3 cm are added.[13] Although lymphovascular invasion is an important prognostic factor, it is a pathological data and there is no clinical and laboratory parameter to predict it. However, the significant correlation of AFP with lymphovascular invasion in this study may provide information about the presence of lymphovascular invasion in patients who have not yet undergone surgery.

Although the pathophysiology of AFP elevation in gastric cancer has not been clearly explained, clinically, the prognosis of this group of patients is poor. It is also speculated that AFP is elevated because gastric cancer metastasis pushes hepatocytes into regeneration and progression, and it is known that 33-72% of AFP-secreting gastric cancers present with liver metastases.[14] Although these types of tumors are prone to metastasize to the liver, liver metastases of other histologic types of gastric cancer and liver metastases of other organs do not raise AFP. In another study, it was reported that AFP is secreted from the yolk sac, hepatocytes and some gastrointestinal system cells in fetal life and its elevation in adults would be due to tumors of these regions.[4] However, the range of normal values of AFP in various publications and the values to define AFP-secreting gastric cancer vary.6 Chun and Kwon[15] set the threshold value as 7 ng/ml, Lin et al.[16] set it as 20ng/ml and Wang et al.[17] set it as 500 ng/ml. Therefore, there is no consensus for the definitive value. Since

the normal range of serum AFP value was determined as 0-8 ng/ml in the center where this study was performed, gastric cancer producing AFP above 8 ng/ml was defined as gastric cancer, but its direct relationship with liver metastasis could not be shown statistically. There was no difference in AFP values between patients with and without liver metastases, but there was a statistically significant difference between AFP values of patients with lung metastases and those without. Although the fact that only three patients had lung metastasis in this study reduces the statistical significance of AFP, it may give an idea about the prediction of lung metastasis in gastric cancers in daily practice.

The most important limitation of the study is its retrospective nature which may lead to missing records and documents. In addition, the limited number of patients, especially only three patients with lung metastases, is another limitation.

CONCLUSION

In gastric cancers, elevated AFP gives an idea about the presence of lung metastasis and lymphovascular invasion. Especially before endoscopic treatment in early-stage gastric cancer, serum AFP levels may predict lymphovascular invasion and guide the clinician to formulate an appropriate treatment plan.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethical Committee of the Ankara Bilkent City Hospital (Date: 22.05.2024, Decision No: TABED1-24-266).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2024;74(3):229-263. doi:10.3322/caac.21834
2. Lu M, Yang Z, Feng Q, et al. The characteristics and prognostic value of signet ring cell histology in gastric cancer: a retrospective cohort study of 2199 consecutive patients. *Medicine (Baltimore)*. 2016;95(27):e4052. doi:10.1097/MD.0000000000004052
3. Zhao L, Yang C, Lin Y, Wang S, Ye Y, Shen Z. Research progress and prospects of AFP-positive gastric cancer. *Foregut Surg*. 2022;2(1):29-38.
4. Abdelwahab H, Tageldin O, Hasak S, Lee H. AFP-producing gastric carcinoma. *Hum Pathol*. 2022;28:300640.
5. Hirajima S, Komatsu S, Ichikawa D, et al. Liver metastasis is the only independent prognostic factor in AFP-producing gastric cancer. *World J Gastroenterol*. 2013;19(36):6055.
6. Xu X, Wang Q, Cao H, et al. Prognostic value of serum alpha-fetoprotein levels in patients with gastric cancer: a meta-analysis. *J Int Med Res*. 2020;48(3):0300060519899780.
7. Fujikawa H, Koumori K, Watanabe H, et al. The clinical significance of lymphovascular invasion in gastric cancer. *In Vivo*. 2020;34(3):1533-1539. doi:10.21873/invivo.11942
8. Lu J, Dai Y, Xie J-W, et al. Combination of lymphovascular invasion and the AJCC TNM staging system improves prediction of prognosis in N0 stage gastric cancer: results from a high-volume institution. *BMC Cancer*. 2019;19:1-9.
9. Mei D, Zhao B, Zhang J, et al. Impact of lymphovascular invasion on survival outcome in patients with gastric cancer: a retrospective cohort study. *Am J Clin Pathol*. 2020;153(6):833-841.
10. Kunisaki C, Makino H, Kimura J, et al. Impact of lymphovascular invasion in patients with stage I gastric cancer. *Surgery*. 2010;147(2):204-211.
11. Zhang CD, Ning FL, Zeng XT, Dai DQ. Lymphovascular invasion as a predictor for lymph node metastasis and a prognostic factor in gastric cancer patients under 70 years of age: a retrospective analysis. *Int J Surg*. 2018;53:214-220.
12. Choi S, Song JH, Lee S, et al. Lymphovascular invasion: traditional but vital and sensible prognostic factor in early gastric cancer. *Ann Surg Oncol*. 2021;28(13):8928-8935.
13. Japanese Gastric Cancer Association. Japanese Gastric Cancer Treatment Guidelines 2021 (6th edition). *Gastric Cancer*. 2023;26(1):1-25. doi:10.1007/s10120-022-01331-8
14. Liu D, Li B, Yan B, et al. The clinicopathological features and prognosis of serum AFP positive gastric cancer: a report of 16 cases. *Int J Clin Exp Pathol*. 2020;13(9):2439.
15. Chun H, Kwon SJ. Clinicopathological characteristics of alpha-fetoprotein-producing gastric cancer. *J Gastric Cancer*. 2011;11(1):23.
16. Lin H, Hsieh Y, Fang W, Huang K, Li A. Clinical manifestations in patients with alpha-fetoprotein-producing gastric cancer. *Curr Oncol*. 2014;21(3):394-399.
17. Wang YK, Shen L, Jiao X, Zhang XT. Predictive and prognostic value of serum AFP level and its dynamic changes in advanced gastric cancer patients with elevated serum AFP. *World J Gastroenterol*. 2018;24(2):266.

Journal of Comprehensive Surgery

Original Article

DOI: 10.51271/JOCS-0035

Contrasted the clinical and radiological results of patients receiving cage-based bone grafting with PLIF surgical treatment that included bone grafting

Fahri Eryılmaz

Department of Neurosurgery, Faculty of Medicine, Bozok University, Yozgat, Turkiye

Cite this article: Eryılmaz F. Contrasted the clinical and radiological results of patients receiving cage-based bone grafting with PLIF surgical treatment that included bone grafting. *J Compr Surg.* 2024;2(3):49-55.

Corresponding Author: Fahri Eryılmaz, drfahrier@hotmail.com

Received: 30/07/2024 ◆ **Accepted**: 18/08/2024 ◆ **Published**: 27/08/2024

ABSTRACT

Aims: Posterior lumbar interbody fusion (PLIF) is frequently used to treat spinal instabilities that can cause neurological symptoms, leg pain and low back pain including lumbar stenosis, degenerative disc disease and spondylolisthesis in which one vertebra slips over another. This study aimed to compare the clinical and radiographic outcomes of PLIF for degenerative L4 unstable grade III spondylolisthesis using bone grafts and cage bone grafts.

Methods: Between from September 2021 to August 2023, 30 patients with degenerative lumbar spine disorders were selected based on the inclusion and exclusion criteria for PLIF.

Results: We enrolled 30 patients and divided them into 2 groups (bone graft group I and cage bone graft group II). The follow-up period was 2 years. Low back pain and leg function of the Japanese Orthopaedic Association score showed significant improvement ($p<0.005$) at 3 months and at the final postoperative (62.1±5.5, 602±5.1) in both groups. The fusion rate was 93% in group I and 83% in group II. Radiological evaluation showed significant changes in slip angle, disc height, lumbar lordosis and translational motion from preoperative to final follow-up in both groups. A computer tomography revealed bilateral spondylolysis, disc collapse and anterolisthesis of the fifth lumbar vertebra. These results were verified by magnetic resonance imaging. There was no spinal canal stenosis.

Conclusion: These findings suggest that successful clinical and radiological results can be obtained with PLIF surgery using either a cage with bone or a bone graft alone. The surgeon's inclination, the particular state of the patient and the resources at hand may influence which of the two approaches is used. The results showed no statistically significant difference between the two groups in terms of clinical and radiological outcomes (bone graft and cage with bone graft). This indicates that neither strategy showed a clear edge over the others in the criteria under study and both were equally successful in yielding favorable outcomes.

Keywords: Spine surgery, lumbar disc surgery, interbody fusion, low back pain, spinal cord

INTRODUCTION

Traditionally surgical treatment known as posterior lumbar interbody fusion (PLIF) has been recommended for a variety of lumbar spinal pathologies, especially in individuals with degenerative lumbar spine problems. Various changes in the PLIF procedure have reportedly improved surgical comfort and arthrodesis rates. Compared to other posterolateral procedures, these circumferential fusion techniques offer clear theoretical advantages.[1,2] Direct access to the intervertebral disc is provided by the PLIF technique, allowing for complete removal of the injured or degenerative disc and careful endplate preparation for fusion.[3] As a result, the likelihood of obtaining solid fusion may increase. PLIF allows for simultaneous decompression of neural elements (such as nerve roots) and stabilization of the spine through fusion. This can effectively relieve pressure on the nerves while ensuring spinal stability.[4,5]

The likelihood of vertebral collapse was reduced and the compressive forces were dispersed more evenly. By filling the intervertebral disc space, the interbody graft stabilizes the motion segment and is frequently made of bone replacement. This helps prevent unwanted motion which can cause discomfort and instability by reducing mobility between

nearby vertebra.[6] In spinal fusion treatments, interbody graft implantation is primarily performed to encourage bone fusion (arthrodesis) between the neighboring vertebra. This fusion stabilized the treated segment structurally and eliminated mobility. The development of less invasive PLIF methods has allowed surgeons to achieve good fusion rates while minimizing tissue damage, postoperative pain and recovery duration.[7]

Traditional spinal fusion procedures include PLIF with an iliac bone transplant but these procedures are associated with a number of risks and difficulties including morbidity related to the donor location and the patient's own iliac crest which is one of the most important problems with using an iliac bone graft for PLIF.[8] Removal of bone from the iliac crest can be extremely painful and uncomfortable which increases the risk of complications such as infection, hemorrhage and nerve damage.[9,10]

The surgical technique takes longer when an iliac crest bone graft is harvested because it requires a different surgical location and precise care during bone extraction. Surgery that lasts longer increases the risk of complications. The iliac crest had a finite supply of bone that could be removed.[11-13] The intervertebral gap may not be completely filled with graft material. Iliac bone grafts may undergo resorption over time. This may lead to less stability and adverse effects on the final outcome of fusion. There is a chance that the nerves and blood arteries in the area will be damaged during the graft-harvesting process which could result in numbness, weakness or vascular problems.[14] Infection is more likely to occur at both the donor and surgical sites in the lumbar spine because of the formation of a second surgical site (the iliac crest). Both the donor and surgical sites are frequently quite painful for patients which can lengthen recovery durations and lower patient satisfaction.[15]

In Turkiye, degenerative lumbar spine disorders are often multifactorial and different individuals may have varying combinations of these risk factors. Lifestyle modifications, regular exercise, maintaining a healthy weight and seeking appropriate medical care are essential for preventing or managing these disorders. Due to these potential problems associated with PLIF using an iliac bone graft alternative methods and graft materials have been developed and refined over the years. The aim of this study to compare the clinical and radiographic outcomes of PLIF for degenerative L4 unstable grade III spondylolisthesis.

METHODS

Study Design and Patients Data Collection

The study was initiated upon receiving approval from the Hitit University Faculty of Medicine Researches Ethics Committee (Date: 05.08.2021, Decision No: 2021-19). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients were prospectively recruited from September 2021 to August 2023 in the Department of Neurosurgery Hitit University Çorum Erol Olçok Training and Research Hospital. The patient population included patients aged 25-60 years. A total number of patients was 30. The patients were divided into two groups. Group A included 15 patients who underwent PLIF of the cage with bone transplant and group B included 15 patients who underwent PLIF with bone grafting. The following problems were present in patients who had a single vertebral level (L4) grade III decompression for unstable degenerative spondylolisthesis and were monitored for 24 months. The Japanese Orthopaedic Association (JOA) score is a thorough evaluation tool for individuals with spinal disorders particularly in the lumbar region. Radiographic imaging was used to assess clinical results. All participants provided written informed consent and the research was authorized by the Hitit University Faculty of Medicine Research Ethical Council. This study was conducted in conformity with the Declaration of Helsinki which is the World Medical Association's Code of Ethics for Human Subject Studies.

Inclusion criteria: Patients who underwent lumbar stability and fusion due to a degenerative lumbar spine condition were admitted to the neurosurgery department.

Exclusion criteria: Patients who are under 18 years old, older than 70 years, have active infections, are pregnant or have cancer.

Surgical Methods

Another form of spinal surgery PLIF is used to treat various lumbar spine disorders. In this step, any bone or tissue that might obstruct the spinal nerves in the lumbar region was removed. Decompression is required to relieve symptoms caused by disorders such as spinal stenosis, ruptured discs or other problems involving nerve compression. The transverse processes of the vertebra were separated using bone graft material. This bone graft material promoted vertebral fusion resulting in a stable spinal segment. An intervertebral disc or disc material is removed during PLIF treatment and replaced with either a bone graft or a spacer device. It is typically positioned in the intervertebral space between the two nearby vertebra. This interbody fusion can help further stabilize the spine by encouraging fusion between the vertebral bodies. The main objectives of PLIF are to decompress the spine, stabilize the injured area using pedicle screws, promote bone fusion and manage intervertebral disc problems. PLIF is frequently used to address spinal instability, disc herniation and degenerative disc degeneration. The cage was chosen based on the surgeon's preference.

Outcome Measurements

Clinical evaluation: Evaluation of a patient's condition both before and after surgery was performed using the JOA score and its subscores. These results are frequently used to assess the condition of people with spinal illnesses, particularly in relation to lumbar problems. It considers a patient's symptoms, functional restrictions and neurological abnormalities among other elements of their illness. The JOA score is an overall numerical number that represents the patient's state and is derived from responses to a series of questions or assessments. While a lower score typically denotes more severe symptoms and impairments a higher score typically denotes greater spinal function and less disability. To monitor the patient's development and success of the surgical intervention, these scores are routinely assessed at various intervals. To establish a baseline assessment of the patient's state, preoperative measurements were performed prior to surgery.

Radiological evaluation: Preoperatively, postoperatively and at the final follow-up, slide length and angle, slip ratio, disc height and lumbar lordosis were evaluated. By performing radiography on maximum flexion and extension at the time of the procedure the slip angle were calculated 3 months, 6 months and 1 year after the procedure. Radiography of the lumbosacral spine should be performed to determine the degree of instability, disc height and degree of lumbar lordosis. Examination of the disc height and pars interarticularis using a lumbar computer tomography (CT) scan. Neurological tissue assessment using magnetic resonance imaging (MRI) of the lumbar spine.

Statistical Analysis

To compare clinical and radiologic measures, T-tests were performed. The intertransverse fusion rates were compared using Fisher's exact test. The SPSS version 26 was used for all analyses. When the p value was less than 0.05 statistical significance was taken into account.

RESULTS

As shown in Table 1; the age and sex distributions in the two treatment groups for PLIF (bone graft and cage with bone graft) were comparable. The following conditions were present in the fourth lumbar vertebra and monitored for two years. A posterior opening of 5 mm in maximal flexion, a slip of 8° and Meyerding grade III or above were all required. There were 30 patients in all including both male and female patients and their ages ranged from 64.5±5.2 65.1±6.6 years. Both groups underwent follow-up period (2.1±0.3, 2.2±0.5).

Table 1. Demographic parameters of patients

Parameters	Group-I bone graft (n=15)	Group-II cage with bone graft (n=15)	p value
Age	64.5±5.2	65.1±6.6	0.87
Both sex	77.5	76.0	0.76
Weight	60.1±10.3	60.3±9.1	0.41
No of days in the hospital	30.5±5.5	29.9±1.3	0.21
Operating time	185.2±9.1	185.3±8.8	0.87
Fusion			
Yes	14=93%	13=87%	0.005
No	1=7%	2=13.3%	
Follow up period (Y)	2.1±0.3	2.2±0.5	0.33

Comparison of Clinical Outcomes from Preoperative to Postoperative between Two Groups

The clinical outcomes were evaluated using radiographic imaging. JOA scores were compared between the bone graft (group I) and cage with bone graft (group II) groups. There was a statistically significant decrease and improvement ($p<0.005$) in low back pain and leg pain (preoperative, 1 month, 3 months, 6 months, 1 year and follow-up) in both groups by analyzing the JOA scale. In group I, low back pain JOA score was significantly increased ($p<0.005$) at 3 months (43.2±11.7), 6 months (55.1±3.6), 1 year (59.1±6.1) and at final follow-up (62.1±5.5) postoperatively as compared to preoperatively (9.3±15.3). In group II, low back pain JOA score was significantly increased after treatment ($p<0.005$), after 3 months (40±21.4), 6 months (53.3±20.1), 1 year (60.2±3.3) and at final follow-up (62.5±5.1) postoperatively as compared to preoperatively (9.3±3.4). In group I, leg function improvement rates, from preoperative to 3 months, 6 months, 1 year and at final follow-up were (35.1±13.1), (40±19.2), (49.5±20.5) and (52.2±20.1) as compared to preoperatively (13.4±5.3); those patients belong to group II were (36.6±12.2), (49±22.6), (47±17.3) and (50.4±20.7) respectively then preoperative (12.5±4.1) in (Table 2, Figure 1).

Table 2. Comparison of LBP and leg function JOA scale between two groups

Parameters	LBP score (n=15) mean±SD		Leg score (n=15) mean±SD		p value
	Group-I	Group-II	Group-I	Group-II	
Preoperative	9.3±15.3	9.3±18.4	13.4±5.5	12.5±4.1	0.003
1 month	18.1±13.2	12.3±23.1	21.1±3.3	21.5±10.1	0.67
3 month	43.2±11.7	40±21.4	35.1±13.1	36.6±12.2	0.05
6 month	55.1±3.6	53.3±20.1	40±19.2	49±22.6	0.05
1 year	59.1±6.1	60.2±3.3	49.5±20.5	47±17.3	0.003
F/U	62.1±5.5	62±5.1	52.2±20.1	50.4±20.7	0.003

LBP: Low back pain, JOA: Japanese Orthopaedic Association, SD: Standard deviation

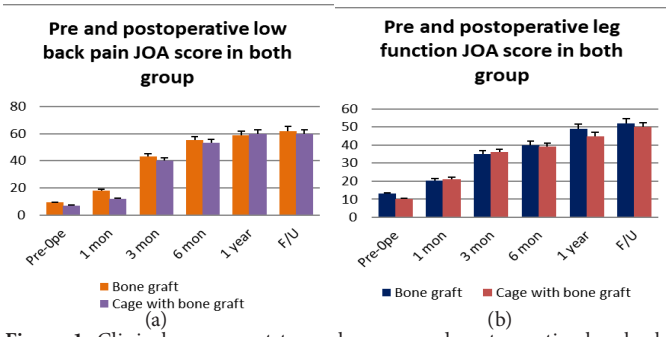


Figure 1. Clinical assessment to analyze pre and postoperative low back pain and leg function, (a) Bar graph shows significantly reduced low back pain by increasing JOA score, (b) Bar graph shows significantly reduced leg pain by increasing JOA score

JOA: Japanese Orthopaedic Association

Comparison of Radiographic Results from Preoperative to Postoperative between Two Groups

In bone graft group I and cage with bone graft in group II, the slip angle were decrease significantly, $p<0.05$, preoperatively, postoperatively and at the final follow-up. In group I, the slip angle increased (12.5°±0.5°) preoperatively and decrease at 6th month (6.0°±1.2°) postoperatively to (2.1°±2.1°) at the final follow-up. In group II, it increased (11.9°±1.1°) preoperatively and decreased at 6 months (6.1°±0.7°) postoperatively and (2.5°±0.9°) at the final follow-up (2.5°±0.9°) in (Table 3). At postoperative follow-up there was a significant ($p<0.05$) better correction from this time point through the final follow-up. In our study, significantly increased ($p<0.005$); disc height in bone graft group I and cage with bone graft in group II preoperatively, postoperatively and at follow-up. In group I, significantly increased preoperatively (20%±9%), at 6 months (55%±22%) postoperatively and at the final follow-up (60%±28%). In group II, preoperative vertebral disc heights were significantly decreased (19%±10%), 6 months (58%±23%) and (60%±25%) respectively. At the postoperative and final follow-up, the disc heights were 60% ($p<0.05$). There were no significant differences between the two groups (Table 3). In lumbar lordosis was significantly increased ($p < 0.005$) in group I and cage with bone graft in group II preoperatively, postoperatively and at follow-up. In group I, preoperative lumbar lordosis L4-S1 were (10.2°±3°), at 6 months (43°±19°) and at the final follow-up (60°±29°) ($p>0.005$). In group II, preoperative lumbar lordosis was 9%±2% and at 6 months (37%±16%) at the final follow-up (58%±21%) ($p>0.005$) in (Table 3), (Figure 2a, b, c). From that time point, translation correction was performed in the PLIF in both groups throughout the final follow-up period.

Table 3. Comparison of radiological assessment between two groups

	Ragiological assessment						
	Group I			Group II			
Parameters	Slip angle (°)	Disc height (%)	Lumbar lordosis (°)	Slip angle	Disc height	Lumbar lordosis	p value
Preoperative	12.5°±0.5°	20%±9%	10.2°±3°	11.9°±1.1°	19%±10%	9%°±2%	0.33
1 month	10.1°±0.5°	40%±19%	19°±8°	9.9°±0.5°	37%±17%	18%°±7%	0.06
3 month	8.0°±0.7°	53%±20%	30°±15°	7.8°±1.1°	55%±21%	31%°±14%	0.05
6 month	6.0°±1.2°	55%±22%	43°±19°	6.1°±0.7°	58%±23%	37%°±16%	0.05
1 year	4.0°±1.1°	60%±27%	51°±22°	3.5°±0.1°	59%±23%	47%°±21%	0.005
F/U	2.1°±2.1°	60%±28%	60°±29°	2.5°±0.9°	60%±25%	58%°±21%	0.005

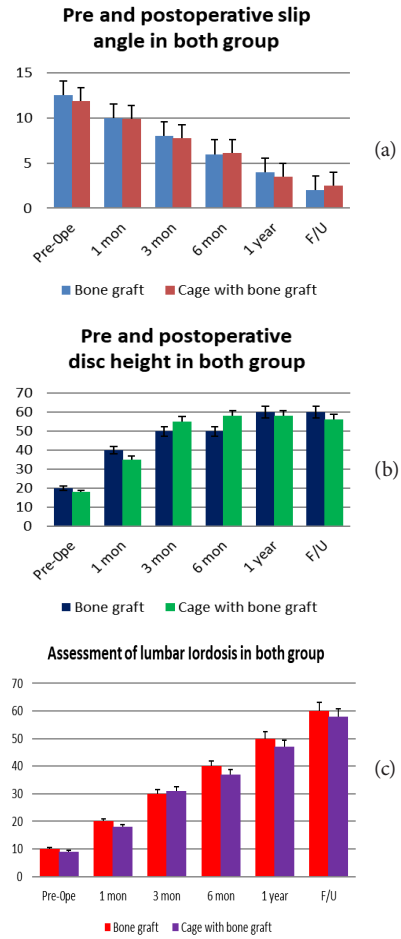


Figure 2. Radiological assessment to observe pre and postoperative in both groups, (a) Slip angle bar graph shows significantly reduced slip angle after surgery, (b) Disc height bar graph shows significantly increase disc height in both group, (c) Lumbar lordosis bar graph shows significantly increase lumbar lordosis in postoperative in both group

In our study, maximum flexion and extension was observed in the bone graft group (3.7±1.1) and cage bone graft group (3.3±0.2). At postoperatively in both groups there was (4.4±2.9) mm and (4.2±2.3) mm and show significantly limited translation motion, p<0.005 in (Table 4), (Figure 3a, b). The fusion rates in both the groups were 93% and 87%, respectively (p>0.005) (Table 1).

Following are the findings for each parameter in group I (bone graft) and group II (cage with bone graft): In Table 1; the hospital stay was (30.5±5.5, 29.9±1.3) days and the surgical time was (185.2±9.1, 185.3±8.8) minutes. The following complications developed: Three serious problems occurred in all groups: one patient experienced persistent leg pain; one had a deep wound infection and one had a vein thrombosis (Figure 4, 5).

Table 4. Comparison of flexion and extension slip and translation between two groups

	Flexion and extension slip (n=15) mean±SD		Flexion and extension translation (n=15) mean±SD		
Parameters	Group-I	Group-II	Group-I	Group-II	p value
Preoperative	3.0±0.2	3.3±0.1	3.7±1.1	3.3±0.2	0.03
1 month	3.5±0.5	2.5±0.6	3.5±2.1	3.3±1.1	0.03
3 month	3.3±0.4	2.9±1.1	3.9±2.1	2.9±1.1	0.05
6 month	3.5±0.7	3.8±1.5	3.9±3.1	3.4±2.8	0.05
1 year	3.7±1.2	3.7±2.1	2.5±3.3	2.2±2.9	0.05
F/U	3.9±1.1	3.5±1.9	4.4±2.9	4.2±2.3	0.05

SD: Standard deviation

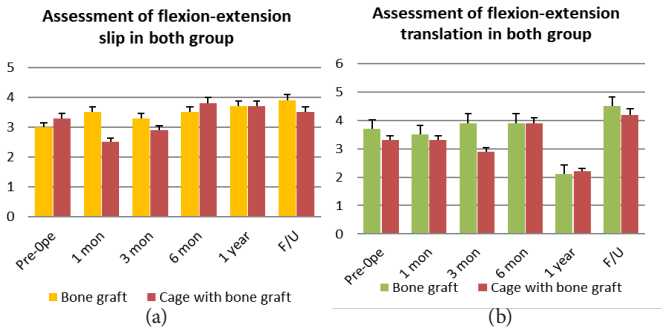


Figure 3. Flexion and extension of slip angle and translation assessment in both groups, (a) Bar graph shows similar flexion and extension slip angle in both group, (b) Bar graph shows similar flexion and extension translation in both group

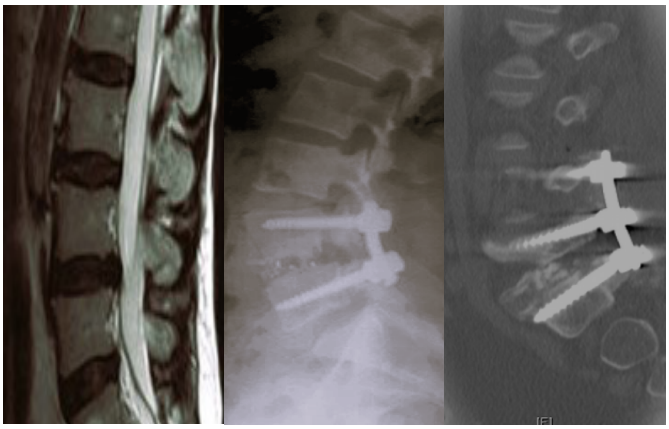
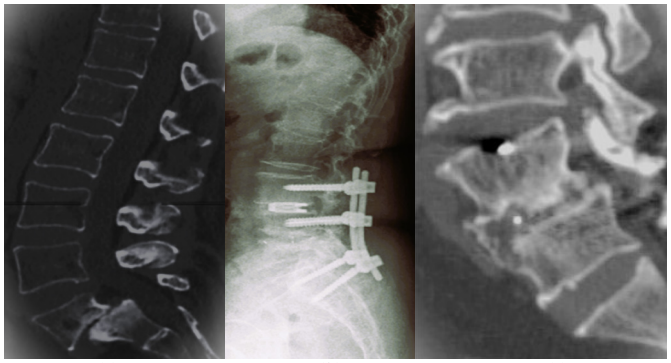


Figure 4. Case 1: Bone graft alone PLIF surgery, (a) Preoperative MRI, (b) 45 years old age patients the intervertebral discs, spinal cord and nerve roots may all be evaluated with MRI well. Following PLIF with a bone graft, MRI can be used to assess the following conditions: the condition of the disc space between the vertebra and any adjustments to disc height. The existence of soft tissue problems, infection or inflammation the way the brain structures and spine are oriented, (b, c) CT scans image, of the spine's bones and are especially helpful for evaluating bone structures. Following PLIF with a bone graft can demonstrate whether the bone graft and surrounding vertebra have effectively fused

PLIF: Posterior lumbar interbody fusion, MRI: Magnetic resonance imaging, CT: Computer tomography



(a) (b) (c)

Figure 5. Case 2: Cage with bone graft PLIF surgery, (a) Preoperative CI image, (b) 50-year-old patient arrived at the hospital complaining of a low back pain. There was no recent trauma in the past, (b, c) CT scan image show vertebra fused

PLIF: Posterior lumbar interbody fusion, CT: Computer tomography

DISCUSSION

Restoration of lordosis, preservation of intervertebral disc height, anterior column support and indirect foraminal decompression are among the potential benefits of PLIF.[16] In patients with grade III lumbar spondylolisthesis, they suggested screw systems and cages because improved stability may permit successful fusion around the cages.[17,18]

In both groups (bone graft and cage with bone graft), PLIF offered improved fusion rates, preservation of reduction and anterior column support.[19,20] In our study, PLIF in both groups demonstrated a noticeably shorter surgery time. In groups I and II, it was possible to obtain better sagittal balance and the JOA scores for leg function and back discomfort were better three months after surgery than before. There was a statistically significant improvement in the postoperative status compared to the preoperative status within the each group.[21,22]

The evaluation of JOA ratings prior to and following PLIF with two distinct graft alternatives (bone graft and cage with bone graft) can shed light on the effect of the procedure on leg function and low back pain. Patients were assessed using the JOA score prior to the PLIF operation and low back pain, leg pain, sensory impairments, motor deficits and bladder function were just a few of the different aspects that the JOA score evaluates. A baseline for the patient's condition was established during this preoperative evaluation which also acted as a benchmark for gauging recovery from surgery. Usually during a follow-up session following PLIF surgery, the JOA score is reevaluated. The patient's condition following surgery is reflected in the postoperative JOA score which assesses changes in leg function and low back discomfort. The difference between preoperative and postoperative JOA scores is a numerical indicator of a patient's condition improvement or decline. Following PLIF, higher postoperative JOA ratings, especially in the low back pain and leg function components, showed improvement in these areas. The nature of the spinal condition, the surgical technique, the patient's age and general health and the success of the graft integration can all have an impact on the postoperative JOA scores for patients who underwent PLIF with a bone graft and those who underwent PLIF with a cage and bone graft.[23] We were agreed from the previous study. It should also be noted that recovery can differ from person to person. The low back pain improvement rates of the bone graft group and the cage with bone graft group showed similar effects.

In our study, the slip angle, disc height space and lumbar lordosis were measured on radiological images of all patients and compared between the bone graft and bone graft groups.[24] In patients undergoing PLIF surgery or with diseases such as spondylolisthesis, the slip angle, disc height and lumbar lordosis are crucial spinal characteristics. They used a slip threshold of 5 mm and a slip angle of 8°-10° to divide the patients into two groups: stable and unstable. Instability was assessed by measuring the degree of slide (>54 mm) and slip angle (>10°) in the subjects. The slippage angle between neighboring vertebra was measured using the slip angle. The degree of spinal displacement is commonly indicated by an increase in slip angle in diseases such as spondylolisthesis.[25,26] PLIF lowers the slip angle and stabilizes the spine. The procedure involves fusing the afflicted vertebra together in order to stop further slippage and enhance spinal alignment. There was a significant reduction in the slip angle postoperatively between the groups treated with PLIF and those treated preoperatively. We were agreed from the previous study.

The distance between neighboring vertebral discs is referred to as disc height. The compression and degeneration of intervertebral discs can result in disorders such as spondylolisthesis which can result in a reduction in disc height. To restore disc height during a PLIF procedure, the degenerative disc is frequently removed and a bone graft or cage is inserted.[27] This promotes fusion and aids in maintaining an appropriate distance between vertebra. There was a significant increase in disc height after surgery in both groups different postoperative and preoperative outcomes.

The typical inward curve of the lumbar spine is called the lordosis. Spondylolisthesis is a condition that can change curvature. Restoring and maintaining lumbar lordosis after PLIF surgery since it is necessary for optimal spinal alignment and function. PLIF surgical methods and equipment are used to maintain or replicate this curvature in bone grafts as well as cages with bone grafts. PLIF surgery aims to enhance the patient's quality of life, reduce pain and restore spinal stability both postoperatively and at follow-up.[28,29] Depending on the needs and unique condition of each patient it is optimal to reduce or eliminate the slip angle after surgery, restore the disc height and maintain or improve lumbar lordosis. After postoperative comparison with preoperative data, the fusion rate was 93% in the first group and 83% in the second group which was achieved in 14 patients in group I and 13 patients in group II using posterior elements removed from the decompression procedure as bone grafts and a cage with bone graft as implemented.[29] We were agreed from the previous study.

When bone grafts and cages with bone grafts are used, a combination of MRI and CT scans may be utilized to offer a thorough assessment of post-PLIF outcomes.[30] Although CT scans offer comprehensive information on bone fusion, hardware placement and radiographic fusion.[31] MRI is useful for evaluating soft tissues and associated problems. Examination of these imaging results is often undertaken during follow-up meetings with surgeons or healthcare professionals.[32] To evaluate the success of the procedure and whether further care or monitoring is required, they will analyze the photographs and consider the clinical symptoms. Working closely with your medical team is crucial to ensuring that the right imaging tests are performed and the

outcomes are carefully assessed in order to monitor recovery and the effectiveness of PLIF treatment with a cage and bone transplant.

CONCLUSION

These findings suggest that successful clinical and radiological results can be obtained with PLIF surgery using either a cage with bone or a bone graft alone. The surgeon's inclination, the particular state of the patient and the resources at hand may influence which of the two approaches is used. The results showed no statistically significant difference between the two groups in terms of clinical and radiological outcomes (bone graft and cage with bone graft). This indicates that neither strategy showed a clear edge over the others in the criteria under study and both were equally successful in yielding favorable outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethical Committee of the Hitit University Faculty of Medicine Researches Ethics Committee (Date: 05.08.2021, Decision No: 2021-19).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution and analysis of the paper and that they have approved the final version.

REFERENCES

1. Kim YH, Ha KY, Rhyu KW, et al. Lumbar Interbody Fusion: Techniques, Pearls and Pitfalls. *Asian Spine J.* 2020;14(5):730-741.
2. Meng B, Bunch J, Burton D, Wang J. Lumbar interbody fusion: recent advances in surgical techniques and bone healing strategies. *Eur Spine J.* 2021;30(1):22-33.
3. Camino-Willhuber G, Tani S, Shue J, et al. Lumbar lateral interbody fusion: step-by-step surgical technique and clinical experience. *J Spine Surg.* 2023;9(3):294-305.
4. Lenz M, Mohamud K, Bredow J, Oikonomidis S, Eysel P, Scheyerer MJ. Comparison of different approaches in lumbosacral spinal fusion surgery: a systematic review and meta-analysis. *Asian Spine J.* 2022;16(1):141-149.
5. Park MK, Son SK, Choi SH. Lumbar interbody fusion by unilateral biportal endoscopy, in unilateral biportal endoscopic spine surgery: basic and advanced technique. *Spine Surg.* 2022:139-154.
6. Matur AV, Mejia-Munne JC, Plummer ZJ, Cheng JS, Prestigiacomo CJ. The history of anterior and lateral approaches to the lumbar spine. *World Neurosurg.* 2020;144:213-221.
7. Zhao H, Wang YJ, Wang RG, et al. Three-dimensional hounsfield units measurement of pedicle screw trajectory for predicating screw loosening in lumbar fusion surgery. *Clin Interv Aging.* 2023;18:485-493.
8. Formica M, Vallerga D, Zanirato A, et al. Fusion rate and influence of surgery-related factors in lumbar interbody arthrodesis for degenerative spine diseases: a meta-analysis and systematic review. *Musculoskelet Surg.* 2020;104(1):1-15.
9. Jain D, Ray WZ, Vaccaro AR. Advances in techniques and technology in minimally invasive lumbar interbody spinal fusion. *JBJS Rev.* 2020;8(4):e0171.
10. Patel PD, Canseco JA, Houlihan N, Gabay A, Grasso G, Vaccaro AR. Overview of minimally invasive spine surgery. *World Neurosurg.* 2020;142:43-56.
11. Wilson KV, McDonnell JM, O'Malley S, et al. Morbidity and mortality of traumatic cervical spinal cord injuries in a geriatric cohort. *Ir J Med Sci.* 2023;192(4):1719-1725.
12. Sharif S, Jazaib Ali MY. Outcome prediction in spinal cord injury: myth or reality. *World Neurosurg.* 2020;140:574-590.
13. Sánchez JAS, Sharif S, Costa F, Rangel JAIR, Anania CD, Zileli M. Early management of spinal cord injury: WFNS spine committee recommendations. *Neurospine.* 2020;17(4):759-784.
14. Pan M, Li Q, Li S, et al. Percutaneous endoscopic lumbar discectomy: indications and complications. *Pain Physician.* 2020;23(1):49-56.
15. Hersey AE, Durand WM, Eltorai AEM, DePasse JM, Daniels AH. Longer operative time in elderly patients undergoing posterior lumbar fusion is independently associated with increased complication rate. *Global Spine J.* 2019;9(2):179-184.
16. Gong K, Lin Y, Wang Z, Li F, Xiong W. Restoration and maintenance of segment lordosis in oblique lumbar interbody fusion. *Restoration Lordosis.* 2022;23(1):1-11.
17. Yang H, Liu J, Hai Y, Han B. What are the benefits of lateral lumbar interbody fusion on the treatment of adult spinal deformity: a systematic review and meta-analysis deformity. *Global Spine J.* 2023;13(1):172-187.
18. Kucharzyk DW, Budimir D, Waldorff EI, Shum LC, Vannabouathong C. The effect of expandable versus static lordotic interbody implants in minimally invasive spine surgery: patient reported outcomes, sagittal alignment, and restoration of disc height and foraminal height. *J Spine Surg.* 2023;9(1):39-53.
19. Mokawem M, Katzouraki G, Harman CL, Lee R. Lumbar interbody fusion rates with 3D-printed lamellar titanium cages using a silicate-substituted calcium phosphate bone graft. *J Clin Neurosci.* 2019;68:134-139.
20. Yao YC, Lin HH, Chou PH, Wang ST, Chang MC. Differences in the interbody bone graft area and fusion rate between minimally invasive and traditional open transforaminal lumbar interbody fusion: a retrospective short-term image analysis. *Eur Spine J.* 2019;28(9):2095-2102.
21. Ran TF, Ke S, Li J, et al. Relieved low back pain after total hip arthroplasty in patients with both hip osteoarthritis and lumbar degenerative disease. *Orthop Surg.* 2021;13(6):1882-1889.
22. Zhou C, Xia H, Yin J, Zheng Y. Three-dimensional gait quantitative analysis in postoperative rehabilitation of lumbar degenerative diseases: a self-controlled before-after study. *Am J Transl Res.* 2021;13(6):6913-6920.
23. Gao A, Wang Y, Yu M, et al. Association between radiographic spinopelvic parameters and health-related quality of life in de novo degenerative lumbar scoliosis and concomitant lumbar spinal stenosis. *Spine (Phila Pa 1976).* 2020;45(16):E1013-E1019.
24. Lv H, Yang YS, Zhou JH, et al. Simultaneous single-position lateral lumbar interbody fusion surgery and unilateral percutaneous pedicle screw fixation for spondylolisthesis. *Neurospine.* 2023;20(3):824-834.
25. Yin Y, Yu Z, Wang J, Sun J. Effectiveness of the rehabilitation training combined with maitland mobilization for the treatment of chronic ankle instability: a randomized controlled trial. *Int J Environ Res Public Health.* 2022;19(22):15328.
26. Ladouceur L, Shakeri A, Khan S, et al. Producing fluorine- and lubricant-free flexible pathogen- and blood-repellent surfaces using polysiloxane-based hierarchical structures. *ACS Appl Mater Interfaces.* 2022;14(3):3864-3874.
27. Elgafy H, Behrens K. Comparing expandable and static interbody cages in lumbar interbody fusion. *J Spine Surg.* 2023;9(1):1-5.
28. Tartara F, Garbossa D, Armocida D, et al. Relationship between lumbar lordosis, pelvic parameters, PI-LL mismatch and outcome after short fusion surgery for lumbar degenerative disease. Literature review, rational and presentation of public study protocol: RELApSE study. *World Neurosurg X.* 2023;18:100162.

29. Tanasansomboon T, Robinson JE, Anand NC. Minimally invasive transforaminal lumbar interbody fusion: strategies for creating lordosis with a posterior approach. *Neurosurg Clin.* 2023;34(4):643-651.

30. Jiang D, Sun G, Jia R, Zhang Y, Wang X, Xu Z. Comparing bone graft techniques for interbody fusion through a posterior approach for treating mid-thoracic spinal tuberculosis: a retrospective analysis. *Orthop Surg.* 2023;15(1):53-61.

31. Subagio EA, Rahmadhan MA, Faris M, et al. Comparison of fusion outcomes of bone morphogenetics proteins-7 and bone autograft in posterolateral lumbar fusion: a systematic review. *Interdisciplinary Neurosurg.* 2023;33:101765.

32. Kaiser R, Varga M, Lang O, et al. Spinal fusion for single-level SPECT/CT positive lumbar degenerative disc disease: the SPINUS I study. *Acta Neurochir (Wien).* 2023;165(9):2633-2640.

Journal of Comprehensive Surgery

Original Article

DOI: 10.51271/JOCS-0036

Efficacy of combined lumbar plexus and parasacral sciatic nerve block in elderly patients undergoing hip fracture surgery: a retrospective analysis

Fethi Akyol[1], Alparslan Koç[1], Muhammet Ali Arı[2], Mustafa Somunkıran[1]

[1]*Department of Anesthesiology and Reanimation, Erzincan Binali Yıldırım University Mengucek Gazi Training and Research Hospital, Erzincan, Turkiye*
[2]*Department of Anesthesiology and Reanimation, Erzurum City Hospital, Erzurum, Turkiye*

Cite this article: Akyol F, Koç A, Arı MA, Somunkıran M. Efficacy of combined lumbar plexus and parasacral sciatic nerve block in elderly patients undergoing hip fracture surgery: a retrospective analysis. *J Compr Surg.* 2024;2(3):56-59.

Corresponding Author: Alparslan Koç, dralparslankoc@gmail.com

Received: 01/08/2024 ◆ **Accepted**: 23/08/2024 ◆ **Published**: 27/08/2024

ABSTRACT

Aims: Hip fractures are a major cause of morbidity and mortality in the elderly population. Anesthesia management significantly affects outcomes in elderly patients. In recent years, peripheral nerve blocks have become important, especially in patients where subarachnoid blocks are contraindicated or in patients with severe pulmonary or cardiac diseases. This study aimed to retrospectively evaluate the efficacy of combined lumbar plexus block and parasacral sciatic nerve block in geriatric populations.

Methods: Data from patients over 70 years of age who underwent surgery for hip fracture and received combined lumbar plexus and parasacral sciatic nerve blocks between 2014 and 2024 were retrospectively analyzed. The efficacy of anesthesia, the need for intraoperative rescue anesthesia, and hemodynamic parameters were evaluated.

Results: The mean age of the 98 patients included in the study was 79.81±8.94 years. Most patients had concomitant chronic diseases. A total of 19 (19.94%) patients were administered fentanyl 50 mcg and propofol 0.5 mg/kg for pain at the beginning of surgery, and none of the patients who received sedoanalgesia experienced severe respiratory distress or low oxygen saturation. Anesthesia and analgesia were effectively administered, and the need for intraoperative rescue anesthesia was low. Hemodynamic parameters remained stable.

Conclusion: Combining lumbar plexus and parasacral sciatic nerve blocks is an effective anesthetic method for hip surgery in elderly patients with comorbidities. This method reduces the need for general anesthesia, provides comprehensive analgesia, and maintains hemodynamic stability.

Keywords: Hip fracture, lumbar plexus block, parasacral sciatic nerve block, elderly patients, hip arthroplasty

INTRODUCTION

Hip fractures are a significant cause of morbidity and mortality in the elderly population, with 80% of these cases occurring in women and an average age of approximately 80 years.[1] Most fractures result from trauma, with risk factors including reduced bone mineral density, lack of mobility, and chronic medication use. The global incidence of hip fractures is expected to increase significantly as the population ages, with projections suggesting an increase to more than 6 million cases annually by 2050.[2] Treatment of hip fractures in elderly patients includes both surgical and non-surgical approaches, with surgery being the preferred option to improve survival and functional outcomes. Prompt surgical intervention, ideally within 48 hours, is associated with reduced mortality and better recovery outcomes.[3]

Nevertheless, because of the increasing incidence of intraoperative and postoperative risk factors associated with aging, postoperative pain, venous thromboembolism, pulmonary complications due to delayed mobilization, and intraoperative bleeding may occur[4] Anesthesia plays a crucial role in the management of hip fractures in elderly patients and significantly affects patient outcomes and recovery. The choice between general and regional anesthesia depends on several factors, including the patient's overall health, comorbidities, and specific circumstances of the fracture. Regional anesthesia, such as spinal or epidural anesthesia, is often preferred because it is associated with fewer postoperative complications, a lower risk of delirium, and better pain control.[5]

Although general anesthesia and neuraxial blocks have been used effectively in hip fracture surgery, peripheral nerve blocks have gained importance in recent years because of the increasing number of elderly patients with multiple chronic diseases. Peripheral nerve blocks may be necessary in cases where regional anesthesia is contraindicated or when the patient has severe pulmonary or cardiac conditions that make other types of anesthesia unsafe. With the introduction of ultrasonography in the operating room, peripheral nerve blocks are becoming more common.[6] Combining a lumbar plexus nerve block with a parasacral sciatic nerve block has shown promising results for hip surgery in elderly patients. This anesthetic approach provides comprehensive pain relief while minimizing the need for general anesthesia, which is particularly advantageous in this vulnerable population.

This study aimed to evaluate the efficacy of combined lumbar plexus block and parasacral sciatic nerve block in elderly patients. The primary outcomes evaluated were the intraoperative efficacy of anesthesia and analgesia and intraoperative rescue anesthesia (opioid and sedative consumption), and the secondary outcomes included intraoperative hemodynamic parameters.

METHODS

After ethics committee approval was obtained, patients who underwent surgery for hip fracture with combined lumbar plexus and parasacral sciatic nerve block at Erzincan Mengücek Gazi Training and Research Hospital between 2014 and 2024 were investigated (Date: 07.03.2024, Decision No: 2024-03/01). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Our hospital's electronic medical records were reviewed to identify patients meeting the following inclusion criteria: patients over 70 years of age, American Society of Anesthesia (ASA) III, frail with comorbidities, and for whom general anesthesia and neuraxial blocks were considered complicated. Patients with coagulopathy, sepsis, hepatic or renal insufficiency, local anesthetic allergy, or preexisting femoral/obturator neuropathy were excluded.

Demographic characteristics, including age, sex, weight, and ASA classification, were recorded. Major comorbidities were documented through chart review. Additionally, pre- and postblock peak heart rate and blood pressure measurements were recorded from the anesthesia sheets. Intraoperative fluid replacement, urine output, and bleeding values were also documented.

Anesthesia Protocol

All patients underwent routine cardiac monitoring after premedication with 1 mg of midazolam. Ultrasonography-guided nerve block was performed to provide adequate anesthesia and analgesia during surgery. A 40 ml mixed solution was prepared, containing 25 ml of 0.5% bupivacaine hydrochloride (5 mg/ml), 14.8 ml of 2% lidocaine hydrochloride (20 mg/ml), and 0.2 ml of adrenaline tartrate (5 µg/ml). For the sciatic nerve block, an average of 20 ml of this solution was administered via the parasacral approach, whereas for the lumbar plexus nerve block, an average of 20 ml was administered at the L2-3 and/or L3-4 levels. Block evaluation began after 20 minutes with a pinprick test. Surgical approval was granted once adequate sensory and motor blocks were achieved. During the perioperative follow-up, midazolam, fentanyl, and propofol were used as rescue anesthesia drugs as needed.

Statistical Analysis

Statistical analysis was performed via SPSS 26.0 software. Categorical variables are presented as numbers (n) and percentages (%), and continuous variables are presented as the means±standard deviations or medians (interquartile ranges). The distribution of the data was tested via the Shapiro–Wilk normality test. Data that were normally distributed were evaluated via the independent samples t test, whereas data that were not normally distributed were examined via the Mann–Whitney U test. $p< 0.05$ was considered statistically significant.

RESULTS

A total of 110 patients who underwent hip fracture surgery between May 2014 and May 2024 and received combined lumbar plexus and parasacral sciatic nerve blocks for anesthesia were included in the study. Twelve patients whose medical records were missing were excluded from the analysis. The majority of patients were over 70 years of age, with a mean age of 79.81±8.94 years. The demographic data are summarized in Table 1. A total of 19 (19.94%) patients were administered fentanyl 50 mcg and propofol 0.5 mg/kg for pain at the beginning of surgery, and none of the sedoanalgesia patients experienced severe respiratory distress or low oxygen saturation. The hemodynamic parameters recorded before and after blocking are summarized in Table 2. No anesthesia-related hemodynamic instability was observed in any patient postprocedure. Surgery commenced approximately 45 minutes after anesthesia. No motor deficits were observed in any of the patients during the 24-hour postsurgery motor control assessments. Analysis of patient comorbidities revealed that 70 (71.43%) patients had hypertension, 43 (43.88%) had chronic obstructive pulmonary disease (COPD), and 42 (42.86%) had diabetes mellitus. Postoperative analgesia requirements indicated that none of the patients needed additional opioids within the first 24 hours. Twenty-eight patients were admitted to the postanesthesia care unit (PACU) for monitoring, with none exceeding a 24-hour stay.

1. Demographic data of the study patients	
	Data
Age, y	79.81±8.94
Weight, kg	71.46±12.2
Sex, male/female	44 (44.9)/54 (55.1)
Sedoanalgesia, n, (%)	19 (19.94)
Time, min	130±21
PACU, n, (%)	28 (28.57)
Comorbidities n, (%)	
Hypertension	70 (71.43)
Chronic obstructive pulmonary disease	43 (43.88)
Diabetic	42 (42.86)
Congestive heart failure	41 (41.84)
Coronary arter disease	38 (38.78)
Arrhytmia	22 (22.45)
Cerebrovascular disease	21 (21.43)
Aortic valve stenosis	8 (8.16)

PACU: Postanesthesia care unit, Data are presented as mean±SD or No. (%), SD: Standard deviation

Table 2. Intraoperative characteristics of patients			
Intraoperative characteristics	**Mean±SD**	**Range**	**p**
SBP 1, mmHg	113.5±6.03	95-145	0.276
SBP 2, mmHg	109.67±7.47	80-140	
DBP 1, mmHg	67.17±7.55	45-95	0.566
DBP 2, mmHg	64.67±10.55	40-80	
MAP 1, mmHg	82.38±8.27	55-106	0.525
MAP 2, mmHg	79.7±10.01	50-96	
HR 1, beat/min	77.68±10.65	54-110	0.66
HR 2, beat/min	80.16±10.75	55-98	

SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, HR: Heart rate, Data are presented as mean±SD, $p<0.05$ is considered significant

DISCUSSION

Most patients who undergo hip arthroplasty are elderly and have poor cardiopulmonary function. While spinal anesthesia is the first choice, peripheral nerve blocks may also be appropriate to prevent complications in patients with comorbidities. Our results indicate that a lumbar plexus block combined with a parasacral sciatic nerve block can effectively serve as an anesthetic method for total hip arthroplasty, reducing early postoperative opioid requirements.

Peripheral nerve and plexus blocks can be utilized for anesthesia and postoperative pain control, either in combination with general anesthesia or epidural or spinal anesthesia. Blocks have gained popularity in recent years because of the long-lasting analgesia they provide. Additionally, compared with other types of anesthesia, nerve blocks may improve intraoperative hemodynamic stability.[7] Major hip fractures have become significant risk factors for mortality in patients over 75 years of age.[8] In our study, patients had a mean age above 75 years. Zhang et al.[9] investigated the efficacy of lumbar plexus blockade on anesthetic comfort and stress reactions in elderly hip replacement patients and reported an effective anesthetic effect, similar to our findings.

Elderly patients who undergo hip replacement have reduced compensatory capacity and organ function, and anesthesia and surgical stress may exacerbate this condition.[10] In our study, no hemodynamic instability requiring inotropic support occurred in patients who underwent block. In a comparative study with subarachnoid blocks, Ahamed et al.[11] reported significant hemodynamic instability in the subarachnoid block group but not in the lumbar plexus group.

Lumbosacral plexus structures innervate the lower limbs and trunk and contain axons of neuron receptors that connect the central nervous system to sensory and motor end organs.[12] The nature and extent of nerve injury in the brachial and lumbosacral plexuses are influenced by the mechanism and severity of the injury. Oliver-Fornies et al.[13] reported that ultrasound guidance reduced neurological complications, similar to our findings.[14] In this study, none of the patients experienced motor deficits or neurological complications.

In light of evidence for successful patient outcomes, the selected lumbar plexus block is a commonly used regional anesthesia technique during hip arthroplasty operations. Compared with general anesthesia and intraspinal block, this method provides hemodynamic stability more effectively and has more positive effects on symptomatic control, especially in the elderly patient population. Recent advances in ultrasound imaging technology have enabled more precise monitoring of anatomical structures and needle progression, significantly increasing the success rate of blocks.[15]

The choice of anesthesia in elderly patients with comorbidities requires special attention. An essential marker of the body's hemodynamics and stress is the catecholamine level. Choi et al.[16] found that elderly patients undergoing lower abdominal surgery who were given lumbar plexus block had lower catecholamine levels than those who were given general anesthesia. This suggests that lumbar plexus block might help older patients maintain their signs. Hypertension was the most common concomitant disease in this study. However, none of the patients experienced fluctuations in blood pressure. Aortic stenosis is a condition in which many forms of anesthesia may be risky in elderly patients, necessitating a sensitive approach. Despite impressive advances in anesthesiology and surgical techniques, morbidity and mortality remain high in patients with severe aortic stenosis. According to conventional wisdom, subarachnoid blockade is thought to produce immediate sympathetic blockade.[17] This may lead to a marked decrease in peripheral vascular resistance and possibly inhibition of cardiac accelerator nerves, resulting in severe and refractory hypotension, potential myocardial damage, and death in patients with aortic stenosis.[18] In our study, 8 (8.16%) patients with aortic stenosis successfully completed surgery without complications following the procedure. Gamlı et al.[19] also reported successful anesthesia with combined peripheral nerve blocks in a patient with aortic stenosis, hypertension, cerebrovascular disease, and a temporary pacemaker.

Postoperative pain control is crucial in hip arthroplasty patients, as is the choice of anesthesia during surgery. The combination of lumbar plexus block and parasacral sciatic nerve block provided effective postoperative pain relief, with minimal painkiller consumption in the first 24 hours. A recent meta-analysis revealed that, compared with control blocks, lumbar plexus blocks decreased overall opioid consumption, reduced side effects, and improved functional recovery.[20] These results emphasize the positive impact of comprehensive and rigorous pain management on patients' clinical outcomes.

Limitations

First, the fact that it is retrospective makes it difficult to compare patients as well as possible data loss. This was a single-center study, and the relatively small number of cases

may also be a limitation. In addition, successful anesthesia management in elderly patients with serious comorbid diseases was the subject of the study.

CONCLUSION

In this study, we observed that lumbar plexus block combined with parasacral sciatic block is an effective anesthetic method for hip fracture surgery in elderly patients. The block provided hemodynamic stability in the intraoperative period and reduced the need for opioids in the postoperative period. The results of the present study suggest that this anesthetic technique is a safe and effective option, especially in the elderly patient population with severe comorbidities.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Erzincan Binali Yıldırım University Faculty of Medicine Researches Ethics Committee (Date: 07.03.2024, Decision No: 2024-03/01).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee evaluation process

Externally peer reviewed.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declare that this study received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

REFERENCES

1. Parker M, Johansen A. Hip fracture. *BMJ (Clinical research ed)*. 2006; 333(7557):27-30. doi:10.1136/bmj.333.7557.27
2. Viganò M, Pennestrì F, Listorti E, Banfi G. Proximal hip fractures in 71,920 elderly patients: incidence, epidemiology, mortality and costs from a retrospective observational study. *BMC Public Health*. 2023; 23(1):1963. doi:10.1186/s12889-023-16776-4
3. Phang JK, Lim ZY, Yee WQ, Tan CYF, Kwan YH, Low LL. Post-surgery interventions for hip fracture: a systematic review of randomized controlled trials. *BMC Musculoskeletal Disorders*. 2023;24(1):417. doi:10.1186/s12891-023-06512-9
4. Kaçmaz M, Turhan ZY. Spinal anesthesia versus combined sciatic nerve/lumbar plexus nerve block in elderly patients undergoing total hip arthroplasty: a retrospective study. *Ann Saudi Med*. 2022;42(3):174-180. doi:doi:10.5144/0256-4947.2022.174
5. Neuman MD, Feng R, Carson JL, et al. Spinal anesthesia or general anesthesia for hip surgery in older adults. *New England J Med*. 2021; 385(22):2025-2035. doi:10.1056/NEJMoa2113514
6. Karmakar MK. Lumbar paravertebral sonography and considerations for ultrasound-guided lumbar plexus block. *Pain*. 2023.
7. Stevens Robert D, Van Gessel E, Flory N, Fournier R, Gamulin Z. Lumbar plexus block reduces pain and blood loss associated with total hip arthroplasty. *Anesthesiology*. 2000;93(1):115-121. doi:10.1097/00000542-200007000-00021
8. Karademir G, Bilgin Y, Erşen A, et al. Hip fractures in patients older than 75 years old: retrospective analysis for prognostic factors. *Int J Surg*. 2015;24(PA):101-104. doi:10.1016/j.ijsu.2015.11.009
9. Zhang J, Li Y, Sun X, Ren W. Effects of Lumbar plexus block combined with infiltration anesthesia on anesthesia comfort scores and stress responses in elderly patients undergoing hip replacement. *Dis Mark*. 2022;2022(1):8692966. doi:https://doi.org/10.1155/2022/8692966
10. Sharma H, Mitra S, Singh J, Gupta S, Garg S. A randomized study comparing the efficacy of ultrasound guided lumbar plexus block and epidural anesthesia for postoperative analgesia in patients undergoing total hip replacement. *Asian J Anesthesiol*. 2020;58(4):131-137. doi:10.6859/aja.202012_58(4).0003
11. Ahamed ZA, Sreejit MS. Lumbar plexus block as an effective alternative to subarachnoid block for intertrochanteric hip fracture surgeries in the elderly. *Anesth Essays Res*. 2019;13(2):264-268.
12. Rubin DI. Brachial and lumbosacral plexopathies: a review. *Clin Neurophysiol Prac*. 2020;5:173-193. doi:https://doi.org/10.1016/j.cnp.2020.07.005
13. Oliver-Fornies P, Ortega Lahuerta JP, Gomez Gomez R, Gonzalo Pellicer I, Herranz Andres P, Sancho-Saldana A. Postoperative neurological complications after brachial plexus block: a retrospective study conducted at a teaching hospital. *J Anesth*. 2021/12/01 2021;35(6): 844-853. doi:10.1007/s00540-021-02989-7
14. Allegri M, Bugada D, Grossi P, et al. Italian registry of complications associated with regional anesthesia (RICALOR). An incidence analysis from a prospective clinical survey. *Minerva Anestesiol*. 2016;82(4):392-402.
15. Memtsoudis SG, Cozowicz C, Bekeris J, et al. Anaesthetic care of patients undergoing primary hip and knee arthroplasty: consensus recommendations from the International Consensus on Anaesthesia-Related Outcomes after Surgery Group (ICAROS) based on a systematic review and meta-analysis. *Br J Anaesth*. 2019;123(3):269-287. doi:10.1016/j.bja.2019.05.042
16. Choi EJ, Choi YJ, Lee SW, et al. Effect of anesthetic method on incidence of delirium after total hip replacement arthroplasty in South Korea: a population-based study using National Health Insurance claims data. *Korean J Anesthesiol*. 2020;73(1):36-43. doi:10.4097/kja.19091
17. Meyhoff CS, Hesselbjerg L, Koscielniak-Nielsen Z, Rasmussen LS. Biphasic cardiac output changes during onset of spinal anaesthesia in elderly patients. *Eur J Anaesthesiol*. 2007;24(9):770-775. doi:10.1017/S0265021507000427
18. Ferré F, Martin C, Bosch L, Kurrek M, Lairez O, Minville V. Control of spinal anesthesia-induced hypotension in adults. *Local Reg Anesth*. 2020;13:39-46. doi:10.2147/LRA.S240753
19. Gamli M, Sacan O, Baskan S, Ozciftci S, Gogus N. Combined lumbar plexus and sciatic nerve block for hip fracture surgery in a patient with severe aortic stenosis. *J Anesth*. 2011;25(5):784-785. doi:10.1007/s00540-011-1179-3
20. AlMutiri WA, AlMajed E, Alneghaimshi MM, et al. Efficacy of continuous lumbar plexus blockade in managing post-operative pain after hip or femur orthopedic surgeries: a systematic review and meta-analysis. *J Cli Med*. 2024;13(11):3194. doi:10.3390/jcm13113194

Journal of Comprehensive Surgery

Review

DOI: 10.51271/JOCS-0037

Gastric volvulus in children: diagnosis and treatment approaches

Sevgi Ulusoy Tangül

Department of Pediatric Surgery, Faculty of Medicine, Yozgat Bozok University, Yozgat, Turkiye

Cite this article: Ulusoy Tangül S. Gastric volvulus in children: diagnosis and treatment approaches. *J Compr Surg.* 2024;2(3):60-65.

Corresponding Author: Sevgi Ulusoy Tangül, sevguu@gmail.com

Received: 06/04/2024 ◆ **Accepted**: 18/04/2024 ◆ **Published**: 27/08/2024

ABSTRACT

Gastric volvulus is a sporadic disease in the pediatric age group and is very complex in terms of etiology and management. In this study, we aimed to discuss 2 late-diagnosed gastric volvulus cases, review the diagnosis and treatment methods of gastric volvulus cases in the pediatric age group encountered in the literature, and reduce concerns about the correct diagnostic approach to these cases. The first case was an 8 year old girl who was followed up due to developmental delay and metabolic disease and was admitted due to recurrent vomiting attacks. Endoscopic reduction was first performed on patients whose upper gastrointestinal tract imaging was compatible with organoaxial gastric volvulus. Since vomiting attacks continued, laparoscopic gastropexy was performed. In the postoperative follow-up, there was weight gain and vomiting complaints wholly regressed. The second case; was a 1-year-old girl who was treated for gastroesophageal reflux at an external center due to vomiting and developmental delay, but she did not receive any response. The endoscopic reduction was performed because the patient's upper gastrointestinal imaging was compatible with the organoaxial gastric volvulus. Laparoscopic gastropexy was performed on the patient whose vomiting recurred. The stomach was expected in the upper passage imaging in the postoperative period. In the systematic search made in the MEDLINE/Pubmed database using the keywords "gastric volvulus and pediatric", 41 literature articles presenting 47 cases between 2013 and 2023 were included. The patient's age, gender, complaints admission, type of gastric volvulus, and treatment-related data were collected. The most common symptoms in the patients were vomiting, abdominal pain, and the most common comorbidities were diaphragmatic pathologies and wandering spleen. The most preferred treatment was anterior gastropexy. Gastric volvulus is a condition that is characterized by vomiting, abdominal pain, and developmental delay, and is very difficult to diagnose, especially in chronic cases. In addition to the conservative approach in chronic cases, anterior gastropexy should be preferred to prevent recurrent volvulus attacks.

Keywords: Gastric volvulus, child, gastropexy

INTRODUCTION

Gastric volvulus (GV) is a rare condition in the childhood age group. It is defined as the abnormal rotation of all or part of the stomach around itself along the transverse or longitudinal axis of more than 180°. It can lead to gastrointestinal obstruction.[1,2] It usually occurs in children under 1 year and older adults over 50. No relationship with gender or race was detected.[3]

Gastric volvulus can be organoaxial or mesenteroaxial type. Approximately 2/3 of the cases are of the organoaxial type, which occurs when the stomach rotates around the pylorus and gastroesophageal junction.[1] Mesenteroaxial rotation is less common and is seen when the stomach rotates in a longitudinal line parallel to the gastrohepaticomentum.[4]

In 10% to 30% of cases, gastric volvulus is considered primary and is caused by looseness of the stomach's gastrohepatic, gastrocolic, gastrosplenic, and gastrophrenic ligaments. Diaphragmatic hernia and spleen anomalies may also cause gastric volvulus secondaryarily.[1,3,5]

Gastric volvulus can occur acutely or with intermittent, recurrent and chronic symptoms. A good history and physical examination raise suspicion of the diagnosis of gastric volvulus.[3] In symptomatic patients, abdominal and upper GI passage radiographs confirm the diagnosis.[6]

This study, based on two cases operated on due to gastric volvulus, aimed to examine the literature on gastric volvulus in children and highlight areas that may allow early diagnosis of these cases and prevention of complications.

CASE 1

An 8-year-old female patient, who was referred by pediatrics with complaints of nausea and vomiting and was followed up at an

external center with preliminary diagnoses of developmental delay, muscle disease, and/or metabolic disease, was hospitalized to regulate her oral intake and evaluate her stomach anomalies. Since organoaxial gastric volvulus was detected in the upper passage radiograph (Figure 1), gastroscopy was planned to evaluate whether the patient needed additional treatment. The gastroscopy detected no pathology, and the patient continued to be fed via nasogastric. Diagnostic laparoscopy was performed on the patient whose gastric volvulus continued to appear on the control upper passage radiograph. On exploration, the stomach appeared 180 degrees volvulated in the prepyloric region. The patient underwent laparoscopic gastropexy. The patient did not vomit in the postoperative period. The control upper passage radiograph taken in the sixth postoperative month showed that the stomach appeared normal (Figure 2).

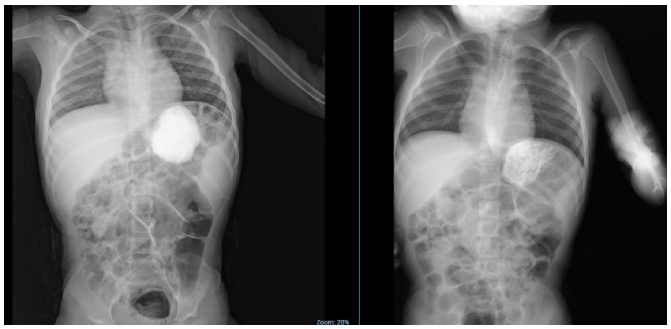


Figure 1. Preoperative contrast radiography of the upper GI tract of Case 1

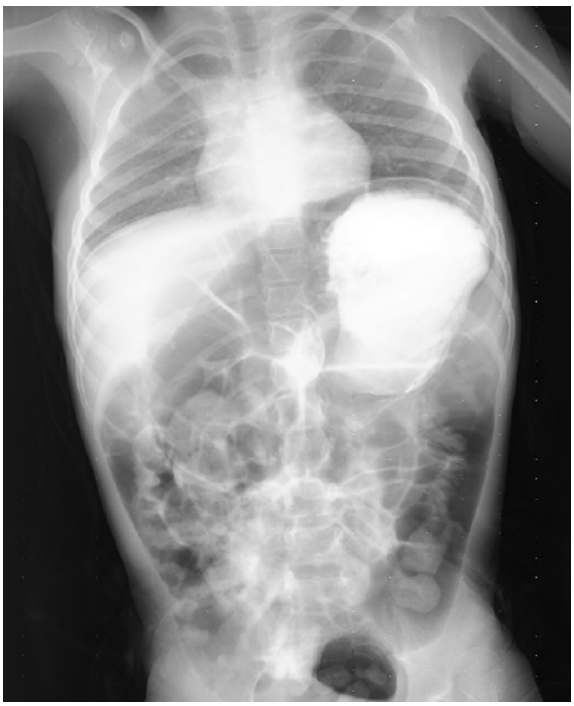


Figure 2. Postoperative contrast radiography of the upper GI tract of Case 1

CASE 2

A 1-year-old girl with developmental delay, who was followed up at an external center with the diagnosis of gastroesophageal reflux due to vomiting, was hospitalized for oral nutrition regulation and examinations. In the patient's medical history, it was learned that the gastroesophageal reflux treatment that was started previously did not produce a response. In addition, since the upper passage radiographs taken in another center approximately six months ago showed gastric volvulus, the patient was diagnosed with chronic gastric volvulus. The patient underwent gastroscopy and upper passage radiography under anesthesia. There was a nodular appearance in the duodenum during gastroscopy. The upper passage radiograph observed that the opaque material did not pass into the duodenum (Figure 3). The patient underwent laparoscopic gastropexy with the preliminary diagnosis of organoaxial gastric volvulus. In the postoperative period, it was observed that the patient's vomiting complaints improved, and weight gain occurred. The stomach appeared normal in the upper passage of the radiograph taken 3 months postoperatively (Figure 4).

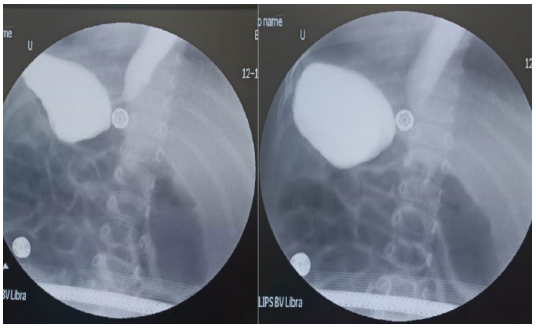


Figure 3. Preoperative contrast radiography of the upper GI tract of Case 2

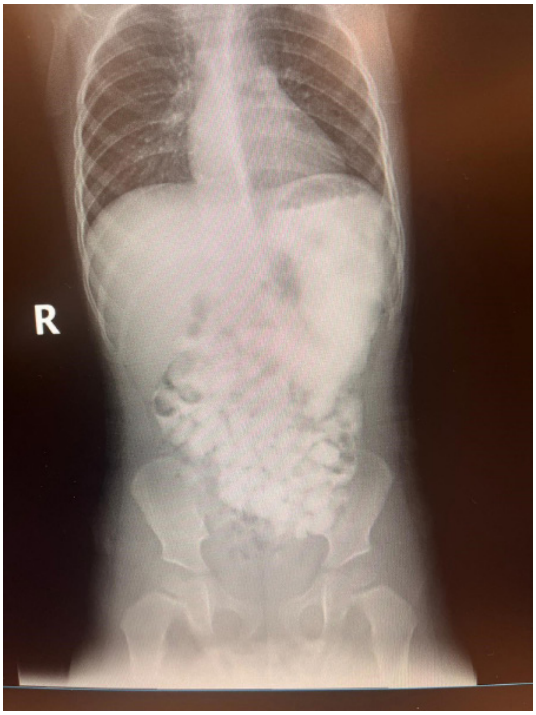


Figure 4. Postoperative contrast radiography of the upper GI tract of Case 2

METHODS

A systematic search was performed in the MEDLINE/Pubmed database using the keywords "gastric volvulus and pediatric". Inclusion criteria were reports published in English that included a description of cases of gastric volvulus in patient's under 18 years of age between 2013 and 2023. Exclusion criteria were non-English literature, studies involving cases older than 18 years, compilations, letters to the editor, and the inability to access the entire article. Data regarding the patients' age, gender, complaints at the time of admission, imaging method used in diagnosis, type of GV, and treatment were collected. In the search made with these parameters, 41 pieces of literature were evaluated.

RESULTS

In total, 47 patients were presented in 41 literature reviews. Twenty-three patients were male, 24 were female, and the age range was 1 day to 18 years. The most common symptoms were non bilious vomiting and abdominal pain. Most cases were in the form of acute gastric volvulus. Although the type of volvulus was not specified in some literature, mesenteroaxial GV was detected in 21 cases, organoaxial in 20 cases, and combined the GV in 1. in other cases, GV type was not specified. Upper GI passage radiography was mainlyused in diagnosis. The most common comorbidities were wandering spleen and diaphragmatic hernia. The most preferred treatment was open or laparoscopic anterior gastropexy. Differently, endoscopic reduction was also performed in 5 cases in the literature. Only one of the reviewed literature reported spontaneous reduction in follow-up upper GI passage imaging. The reviewed literature is given in Table.

DISCUSSION

Pediatric gastric volvulus (GV) is a surgical emergency characterized by variable degrees of stomach rotationaround its short or long axis and can lead to gastrointestinal obstruction.[4] Singleton classified gastric volvulus as organoaxial, mesenteroaxial, and combined, according to the axis around which the stomach rotates.[44] Organoaxial GV is the most common type (59%), describing the rotation of the stomach on a longitudinal axis connecting the gastroesophageal junction with the pylorus. Strangulation and necrosis are frequently observed.[8] Mesenteroaxial GV is the second most common type in which the mesenteroaxial axis divides the lesser and greater curvatures of the stomach into two.[5] The less common combined type is in which mesenteroaxial and organoaxial stomach rotation coincide, primarily observed in patients with chronic GV.[4] Both patients we treated had organoaxial type gastric volvulus.

Although the exact cause of GV is not fully known, its pathogenesis can be explained by the laxity of the gastrosplenic or gastrocolic ligaments.[5] The frequent presence of diaphragmatic defects allows the stomach to migrate towards the thorax. Congenital diaphragmatic defects, Morgagni, and paraesophageal hernia are major predisposing factors associated with acute gastric volvulus.[6,11,16,18,20-23,31,34,36,40,41,43] The wandering spleen is also frequently seen with GV.[10,12-14,21,23,25,34,40] Among the two cases we followed up with chronic type organoaxial GV, our 8-year-old girl was being followed up due to metabolic disease and muscle disease. Apart from this, there was no additional diaphragmatic defect or wandering spleen in either of our cases.

GV can be seen clinically as acute or chronic. While the most common symptoms in acute cases are vomiting, abdominal pain, and abdominal distension, recurrent vomiting attacks, developmental delay, and abdominal pain are prominent in chronic cases.[30] Upper GIS imaging is efficient in diagnosing, especially in chronic GV cases. While radiological imaging methods such as plain abdominal radiography, abdominal ultrasound, and computed tomography help diagnosis with low sensitivity in suspicious cases, the effectiveness of upper GI imaging examinations in making the diagnosis is around 93%.[1,6,15] In our first case, although upper passage imaging had been performed previously, GV was missed due to inadequate examination evaluation and was evaluated as gastroesophageal reflux. In our second case, upper GI imaging was not performed, and vomiting and developmental delay were attributed to gastroesophageal reflux. We detected organoaxial GV in the upper GIS imaging we performed in both cases. From this perspective, upper GI imaging efficiently diagnoses cases with chronic GV.

Endoscopic examination can be used both for diagnostic purposes to evaluate the gastric mucosa and for therapeutic purposes to reduce GV. Endoscopic treatment has been used successfully to treat patients with high surgical risk and acute presentation while allowing decompression and reduction of volvulus; it is also preferred in most chronic cases.[13-15,17,24,27] We first tried endoscopic reduction in two cases we followed due to chronic GV. Although their complaints subsided for a while after endoscopic treatment, vomiting attacks continued in both cases. Thereupon, we performed laparoscopic anterior gastropexy in both of our patients.

Surgical intervention in GV aims to fix the stomach and limit the possibility of recurrence. The generally preferred surgical procedure is open or laparoscopic anterior gastropexy, in which the greater curvature of the stomach is fixed to the anterior abdominal wall.[4] However, partial or total gastrectomy may be preferred in case of GV-related gastric necrosis depending on the degree of ischemia.[16,20,42] Laparoscopic anterior gastropexy was preferred as a surgical intervention in both of our cases.

CONCLUSION

GV is a condition that can frequently occur with various symptoms, such as vomiting, abdominal pain, abdominal swelling, and developmental delay. It is tough to diagnose and treat, especially in chronic cases. The treatment approach in cases presenting with acute GV is surgery. A conservative treatment approach may be preferred in clinically and radiologically suspected chronic cases. However, it would be appropriate to consider anterior gastropexy as the first choice to prevent recurrent volvulus attacks.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Table. Age, gender, clinic, GV type, comorbidities and treatments of the patients in the literature evaluated

Article	Age	Gender	Symptom	Type	Comorbidity	Treatment
McCarty[7]	2 months	M	Choking episodes, vomiting	OA	-	Laparoscopic gastropexy and gastrostomy
Trecroci[8]	16 months	F	Recurrent and postprandial vomiting episodes, which started at 11 months of age. A history of gastroesophageal reflux	OA	-	Anterior gastropexy and Nissen fundoplication
	9 mounths	M	Chronic, recurrent, postprandial vomiting, which started at 7 months of age. A history of gastroesophageal reflux	OA	-	Anterior gastropexy and Nissen fundoplication
Malhotra[9]	4 years	F	Retching and abdominal colic	MA	-	Gastropexy, gastrostomy and jejunostomy
Patoulias[10]	6 years	M	Repeatedly non bilious vomiting and food refusal during the last 72 hours before admission	OA	Wandering spleen	Exploratory laparotomy, anterior gastropexy
Zain, Mostafa[11]	8 years	M	Acute episode of severe epigastric pain, and uncontrolled non bilious vomiting	OA	Left diaphragmatic defect	Laparotomy, diaphragmatic defect repair, anterior gastropexy
Bhambu[12]	2 years	M	Abdominal pain, intractable retching with one episode of non-bilious vomiting for two to three hours, and a suspected history of foreign body ingestion	MA	Wandering spleen	Laparotomy, anterior gastropexy, splenopexy
Yokoyama, Koji[13]	3 years	M	The acute onset of abdominal pain and repeated non-bilious vomiting	MA	Wandering spleen	Gel immersion endoscopy, laparoscopic splenopexy eight months later
Yeh,Pai-Jui[14]	4 years 8 months	F	The progressively frequent episodes of abdominal pain along with a nonbilious but coffee-ground emesis for four days	MA	Wandering spleen	Endoscopic reduction, laparoscopic anterior gastropexy
Tillman, Bourke[5]	6 years	F	4 h history of vomiting and abdominal pain	OA	-	Laparotomy, anterior gastropexy
Haga,Mitsuhiro[15]	6 years	F	Suddenly developed abdominal pain and nausea	MA	-	Endoscopic reduction
Perez-Egido[16]	56 days	M	24 h history of nonbilious nonfeeding related vomiting	MA (preop OA)	Left diaphragmatic eventration, hypertrophic pyloric stenosis	Laparotomy closure of the diaphragmatic defect, Ramstedt pyloromyotomy and anterior gastropexy
	4 years	F	24 h abdominal pain and nonbilious vomiting, chronic postprandial abdominal pain history	MA	Left diaphragmatic hernia	Laparotomy, closure of the diaphragmatic defect and anterior gastropexy
Hara,Tomoko[17]	4 years	M	Sudden onset nausea, upper abdominal pain, and abdominal distension	MA	-	Fluoroscopy-guided endoscopic reduction
	8 years	F	3 weeks history of vomiting and a high gastric residual volume	MA	Neurological disorders	Endoscopic reduction, after 2months elective laparoscopic gastrostomy
Shadrack, Mathayo[18]	6 months	F	Projectile, bilious vomiting for four days, inability to pass stool, abdominal distention for three days		Left diaphragmatic defect	Correction of rotation of the stomach, diaphragmatic defect was repaired
Takahashiş, Toshiaki[2]	6 years	M	Suddenly have abdominal pain and vomiting	MA	-	Single-incision laparoscopic gastropexy
	4 years	M				
	2 years	F				
Porcaro, Federica[4]	16 months	F	11 months of age, occurring, on average, 6 times per day. A history of gastroesophageal reflux unresponsive to drug therapy	OA	Gastroesophageal reflux	Gastropexy, both anterior and fundal, without fundoplication
Kadam, Rahul[6]	1 day	M	Severe respiratory distress soon after birth	MA	Left sided congenital diaphragmatic eventration	Laparotomy, stomach detorsion, plication of diaphragm, anterior gastropexy
Nalwalla, ZahaZahabiya[19]	1 years	F	Abdominal distension for 1 week, intermittent abdominal pain	OA	Left diaphragmatic defect	Gastropexy with left diaphragmatic repair
Kumar, Shishir[20]	9 years	M	Acute onset abdominal pain, a history of several episodes of similar pain in the preceding three months	MA	Diaphragmatic defect	Gastropexy, gastrostomy, diaphragmatic repair
Oyachi, Noboru[21]	Newborn	F	Operated Bochdalek hernia, inability to tolerate enteral nutrition in the postoperative period	OA	Bochdalek hernia, wandering spleen	Laparotomy, gastric decompression duodenum enteral feeding tube, anterior gastropexy
Miyano, Go[22]	5 years	F	Sudden onset of severe epigastric pain accompanied by nonbilious vomiting after eating	MA	Diaphragmatic eventration	Laparoscopic gastropexy plication of diaphragm
Kataria, Riya[23]	13 years	M	Abdominal pain, nausea and vomiting that has been going on for 10 days		Diaphragmatic eventration, wandering spleen	Splenopexy, anterior gastropexy, diaphragmatic repair
Cianci, Maria Chiara[24]	10 years	F	Recurrent attacks of nonbilious vomiting, weight loss and liquid defecation for 5 months	OA	-	Laparoscopic assisted percutaneous endoscopic gastrostomy
Umeda, Satoshi[25]	12 years	M	Abdominal distansion and vomiting		Wandering spleen	Splenopexy, anterior gastropexy
Jones, Gurpal[26]	3 years	F	Intractable, nonbloody, nonbilious emesis, and decreased oral intake and urine output	OA	-	Gastrostomy, gastropexy
Lee, Han Shin[27]	9 years	M	Recurrent abdominal pain, upper abdominal discomfort and bloating after meals, and intermittent vomiting attacks lasting 1 year. Use of prokinetic drugs for 3 months with a preliminary diagnosis of GERD	Chronic GV	Hepatoblastoma	Laparoscopic detorsion, gastropexy

Table. Age, gender, clinic, GV type, comorbidities and treatments of the patients in the literature evaluated (Continues)

Article	Age	Gender	Symptom	Type	Comorbidity	Treatment
Tetsuhara, Kenichi[28]	8 months	M	Decreased mental status persisting for about 2 hours	Mix tip	Hypertelorism, saddle nose, forehead creases and cleft lip, laryngomalacia and multicystic dysplastic kidney, malrotation	Laparoscopic gastrostomy, gastropexy and the Ladd procedure
Schneider, Joanna[29]	13 years	F	Nausea, non-bloody, non-bilious vomiting, abdominal pain	MA	Leprosy	Gastropexy
Qadri, Syeda Kashfi[30]	10 months	F	In upper GI imaging performed before gastrostomy placement	OA	Skeletal dysplasia (spondyloepiphyseal dysplasia congenital), posterior cleft palate, GORD and oropharyngeal dysplasia	Laparoscopic gastrostomy
Serradilla, Javier[31]	12 days	M	Recurrent nonbilious vomiting	MA	Marfan syndrome	Laparotomy, thal fundoplication, gastrostomy (Stamm)
Vaghela, Mamahesshkumar Manilal[32]	4 months	F	Non-bilious, non-projectile vomiting 20-30 minutes after each feeding, starting from 1 month of age	-	-	Laparotomy, anterior gastropexy
Hasan, M Tasdik[33]	17 years	M	Abdominal fullness and sudden onset of episodic epigastric pain after eating for 2 months. Bilious vomiting, frequently foul-smelling, nonprojectile, often containing undigested food material	OA	-	Laparotomy, anterior gastropexy
Cantone, Noemi[34]	13 years	F	Recurrent severe epigastric pain, abdominal distension, vomiting, history of Morgagni hernia and OA GV surgery	OA	Morgagni hernia, wandering spleen	Laparotomy, anterior gastropexy anterior Boerema gastropexy, splenopexy
Takano, Yoshihiko[35]	4 months	M	Cyanosis, hypotonia, apnea attacks. Gastric decompression by inserting a nasogastric tube	OA	Esophageal motility disorder epilepsy	Follow up upper GI imaging at 7 months was normal
Kumar, Kashish[36]	4 years	F	Upper abdominal pain, distension and non-bilious vomiting for the last 2 days	MA	Left diaphragmatic defect	Defect repair, anterior gastropexy
Farber, Benjamin A[37]	18 years	M	Left chest pain	MA	Inflammatory myofibroblastic tumor cholelithiasis	Laparoscopic gastropeksi, Stamm gastrostomisi
Espinola, Dimas C[38]	16 years	M	Acute onset epigastric pain, non-bilious, non-bloody vomiting attacks	MA	-	Laparotomy, anterior gastropexy
Bhesania, Natalie[39]	2 years	F	Persistent vomiting and abdominal pain that has been going on for 1 day	OA	Congenital posterior hiatal hernia	Hiatal hernia was repaired at laparotomy with thal fundoplication
El Azzouzi, Driss[40]	1 day	F	Excessive salivation, vomiting and failure to advance the nasogastric tube	OA	Hiatal defect wandering spleen	Laparotomy, hiatal defect repaired, thal fundoplication anterior gastropexy
Rai, Birendra[41]	8 months	F	Vomiting and irritability that have been going on for 7 days, and a slight cough with decreased oral intake in the last few days	OA	Paraesophageal hiatus hernia	Laparoscopic hiatal hernia repair
Shukla, Ram Mohan[42]	10 months	M	Acute intestinal obstruction, bilious vomiting and occasional hematemesis for the last two days. Difficulty inserting the Ryle's tube even with repeated attempts	OA	-	Total gastrectomy with closure of duodenal stump and esophago jejunostomy (Roux loop) (Figure 3) and jejunojejunostomy was done and diaphragmatic eventration repair
	6 months	F	Sudden abdominal distention, nonbilious vomiting, and restlessness for three days	MA	-	The necrotic stomach was excised, pyloromyotomy and oesophago-pylorostomy Plication of the diaphragm, jejunostomy
Hadjittofi, Christopher[43]	17 years	M	Acute severe epigastric pain which occurred a few minutes after meals	OA	Left-sided diaphragmatic hernia	Laparoscopic diaphragmatic hernia repair, anterior gastropexy

OA: Organoaxial, MA: Mesenteroaxial, GERD: Gastroesophageal reflux disease, GV: Gastric volvulus

REFERENCES

1. da Costa KM, Saxena AK. Management and outcomes of gastric volvulus in children: a systematic review. *World J Pediatr*. 2019;15(3): 226-234.
2. Takahashi T, Yamoto M, Nomura A, Ooyama K, Sekioka A, Yamada Y, et al. Single-incision laparoscopic gastropexy for mesentero-axial gastric volvulus. *Surgic Case Rep*. 2019;5(1):19.
3. Coe TM, Chang DC, Sicklick JK. Small bowel volvulus in the adult populace of the United States: results from a population-based study. *Am J Surg*. 2015;210(2):201-210.
4. Porcaro F, Mattioli G, Romano C. Pediatric gastric volvulus: diagnostic and clinical approach. *Case Rep Gastroenterol*. 2013;7(1):63-68.
5. Tillman BW, Merritt NH, Emmerton-Coughlin H, Mehrotra S, Zwiep T, Lim R. Acute gastric volvulus in a six-year-old: a case report and review of the literature. *J Emerg Med*. 2014;46(2):191-196.
6. Kadam R, Prasad V. Intrathoracic gastric volvulus presenting with GIT bleed. *J Neonat Surg*. 2017;6(2):40.
7. McCarthy LC, Raju V, Kandikattu BS, Mitchell CS. Infantile feeding difficulties: it is not always reflux. *Glob Pediatr Health*. 2014;1: 2333794X14553624.
8. Trecroci I, Morabito G, Romano C, Salamone I. Gastric volvulus in children-a diagnostic problem: two case reports. *J Med Case Rep*. 2016; 10(1):138.
9. Malhotra R, Daniel R, Besarovic S. A twist in the tale. *Case Rep*. 2013; 2013:bcr2012007905.
10. Patoulias D, Rafailidis V, Kalogirou M, Farmakis K, Rafailidis D, Patoulias I. Acute primary mesenteroaxial gastric volvulus in a 6 years old child; the contribution of ultrasonographic findings to the prompt diagnosis (a case report and review of the literature). *Folia Med Cracov*. 2017;57(3):47-55.
11. Zain M, Abada M, Abouheba M, Elrouby A, Ibrahim A. Acute intrathoracic gastric volvulus: a rare delayed presentation of congenital diaphragmatic hernia: a case report. *Int J Surg Case Rep*. 2020;70:123-125.

12. Bhambu SK, Awasthi PK, Mangal R, et al. Acute gastric volvulus with wandring spleen in a two-year-old child: a rare association. *Cureus*. 2023;15(5):e38386.

13. Yokoyama K, Yano T, Kumagai H, et al. Reduction of acute gastric volvulus in a 3-year-old using a balloon-attached endoscope combined with gel immersion endoscopy. *Clin J Gastroenterol*. 2022;15(1):95-100.

14. Yeh PJ, Lo WC, Chen JC. Gastric volvulus presented with an upside-down stomach. *Pediatr Neonatol*. 2022;63(4):422-423.

15. Haga M, Sano N, Kamiyama T, et al. Acute gastric volvulus successfully treated by endoscopic reduction in a 6-year-old girl and a review of the Japanese literature. *Pediatr Emerg Care*. 2019;35(11):e217-e219.

16. Pérez-Egido L, Parente A, Cerdá JA. Acute gastric volvulus and congenital diaphragmatic hernia, case report and review. *Afr J Paediatr Surg*. 2015;12(3):200-202.

17. Hara T, Iwama I, Hosokawa T, Nambu R. Successful endoscopic reduction of gastric volvulus in 2 children: acute and chronic cases. *J Pediatr Gastroenterol Nutr*. 2022;75(2):e30.

18. Shadrack M, Suleiman J, Msuya D, et al. Congenital diaphragmatic hernia with gastric volvulus and splenic herniation: an unusual delayed presentation in a six-month child. *East Afr Health Res J*. 2022;6(1):18.

19. Nalwalla Z, Dirkhipa TY, Jain R, Shah I, Bendre P. Retching without vomiting with acute abdominal distension: a clinical cue. *JPGN Rep*. 2023;4(4):e363.

20. Kumar S, Saxena R, Kumar R, Chauhan S, Diwakar K. Congenital diaphragmatic hernia with intra thoracic gastric volvulus: a rare, life-threatening combination. *Cureus*. 2023;15(4):e38354.

21. Oyachi N, Numano F, Fukatsu T, Nemoto A, Naito A. Volvulus of the stomach and wandering spleen after repair of congenital diaphragmatic hernia: unexpected manifestations in a neonate. *Surgic Case Rep*. 2022;8(1):178.

22. Miyano G, Murakami H, Nakamura H, Lane GJ, Yamataka A. Gastric volvulus associated with anomalous mediastinal origin of the diaphragm. *Pediatr Int: Offic J Japan Pediatr Soc*. 2022;64(1):e15097.

23. Kataria R, Sundaram J, Agarwal P, Lal T. Laparoscopic management of gastric volvulus, diaphragmatic eventration and wandering spleen in a child. *BMJ Case Reports CP*. 2021;14(6):e242441.

24. Cianci MC, Coletta R, Morabito A. Let's (not) twist again: laparoscopic-assisted percutaneous endoscopic gastrostomy in paediatric gastric volvulus. *Digest Dis Sci*. 2021;66(8):2533-2536.

25. Umeda S, Kimura K, Takama Y, Yamauchi K, Yonekura T. Laparoscopic retroperitoneal splenopexy for wandering spleen: a novel technique using a three-incision retroperitoneal pouch. *Asian J Endoscop Surg*. 2021;14(3):644-647.

26. Jones G, Adams L, Metz T, Akay B. Child with profound gastric distension. *Ann Emerg Med*. 2020;75(5):626.

27. Lee HS, Jung EJ, Park JS, Park T. Chronic gastric volvulus as a late complication of hepatectomy for hepatoblastoma in a child: a case report. *Pediatr Gastroenterol Hepatol Nutr*. 2019;22(6):608.

28. Tetsuhara K, Tsuji S, Tomonaga K. Paediatric abdominal compartment syndrome and shock associated with gastric volvulus improved rapidly by gastric suction in the emergency department. *BMJ Case Rep*. 2019;12(7):e229198.

29. Schneider J, Mays R. A 13-year-old with coexistence of gastric volvulus and leprosy: a case report of two rare entities. *Case Rep Infect Dis*. 2018;2018:6125215.

30. Qadri SK, Logarajah V, Nah SA, Jamuar SS. Feeding difficulty in an infant: an unusual cause. *BMJ Case Rep*. 2018;2018:bcr2018225289.

31. Serradilla J, Bueno A, De La Torre C, et al. Neonatal intrathoracic gastric volvulus in Marfan's syndrome. *Eur J Pediatr Surg Rep*. 2018;6(01):e48-e51.

32. Vaghela MM, Sinha AK, Kumar B, Kumar P. Chronic recurrent vomiting associated with primary gastric volvulus in infant: a case report and review of literature. *Afr J Paediatr Surg*. 2017;14(1):12-14.

33. Hasan MT, Rahman ST, Shihab HM, Mahmood HR, Chowdhury T, Sanju QA. A case report on gastric volvulus of a 17 years old boy from Bangladesh. *Int J Surg Case Rep*. 2017;40:32-35.

34. Cantone N, Gulia C, Miele V, Trinci M, Briganti V. Wandering spleen and organoaxial gastric volvulus after Morgagni hernia repair: a case report and review of the literature. *Case Rep Surg*. 2016;2016:6450765.

35. Takano Y, Horiike M, Tatsumi A, Sakamoto H, Fujino H, Sumimoto SI. A case of apparent life-threatening event: comorbid gastric volvulus associated gastroesophageal reflux disease and epilepsy in a 4-month-old boy. *Case Rep Pediatr*. 2016;2016:5717246.

36. Kumar K, Khanna V, Dhua AK, Bhatnagar V. Congenital diaphragmatic hernia with recurrent gastric volvulus and pulmonary sequestration: a "chance" combination. *J Indian Assoc Pediatr Surg*. 2016;21(1):38-40.

37. Farber BA, Lim IIP, Murphy JM, Price AP, Abramson SJ, La Quaglia MP. Gastric volvulus following left pneumonectomy in an adolescent patient. *J Pediatr Surg Case Rep*. 2015;3(10):447-450.

38. Espinola DC, Nankoe SR, Eslami PW. Acute gastric volvulus in a 16-year-old male adolescent: a case report. *Pediatr Emerg Care*. 2017;33(1):34-37.

39. Bhesania N, Anani A, Ochs H, Okwu V, Magnuson D, Kay M. Vomiting in a 2-year-old with a twist: undiagnosed gastric volvulus. *J Pediatr Gastroenterol Nutr*. 2017;64(4):e106.

40. El Azzouzi D. Primary intrathoracic gastric volvulus in the neonatal period: a differential diagnosis of esophageal atresia. *Pan Afr Med J*. 2014;17:261.

41. Rai B, Ahmed R, Amer N, Sharif F. Paraesophageal hiatus hernia in an 8-month-old infant with organoaxial volvulus of the stomach. *BMJ Case Rep*. 2014;2014:bcr2014204385.

42. Shukla RM, Mandal KC, Maitra S, et al. Gastric volvulus with partial and complete gastric necrosis. *J Indian Assoc Pediatr Surg*. 2014;19(1):49-51.

43. Hadjittofi C, Matter I, Eyal O, Slijper N. Laparoscopic repair of a late-presenting Bochdalek diaphragmatic hernia with acute gastric volvulus. *BMJ Case Rep*. 2013;2013:bcr2013008990.

44. Singleton AC. Chronic gastric volvulus. *Radiol*. 1940;34(1):53-61.

Journal of Comprehensive Surgery

Case Report

DOI: 10.51271/JOCS-0038

Atypical arachnoid cyst with progression: a case report

Ulaş Yüksel, Alemiddin Özdemir, Ahmet Melih Erdoğan, Özge Sevimoğlu

Department of Neurosurgery, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

Cite this article: Yüksel U, Özdemir A, Erdoğan AM, Sevimoğlu Ö. Atypical arachnoid cyst with progression: a case report. *J Compr Surg.* 2024;2(3):66-69.

Corresponding Author: Ahmet Melih Erdogan, ahmetmelih.erdogan76@gmail.com

Received: 19/07/2024 ◆ **Accepted**: 24/08/2024 ◆ **Published**: 27/08/2024

ABSTRACT

A 26-year-old female patient applied to the outpatient clinic in 2018 due to pain that had been present for a long time (16 years) and had recently spread from the top of the head to the nape of the neck. It was learned from the patient's anamnesis that her pain was relieved with analgesics. Although no pathological findings were found in the neurological examination, brain magnetic resonance imaging (MRI) was requested to reveal possible intracranial pathological conditions. In the MRI images taken, a cystic mass with a lobulated contour and thin septa of 24x31x40 mm and similar intensity to CSF was detected in the right parasagittal area posteriorly at the vertex level. The patient's control brain MRI images 3 months later showed no increase in cyst size. However, the patient's anamnesis, which came for a control in 2022, showed that his current complaints and headaches had increased. The MR images showed that the existing cyst had reached a size of approximately 60x35 mm. Medical treatment was initially planned for the patient (Acetazolamide, 750 mg/day). The MR taken one month later showed that there was no reduction in the cyst size and the optic discs were slightly swollen in the fundus examination. Considering the cyst growth, the patient's failure to benefit from medical treatment and the swelling noted in the optic discs, the patient was fitted with a cystoperitoneal shunt. The patient's early postoperative tomography image showed a significant reduction in the cyst (50.15x25.66) and a slightly swollen optic disc image with blurred borders was detected in the fundus examination. The patient's complaints regressed, and in the radiological images it was determined that the cyst continued to shrink [(45.8x23.19 mm) and (41.1x20.3 mm)], the shunt was in place, and she had no clinical complaints. As a result, it was argued that patients with atypically located arachnoid cysts, as in this case, should be taken under close clinical and radiological follow-up, and surgical treatment methods should definitely be considered in patients who are found to have an increase in cyst size and clinical findings during this follow-up and who do not respond despite medical treatment.

Keywords: Arachnoid cyst, cystoperitoneal shunt, papilledema

INTRODUCTION

Arachnoid cysts (ACs) are cystic dilatations that develop within the arachnoid membrane and are filled with cerebrospinal fluid (CSF).[1] Although it generally does not cause symptoms, it is often detected incidentally due to reasons such as increased access to health services and opportunities.[2,3] The most common symptom is headache. Although ACs generally do not change throughout life, examinations have demonstrated that some cysts grow. On the other hand, it has been reported that traumatic or spontaneous subdural hemorrhage may occur in patients followed with ACs.[1]

Arachnoid cysts generally do not require surgical treatment.[1,4] However, there is no clear procedure for surgical treatment to be applied to patients who are considered for surgery because of various reasons.[2,4-7]

In this case report, the clinic and treatment process of a patient with a growing arachnoid cyst are discussed with the literature.

CASE

A 26-year-old female patient applied to the outpatient clinic in 2018 due to pain that had been present for a long time (16 years) and had recently spread from the top of her head to her nape. It was learned from the patient's anamnesis that her pain was relieved with analgesics. Although no pathological findings were found in the neurological examination, brain

MRI was requested to reveal possible intracranial pathological conditions. In the MR images, a cystic mass (arachnoid cyst?) measuring 24x31x40 mm (Figure 1A) with lobulated contours and thin septa, suppressed in FLAIR and of similar intensity to CSF, was observed in the right parasagittal area posteriorly at the vertex level. The patient was recommended to be followed up in 3 months. No additional pathological findings were found in the patient's examination in 2019, and no increase in cyst size was seen in the brain MRI images. Since no increase in cyst size was detected and there was no deterioration in the neurological level, surgical intervention was not considered, and follow-up was recommended. The patient was asked to come for a check-up after one year.

There were no new pathological findings in the patient's examination in 2021. In the brain MRI images, it was seen that the cystic mass persisted, and its dimensions were 34.50x 16.66 mm. The patient was recommended to follow up again.

It was learned from the anamnesis of the patient who came for a check-up in 2022 that his current complaints increased, her headache started from the nape of her neck and spread to the top of head and then hit her eyes and was occasionally triggered by light and sound, but she did not have complaints that increased with Valsalva, and she did not have any history of seizures, syncope or new trauma. The patient also stated that there was ringing in her right ear but no hearing problem. The patient's neurological examination revealed that there was no neurological deficit, her muscle strength was normal, and there were no pathological reflexes.

The patient underwent a control brain MRI for her current complaints. The MRI images showed that the existing cyst had reached approximately 60x35 mm in size. (Figure 1B). Medical treatment was initially planned for the patient and acetazolamide (750 mg/day) was started. The patient was advised to have visual field, visual acuity and fundus examination at the ophthalmology examination department. As a result of the examination and tests performed one month later, it was seen that the cyst size continued to grow, and the optic discs were slightly swollen in the fundus examination performed by the ophthalmologist (Figure 1C, Figure 1D). Considering the growth of the cyst, the patient's failure to benefit from medical treatment, and the swelling noted in the optic discs, surgical intervention was recommended to the patient.

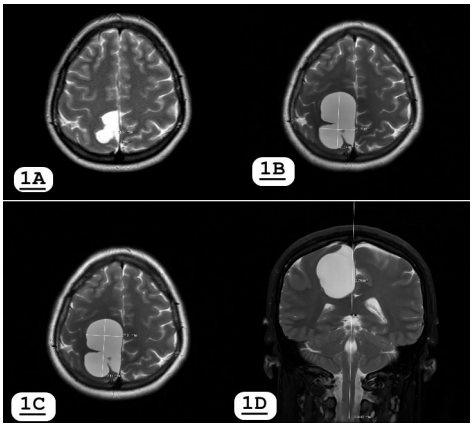


Figure 1. In the images, the arachnoid cyst image of the patient at the time of initial diagnosis (1A), the image with increased size during follow-up (1B), and the image taken after acetazolamide treatment (1C and 1D) are shown in T2-weighted MR images

The patient was placed on the operating table under general anesthesia in a supine position with the head slightly deviated to the left. Following the necessary field sterilization, the patient was covered in a sterile manner. The skin flap with the base remaining in the occipital was turned over in a C shape to the right Frazier point. One hole was opened with a high-speed drill to the Frazier point. A 3 cm skin incision was made from the right Mc Burney point. The peritoneum was seen by passing the subcutaneous layers. The peritoneal end of the shunt was advanced subcutaneously with the help of a shunt passer. The cranial end was sent to the cyst. Pressurized shunt flow was observed. The cranial end was connected to a medium-pressure dome. Subsequently, the peritoneal end was connected. Active shunt flow was observed. The catheter tip was sent into the abdomen through the previously opened peritoneal tunnel. The layers were closed in accordance with the procedure. Prophylactic antibiotic therapy was provided with 1 gram of ceftriaxone in the preoperative and postoperative processes.

No complications were observed in the patient who was hospitalized for 4 days after the operation. Postoperative tomography image of the patient revealed a significant reduction in the cyst (50.15x25.66) (Figure 2A). Fundus examination performed before discharge revealed a slightly swollen optic disc image with blurred borders. Postoperatively, the patient reported a significant reduction in headaches and improvement in blurred vision. In the patient's follow-ups, it was reported that the cyst continued to shrink (45.8x23.19 mm) and (41.1x20.3 mm) the shunt was in place, and that he had no clinical complaints (Figure 2B, Figure 2C).

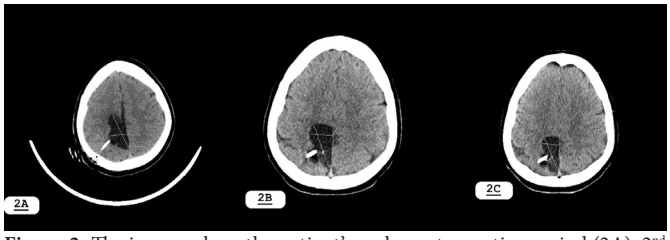


Figure 2. The images show the patient's early postoperative period (2A), 2nd month (2B) and 9th month (2C) CT images taken during clinical follow-up

DISCUSSION

Arachnoid cysts, described more than 150 years ago, are of two types: primary cysts and secondary cysts. Primary cysts occur congenitally after the division of the arachnoid membrane in the intrauterine period. Secondary cysts occur due to later factors such as trauma, infection, and surgery.[4,6] It constitutes approximately 1% of lesions causing intracranial mass and similar effects and generally occurs in the second decade of life.[8] The incidence is 1.4% [may be up to 2.6% in pediatric patients[9] and is more common in women.[6]

During pregnancy, after the 15th week of the fetus, the subarachnoid membrane is formed and then CSF is secreted. The secreted CSF contributes to the development of the network structure in the subarachnoid space and also helps the development of the arachnoid. First trapped in the ventricles, CSF later replaces the extracellular ground substance and begins to circulate freely in the subarachnoid space. As the arachnoid membrane develops, it can be trapped inside the contractions that occur. This cystic pocket is separated from the arachnoid membrane by the absence of trabecules crossing the cyst without any pathological changes in the underlying pia and cortex. All these conditions can

express the formation of ACs.[1,4,10] Briefly, the formation of this cyst may be caused by abnormal division or abnormal release of CSF.[1]

Arachnoid cysts can be located in different parts of the brain. The middle cranial fossa (MCF) is the most common location with 50% and is more common in men.[1,3,4,6,8-10] There are 3 types of cysts in MCF according to Galassi classification. Type-1 cysts are found in the anterior middle cranial fossa (MCF-A) and are asymptomatic. Type-2 cysts extend above the Sylvian fissure and are usually seen on the left. In some cases, it is seen that they can change the location of the temporal lobe. Type-3 cysts completely occupy the MCF and affect the parietal and frontal lobes along with the temporal lobe.[2,4,6] The frequency of ACs in the posterior cranial fossa (PCF) is 38%. However, ACs can also be seen in the quadrigeminal cistern, retro cerebellar area, cerebellopontine angle, and suprasellar areas, and the frequency of occurrence in these areas is approximately 10%. In some areas such as the interhemispheric fissure, ventricles, and cerebral convexities, the frequency of ACs is less.[1,3,4,6,8-10] Interhemispheric cysts were examined by Mori et al.[6] in two classes as parasagittal and midline cysts. Parasagittal cysts are unilateral; they generally do not show hydrocephalus because they are not close to the ventricle. Midline cysts are complex, multiloculated cysts. They occur with hydrocephalus. They generally show close proximity to the cyst at the level of the roof of the third ventricle. Midline cysts, unlike parasagittal cysts, may be associated with agenesis of the corpus callosum.

Many ACs do not change throughout life. However, studies have shown that some cysts grow. There are three possible reasons for growth: (a) a ball mechanism that allows CSF to enter the cyst, (b) abnormal production of CSF within the cyst, and (c) an osmotic gradient difference resulting from a high protein content within the cyst.[1,2,7,8] On the other hand, the gradient difference proposal is currently less acceptable. The reason for this is that the cyst content cannot be distinguished biochemically from CSF, the amount evacuated by shunt is generally equal to the daily CSF production, and there are publications stating that it has lost its validity and that the ball-valve mechanism is the main factor in cyst growth.[2,7] ACs usually do not cause symptoms, so they are diagnosed incidentally. In fact, they are often detected after head trauma in adults.[8,10] On the other hand, when the symptoms are examined from pediatric age group to adult, there is a wide range such as headache (66%), dizziness, nausea, vomiting, macrocephaly, hydrocephalus, papilledema, seizures, mental status changes.[2,3,6,8]

ACs are generally followed periodically, and conservative approaches are at the forefront. However, surgeons agree that patients with neural compression, persistent seizures, mass effect, focal neurologic deficits, and signs and symptoms of intracranial hypertension should be operated on.[8,10] On the other hand, researchers think that the area where the ACs are located plays an important role in the surgical treatment to be chosen and outcome of operation.[2,6] There are multiple options for surgical treatment, including craniotomy, open cyst fenestration, stereotactic cyst aspiration, endoscopic cyst fenestration, and shunt application. There is no consensus on which of these options is superior.[5,9] The main purpose of treatment is to eliminate the pressure created by the accumulated CSF and the symptoms related to it. There are publications recommending endoscopic fenestration in ACs in the suprasellar and quadrigeminal areas. There are also publications that consider endoscopic procedures to be more beneficial in terms of avoiding shunt and craniotomy complications.[7] The best results in terms of endoscopy have been reported in suprasellar cysts. Endoscopy is controversial in patients with middle fossa cysts; some authors prefer microsurgery over endoscopic surgery for cysts in this location.[6] There are studies that prioritize shunt application because of its low recurrence and complication rate, its effect on cyst reduction, and its ability to keep hydrocephalus and intracranial hypertension under control.[3,5,10] In addition, the fact that it is a relatively simple technique and that intraoperative guidance (ultrasonography and neuronavigation) can be used also makes shunt use advantageous.[8] It has also been stated that the superficiality of the cyst is an important factor in shunt preference.[2] In another study, it has been stated that shunt preference should be the first choice in elderly patients and complications are less common.[3]

Our patient was 26-years-old when diagnosed in the outpatient clinic and her gender was female. The location and structure of the cyst (frontoparietal area, multilobule) were atypical when compared to the literature. Although many arachnoid cysts are generally asymptomatic, the main complaint of the patient was headache. However, considering that the patient re-applied to the outpatient clinic with an increase in headaches, it should be considered that the patient's complaints may change during the follow-up period. During this time, the growth of the cyst observed in the radiological imaging and the increase in the patient's clinical complaints in direct proportion to this should be taken into account when evaluating the patient. However, the lack of response to the given medical treatment, failure to reduce in the cyst borders despite the medical treatment and the continuing complaints led to the consideration of the surgical option. The cyst in the patient was atypical, multiloculated, rare and growth faster which distinguishes it from other ACs. In addition, the presence of an atypical cyst is also important because it affects the clinical course of the disease, its progression and the surgical treatment to be chosen.

CONCLUSION

Although ACs are generally kept under clinical follow-up because they are asymptomatic, surgery may be performed if they grow and if signs related to increased intracranial pressure occur. The surgical method to be applied is determined by the location of the cyst and the surgeon's preference. In the case report mentioned in this article, cyst growth, increasing headache and papilledema occurred; in the surgical option, cystoperitoneal shunt was preferred and successfully applied due to the low probability of ACs recurrence, not being a high-level invasive procedure, tolerable complications and the location of the cyst which is atypical and close to the surface. Although it has been stated in previous publications that it is the first choice in the elderly patient population, its successful use in a superficial cyst in a young patient shows that the surgical option chosen for the patient is correct. This situation reveals the importance of the localization of the cyst and the surrounding anatomical structures in the treatment option. In postoperative observations, it was observed that the patient's complaints decreased, and the cyst shrank and the patient did not develop any complications.

REFERENCES

1. Martínez-Lage JF, Pérez-Espejo MA, Almagro MJ, López-Guerrero AL. Hydrocephalus and arachnoid cysts. *Childs Nerv Syst.* 2011;27(10):1643-1652. doi: 10.1007/s00381-011-1481-2
2. Masoudi M, Yousefi O, Azami P. Results of surgical treatment in patients with intracranial arachnoid cyst during last 5 years in a referral center in a developing country: Shiraz, Iran. *World Neurosurg.* 2021;150:e420-e426. doi: 10.1016/j.wneu.2021.03.038
3. Merola J, Manivannan S, Ooi S, et al. The efficacy of cystoperitoneal shunting for the surgical management of intracranial arachnoid cysts in the elderly: a systematic review of the literature. *Surg Neurol Int.* 2021;12:624. doi: 10.25259/SNI_463_2021
4. Chen Y, Fang HJ, Li ZF, et al. Treatment of middle cranial fossa arachnoid cysts: a systematic review and meta-analysis. *World Neurosurg.* 2016;92:480-490. doi: 10.1016/j.wneu.2016.06.046
5. Locatelli D, Bonfanti N, Sfogliarini R, Gajno TM, Pezzotta S. Arachnoid cysts: diagnosis and treatment. *Childs Nerv Syst.* 1987;3(2):121-124. doi: 10.1007/BF00271139
6. Mustansir F, Bashir S, Darbar A. Management of arachnoid cysts: a comprehensive review. *Cureus.* 2018;10(4):e2458. doi: 10.7759/cureus.2458
7. Shim KW, Lee YH, Park EK, Park YS, Choi JU, Kim DS. Treatment option for arachnoid cysts. *Childs Nerv Syst.* 2009;25(11):1459-1466. doi: 10.1007/s00381-009-0930-7
8. Pradilla G, Jallo G. Arachnoid cysts: case series and review of the literature. *Neurosurg Focus.* 2007;22(2):E7. doi: 10.3171/foc.2007.22.2.7
9. El Damaty A, Issa M, Paggetti F, Seitz A, Unterberg A. Intracranial arachnoid cysts: what is the appropriate surgical technique? A retrospective comparative study with 61 pediatric patients. *World Neurosurg X.* 2023;19:100195. doi: 10.1016/j.wnsx.2023.100195
10. Rogers MA, Klug GL, Siu KH. Middle fossa arachnoid cysts in association with subdural haematomas. A review and recommendations for management. *Br J Neurosurg.* 1990;4(6):497-502. doi: 10.3109/02688699008993799

Journal of Comprehensive Surgery

Letter to the Editor

DOI: 10.51271/JOCS-0039

Efficacy of thoracic sympathectomy in the treatment of hyperhidrosis and management of compensatory sweating

Mesut Buz

Department of Thoracic Surgery, Kartal Dr. Lütfi Kırdar City Hospital, İstanbul, Turkiye

Cite this article: Buz M. Efficacy of thoracic sympathectomy in the treatment of hyperhidrosis and management of compensatory sweating. *J Compr Surg.* 2024;2(3):70-71.

Corresponding Author: Mesut Buz, mesutbuzmd@gmail.com

Received: 23/07/2024 ◆ **Accepted**: 16/08/2024 ◆ **Published**: 27/08/2024

Dear Editor,

The effectiveness of thoracic sympathectomy in treating hyperhidrosis and the subsequent management of compensatory sweating (CS) warrants significant attention. Hyperhidrosis, characterized by excessive sweating, can significantly impair patients' quality of life, affecting both their personal and professional lives. Thoracic sympathectomy has proven to be a highly effective surgical intervention for this condition, although it is often associated with the side effect of CS.

Several studies have highlighted the benefits and challenges associated with thoracic sympathectomy. For instance, Yamamoto and Okada address the management of CS that occurs after endoscopic thoracic sympathectomy (ETS), a common treatment for localized hyperhidrosis. ETS generally involves resection of the sympathetic trunk or ganglia between the second and sixth ribs, but can lead to excessive sweating on the back, chest, and abdomen, known as compensatory sweating. The study utilized laser speckle flowgraphy (LSFG) to identify the sympathetic nerves associated with CS and performed ganglionectomy based on these findings. In all eight patients treated, compensatory sweating was resolved after the targeted sympathetic nerves were interrupted. The results demonstrate that CS is not a physiological response but is caused by denatured sympathetic nerves affected by ETS. With LSFG, the sympathetic nerve responsible for sweating in various body parts can be identified, making the treatment of compensatory sweating feasible.[1] This finding challenges the long-held belief that CS is untreatable and opens new avenues for managing this side effect.

Ravendran et al.[2] conducted a comprehensive review on the application of robotic sympathectomy in the treatment of hyperhidrosis, a condition marked by excessive sweating due to hyperactive sweat glands. The review systematically compared the clinical outcomes, complication rates, and inherent advantages and disadvantages of robotic sympathectomy relative to more conventional surgical approaches, such as video-assisted thoracic sympathectomy (VATS). The analysis of nine studies revealed that robotic sympathectomy not only yields outcomes comparable to those of traditional methods but also appears to mitigate the incidence of CS. This reduction in CS is likely attributable to the superior dexterity and enhanced visualization afforded by robotic systems, which enable more precise and controlled interruption of the sympathetic chain. Such precision may reduce the extent of unintended nerve damage, thereby improving the management of CS postoperatively. However, despite these potential benefits, the review highlighted significant barriers to widespread adoption, including the high costs associated with robotic systems, prolonged setup times, and the need for specialized surgical training. The authors concluded that while robotic sympathectomy holds promise, further research is required to thoroughly evaluate its long-term efficacy and broader applicability in the clinical setting.

Huang et al.[3] conducted a comparative study on the efficacy and safety of thoracoscopic T3 and T4 sympathectomy for treating primary hyperhidrosis focused on hand sweating. The study included 192 patients divided into T3 and T4 groups, each undergoing thoracoscopic bilateral sympathectomy. Results indicated that both T3 and T4 sympathectomy were effective in improving sweating symptoms. However, the incidence of CS was lower in the T4 group, particularly at the 12-month follow-up, compared to the T3 group. Additionally, patients in the T4 group reported higher satisfaction rates and lower incidences of palm dryness, although they experienced more palm moisture. This study suggests that lowering the sympathetic chain resection plane (T4) can enhance patient satisfaction and reduce long-term CS, making it a preferable approach for treating severe hand sweating.

Loizzi et al.[4] conducted a systematic review to evaluate the surgical management options for CS, a common and distressing side effect of ETS for treating primary hyperhidrosis. The review focuses on three main surgical techniques: unclipping, extended sympathectomy, and sympathetic nerve reconstruction. The study highlights that the incidence of CS can reach up to 98%, significantly

affecting patients' quality of life. The effectiveness of unclipping was variable, with satisfaction rates ranging from 25% to 89%. Extended sympathectomy, including lower levels of the sympathetic chain, showed promising results with satisfaction rates from 45% to 100%. Sympathetic nerve reconstruction, though complex and resource-intensive, also demonstrated potential, with a 72.5% satisfaction rate among patients. The review concludes that while these surgical techniques offer some relief, the outcomes are inconsistent, and there is no universally effective solution for CS. Patients should be well-informed about the potential risks and benefits of these treatments.

Hamilton et al.[5] conducted a prospective, controlled, randomized multicenter study designed to evaluate and compare the severity of CS following two surgical approaches: one-stage bilateral thoracic sympathectomy (BTS) and unilateral thoracic sympathectomy (UTS) on the dominant side for the treatment of palmar hyperhidrosis. The study enrolled 200 participants who were randomly assigned to either the BTS or UTS group. At the six-month mark, participants in the UTS group were given the option to undergo a contralateral surgery, thus forming a third group that underwent two-stage bilateral sympathectomy. The severity of sweating was assessed using the Hyperhidrosis Disease Severity Scale (HDSS), while the quality of life was measured using the HidroQOL and Horn questionnaires. Preliminary data from 96 participants indicated that both groups exhibited comparable HDSS and quality of life scores, with no statistically significant difference in the severity of CS between the groups. These findings suggest that neither UTS nor staged BTS offers a substantial advantage over one-stage BTS in reducing CS severity. The study highlights the need to explore alternative surgical strategies or adjunctive therapies to improve the management of CS in patients undergoing sympathectomy for palmar hyperhidrosis.

Keywords: Thoracic sympathectomy, hyperhidrosis, compensatory sweating

CONCLUSION

Thoracic sympathectomy is an effective treatment for hyperhidrosis, significantly improving patients' quality of life. However, managing CS remains a challenge. Recent studies have shown promising results with techniques like laser speckle flowgraphy and targeted ganglionectomy, as well as comparisons of robotic sympathectomy and different thoracic sympathectomy levels. These advancements suggest new strategies for reducing CS and enhancing patient satisfaction, though further research is needed to confirm their long-term efficacy.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Yamamoto H, Okada M. The management of compensatory sweating after thoracic sympathectomy. *J Thorac Cardiovasc Surg.* 2019;158(5):1481-1488.
2. Ravendran K, Babu B, Madouros N, Panagiotopoulos N. Robotic sympathectomy for hyperhidrosis. *Cureus.* 2023;15(1):e33885.
3. Huang L, Jiang H, Wei D, Xue Q, Ding Q, Hu R. A comparative study of thoracoscopic sympathectomy for the treatment of hand sweating. *J Thorac Dis.* 2019;11(8):3336-3340.
4. Loizzi D, Mongiello D, Bevilacqua MT, et al. Surgical management of compensatory sweating: a systematic review. *Front Surg.* 2023;10:1160827.
5. Hamilton NN, Tedde ML, Wolosker N, et al. A prospective controlled randomized multicenter study to evaluate the severity of compensatory sweating after one-stage bilateral thoracic sympathectomy versus unilateral thoracic sympathectomy in the dominant side. *Contemp Clin Trials Commun.* 2020;19:100618.