Original Article

The feasibility and safety of the brachial artery approach in the treatment of hepatic artery infusion chemotherapy: a retrospective study

Jian Xiong[1#], Yanyan Zhou[1#], Kai Tan[2#], Haofeng Liu[3,4], Yunbao Cao[1], Junde Liu[1], Wenhao Wu[1], Xilin Du[2], Zhonghua Luo[1]

[1]Department of Interventional Radiology, Tangdu Hospital, The Fourth Military Medical University, Xi'an, China; [2]Department of General Surgery, Tangdu Hospital, The Fourth Military Medical University, Xi'an, China; [3]SenseTime Joint Lab of Smart Health Care, Xidian University, Xi'an, China; [4]School of Artificial Intelligence, Xidian University, Xi'an, China

Contributions: (I) Conception and design: J Xiong, Y Zhou, K Tan; (II) Administrative support: Z Luo, X Du; (III) Provision of study materials or patients: K Tan; (IV) Collection and assembly of data: J Xiong, Y Zhou; (V) Data analysis and interpretation: J Xiong; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Zhonghua Luo, MD. Department of Interventional Radiology, Tangdu Hospital, The Fourth Military Medical University, No. 1 Xinsi Road, Baqiao District, Xi'an 710038, China. Email: llhuaxian@163.com; Xilin Du, MD. Department of General Surgery, Tangdu Hospital, The Fourth Military Medical University, No. 1 Xinsi Road, Baqiao District, Xi'an 710038, China. Email: dxlin0705@163.com.

Background: Compared to hepatic artery infusion chemotherapy (HAIC) treatment through the femoral artery (TFA), the brachial artery (TBA) is more flexible and easier for patients to accept. However, the feasibility of TBA has not been studied yet. This study aims to evaluate the feasibility and safety of HAIC via the TBA.

Methods: We retrospectively reviewed the medical records of 63 patients with primary liver cancer who were treated with HAIC via TBA. In this study, a total of 163 HAIC procedures were performed via the left brachial artery pathway, and each patient underwent an average of 2.59 procedures. One patient received 5 treatments, 18 patients received 4 treatments, 15 patients received 3 treatments, 12 patients received 2 treatments, and 17 patients received 1 treatment. The main evaluation indicators were the technical success rate and complication rate.

Results: The main technical success rate was 99.4% (162/163). No patient required conversion to the femoral artery (TFA) access. All the complications were minor and occurred in 11 patients (6.75%). Subcutaneous ecchymosis occurred in 3 (1.84%) patients, arterial thrombosis in 2 patients (1.23%), and catheter displacement in 6 patients (3.68%). No serious complications occurred.

Conclusions: TBA pathway is feasible and safe for HAIC treatment of liver cancer patients. More research is needed in the future to confirm whether TBA is superior to other pathways.

Keywords: Brachial artery access; hepatic artery infusion chemotherapy (HAIC); safety; feasibility

Submitted Jun 25, 2023. Accepted for publication Aug 18, 2023. Published online Aug 30, 2023.
doi: 10.21037/jgo-23-523
View this article at: https://dx.doi.org/10.21037/jgo-23-523

Introduction

Hepatic artery infusion chemotherapy (HAIC), an important chemotherapy method for the treatment of liver cancer, allows direct infusion of chemotherapy drugs into the tumor blood supply artery (1-10). Specifically, HAIC can play an antitumor role by increasing the local drug concentration in liver tumors. In Asian countries such as China, Japan and South Korea, HAIC is recommended as one of the standard treatment regimens for liver cancer (11-13).

In China, the commonly used regimen for HAIC treatment is oxaliplatin plus fluorouracil (FOLFOX), most of which is administered via the femoral artery (TFA) (11). The infusion typically lasts for more than 48 hours. Hemostasis is usually achieved after 6–8 hours of compression, strict bed rest is needed, and hips must not be flexed for more than 50 hours (7,14-16). Due to prolonged bed rest, patients are prone to complications such as urinary retention and lower limb vein thrombosis, which seriously affect the patients' compliance and quality of life and limits the use of TFA in HAIC treatment of liver cancer (17).

In addition to the TFA, the brachial artery (TBA) pathway plays an important role in interventional surgery. In previous studies, the incidence of TBA complications was as high as 11% (18-20). The purpose of this study was to analyze the technical success and complication rates of HAIC treatment in patients with liver cancer and evaluate the feasibility and safety of HAIC via the TBA. We present this article in accordance with the STROBE reporting checklist (available at https://jgo.amegroups.com/article/view/10.21037/jgo-23-523/rc).

Methods

Patients

Hepatic artery catheterization was performed 163 times through TBA pathway in 63 patients. The baseline characteristics and complications of the patients are shown in *Table 1*. Inclusion criteria: (I) pathological diagnosis of primary liver cancer in patients aged 18–75 years; (II) CHILD PUGH stage A or B; (III) Eastern Cooperative Oncology Group (ECOG) PS score of 0/1. Exclusion criteria: (I) severe dysfunction of the heart, liver, kidney and lung; (II) malignant tumors in other parts; (III) iodine allergy; (IV) coagulation dysfunction.

Highlight box

Key findings

- The brachial artery (TBA) pathway is feasible and safe for HAIC treatment of liver cancer patients.

What is known and what is new?

- The commonly used regimen for HAIC treatment is administered via the femoral artery (TFA), which seriously affect the patients' compliance and quality of life.
- In addition to the TFA, TBA pathway plays an important role in interventional surgery. Our study aims to evaluate the feasibility and safety of hepatic artery infusion chemotherapy (HAIC) via TBA.

What is the implication, and what should change now?

- Due to prolonged bed rest, patients are prone to complications such as urinary retention and lower limb vein thrombosis, which seriously affect the patients' compliance and quality of life and limits the use of TFA in HAIC treatment of liver cancer.

Study methods

This retrospective study was approved by the Ethics Committee of Tangdu Hospital (No. K202108-43). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and individual consent for this retrospective analysis was waived. Patients with primary liver cancer were treated with HAIC via TBA at the Intervention Center of Tangdu Hospital of The Fourth Military Medical University from January 1, 2020, to April 30, 2022. There was no embolic disease in the left brachial artery, axillary artery or subclavian artery detected by B-ultrasound before the operation. The puncture site was at the place where TBA pulsation of the left elbow joint was most obvious, 2% lidocaine was used for local infiltration anesthesia, and an 18-G puncture needle was used for blood vessel puncture.

After successful vascular puncture by using the Seldinger technique, a 5-F (Terumo, Tokyo, Japan) was placed into the celiac trunk, and a 5-F H1 catheter (Cook, Bloomington, USA) was guided into the celiac trunk for arteriography with a 0.035-inch loach guide wire (Terumo). Then, a 0.018-inch micro guide wire (ASAHI, Tokyo, Japan) was used to guide a 2.7-F micro catheter (ASAHI, Tokyo, Japan) into the tumor feeding artery. If the tumor received blood supply from both the celiac trunk and the superior mesenteric artery, the microcatheter was placed in the largest tumor blood supply artery. The peripheral end of the microcatheter was anticoagulated with heparin to prevent the catheter from clotting. The part of the catheter that was exposed outside the body was covered with sterile gauze and then fixed on the skin of the left arm with medical tape. Finally, the patient was transferred to the ward remained in bed for more than 54 hours. Chemotherapy was administered according to the FOLFOX4 protocol (the first day: oxaliplatin 85 mg/m^2 intra-arterial injection for 2 hours, calcium folinate 200 mg/m^2 intra-arterial injection for 2 hours, fluorouracil 400 mg/m^2 intra-arterial injection for 2 hours, fluorouracil 600 mg/m^2 intra-arterial injection for 22 hours; the second day: calcium folinate 200 mg/m^2 intra-arterial injection for 2 hours, fluorouracil 400 mg/m^2

Table 1 Baseline patient characteristics and comorbidities

Characteristic	Value
Gender	
Male	49
Female	14
Age (years)	55.4±11.2
Smoking	42 (66.67)
Drinking	21 (33.33)
Comorbidities	
Diabetes	9 (14.29)
Hypertension	14 (22.22)
Cerebrovascular disease	5 (7.94)
Coronary artery disease	8 (12.70)
Tumor distribution	
Left lobe	12 (19.05)
Right lobe	44 (69.84)
Caudate lobes	3 (4.76)
Multi-lobular	4 (6.35)
ECOG (PS score)	
0	42 (66.67)
1	21 (33.33)

Continuous data are expressed as mean ± standard deviation; categorical data are expressed as count (%). EOCG, Eastern Cooperative Oncology Group; PS, performance status.

Table 2 Surgical details

Statistical Items	N=163 (%)
Number of punctures (times)	
1	78 (47.9)
2	56 (34.4)
3	29 (17.8)
Puncture time (min)	10.3±2.9
Tube placement time (min)	9.9±1.8
Catheter head end position	
Left hepatic artery	24 (14.7)
Right hepatic artery	102 (62.6)
Intrinsic hepatic artery	34 (20.9)
Superior mesenteric artery	3 (1.8)
Treatment modality	
HAIC	118 (72.4)
HAIC + embolism	45 (27.6)
Number of tube placement	
1	17 (10.4)
2	12 (7.4)
3	15 (9.2)
4	18 (11.0)
5	1 (0.6)

Continuous data are expressed as mean ± standard deviation; categorical data are expressed as count (%). HAIC, hepatic artery infusion chemotherapy.

intra-arterial injection for 2 hours, fluorouracil 600 mg/m^2 intra-arterial injection for 22 hours, once every 3 weeks). The vessel sheath was sealed with 10 mL of normal saline and 0.0625 million U of heparin sodium once every 4 hours. After chemotherapy, fluoroscopy was performed under DSA to determine if the catheter was displaced. The puncture point should be locally sterilized, the puncture point should be covered with sterile dressing, the vascular sheath and catheter should be removed, the left upper arm should be pressure bandaged with the bandage loosely wound so that the radial artery pulse can be taken and the puncture point will not bleed.

End point and definition

The main outcome measures were the success and complication rates of catheterization. Successful catheterization was defined as successful catheterization via puncture of the left brachial artery, and complications were mainly defined as access- and puncture-related complications. An auxiliary femoral artery puncture was considered a failure of catheterization. Minor complications are those that do not require treatment or have no adverse consequences. Serious complications refer to those that require prolonged hospitalization, special treatment or reoperation.

Results

A total of 163 HAIC treatments were performed via the left brachial artery pathway (see *Table 2*), and each patient underwent an average of 1.65 treatments via this access point. One patient received 5 treatments, 18 patients received

Table 3 Incidence of complications

Complications	Patients, n (%)
Slight	
Subcutaneous ecchymosis	3 (1.84)
Local hematoma	0 (0.00)
Pseudoaneurysm	0 (0.00)
Arterial thrombosis	2 (1.23)
Arterial dissection	0 (0.00)
Hemorrhage	0 (0.00)
Catheter abscission	0 (0.00)
Catheter displacement	6 (3.68)
Catheter block	0 (0.00)
Serious	
Vascular occlusion	0 (0.00)
Hematoma	0 (0.00)
Pseudoaneurysm	0 (0.00)
Median nerve injury	0 (0.00)
Total	11 (6.75)

4 treatments, 15 patients received 3 treatments, 12 patients received 2 treatments, and 17 patients received 1 treatment. In 1 patient, the puncture failed but was later successful under ultrasound guidance. The main technical success rate was 99.4% (162/163). No patient required conversion to TFA access. All the complications were minor (see *Table 3*) and occurred in 11 patients (6.75%). Subcutaneous ecchymosis occurred in 3 (1.84%) patients, arterial thrombosis in 2 (1.23%) patients, and catheter displacement in 6 (3.68%) patients. No serious complications occurred.

Discussion

TBA access has been increasingly used in endovascular therapy for peripheral vascular disease, aortic disease, and cardiac disease (21-23). In a part of the study, the brachial access was considered to be a complement to the femoral access, and the brachial access was chosen only when the femoral access failed. In this study, we chose the brachial access in all the patients and then chose the femoral access if the first puncture attempt was unsuccessful.

TBA is better than TFA due its superficial anatomical location and large diameter (3.93±0.49 mm) (24), which allows for an extremely high technical success rate (95–100%) and excellent access for vascular interventions (25). In an analysis of 265 procedures performed through the brachial access, Franz *et al.* showed a high technical success rate of 98.9% (26). The technical success rate in this study was approximately 100%, with only one case of difficult puncture of TBA, which was ultimately successful under ultrasound guidance. The brachial access is the preferred access for HAIC.

TBA is the most prominent artery in the forearm, and serious consequences can occur if TBA is occluded. Therefore, it has been suggested that although the complication rate of accessing TBA is low, complications are often serious and even require surgery or rehospitalization for intervention (25). More than 30 years ago, a study of 225 brachial artery access placement in 157 patients who underwent perfusion chemotherapy was performed, and the median placement time was 68 days, 52 (23%) root catheters were removed due to complications, and the rate of placement complications was high (27). In the present study, the complication rate was 6.75%, all of which were minor complications, and no cases required surgery or an extended hospital stay. This is strongly related to the advances in materials and the puncture placement technique and the shortening of the placement time.

There is a strong relationship between the size of the vascular sheath and the complication rate (21). In a review of 157 transbrachial procedures, Madden *et al.* (28) found that the complication rates were 5.4% (2/37), 12.4% (11/89), and 12.5% (2/16) for vascular sheaths that were size 5, 6, and 7 F, respectively. A 5-F vascular sheath was chosen for most of the placements in this study, which may be one of the reasons for the low complication rate.

TBA is close to the median nerve, so interventions via TBA may cause a hematoma or pseudoaneurysm to compress the median nerve, resulting in patient discomfort or disability. Median nerve injuries were observed in the studies by Stavroulakis *et al.* (29) and Treitl *et al.* (21). A nerve ultrasound is important in the diagnosis of these patients (30). To avoid causing injury to the median nerve, some vascular surgeons prefer brachial artery dissection (31-33). In the present study, no median nerve injury or compression symptoms were observed, which may have been related to the fact that we tried to perform the puncture operation at a more distant pulsation point of TBA. The exact method of achieving hemostasis with compression also plays a great role.

A stroke or transient ischemic attack used to be a serious complication of the transbrachial access, thus limiting the use of the brachial access in interventional procedures (26,27,32). Hamon *et al.* (34) used MRI to observe the occurrence of cerebral microthrombosis after transradial coronary cannulation. Cerebral complications may be related to the manipulation of the guidewire or catheter as it passes through the aortic arch. In this study, there were no encephalitic complications, and we tried to avoid manipulation of the aortic arch to reduce the risk of microthrombosis during treatment.

Catheter displacement is a noteworthy problem that occurs during HAIC and may affect the outcome. Catheter displacement was observed in 3.68% of patients in this study. This was closely related to the patients' substantial shoulder joint movement. Extensive joint movement may cause the microcatheter to exit the target vessel. To reduce the risk of catheter displacement, the left upper arm can be attached to the chest wall and secured with a bandage to limit substantial shoulder joint motion.

A preliminary exploration of how many HAIC procedures can be tolerated via TBA access was performed. In this study, one patient underwent five HAIC procedures, 18 patients underwent four HAIC procedures, and 15 patients underwent more than three HAIC procedures without serious complications. It is probably safe to perform 3 to 4 HAIC treatments via TBA access.

Perfusion chemotherapy via the hepatic artery access is worth noting. In one patient, the chemotherapy drugs that were infused via the vascular sheath entered the circulation via TBA, causing temporary vascular irritation in the left upper arm and contracture of the left arm and resulting in the inability to straighten it. After rehabilitation exercises, the left arm function was largely restored to normal after 1 month. The team performing HAIC requires specialized training to avoid such events and reduce the incidence of adverse events.

This study was retrospective and may have led to reporting bias. Patients were routinely screened via preoperative ultrasound, which may have resulted in a higher success rate. A randomized controlled trial is needed to further analyze whether TBA is superior to other access points.

Conclusions

In conclusion, brachial artery access is feasible and safe in HAIC for patients with hepatocellular carcinoma. More studies are needed in the future to confirm whether TBA is superior to other accesses.

Acknowledgments

Funding: This study was supported by Scientific Innovation and Development Project of Tangdu Hospital (Grant No. 2021TYJC-004) and is partially supported by the SenseTime Joint Lab of Smart Health Care, Xidian University (Grant No. A202201).

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jgo.amegroups.com/article/view/10.21037/jgo-23-523/rc

Data Sharing Statement: Available at https://jgo.amegroups.com/article/view/10.21037/jgo-23-523/dss

Peer Review File: Available at https://jgo.amegroups.com/article/view/10.21037/jgo-23-523/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jgo.amegroups.com/article/view/10.21037/jgo-23-523/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This retrospective study was approved by the Ethics Committee of Tangdu Hospital (No. K202108-43). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and individual consent for this retrospective analysis was waived.

References

1. Yan L, Lin J, Ke K, et al. A meta-analysis comparing hepatic arterial infusion chemotherapy and sorafenib for

advanced hepatocellular carcinoma. Transl Cancer Res 2022;11:99-112.
2. Wang T, Dong J, Zhang Y, et al. Efficacy and safety of hepatic artery infusion chemotherapy with mFOLFOX in primary liver cancer patients with hyperbilirubinemia and ineffective drainage: a retrospective cohort study. Ann Transl Med 2022;10:411.
3. Ogasawara S, Kanogawa N, Kato N. How we use hepatic arterial infusion chemotherapy in the new era of systemic therapy? Hepatobiliary Surg Nutr 2022;11:775-8.
4. Kudo M, Ueshima K, Yokosuka O, et al. Sorafenib plus low-dose cisplatin and fluorouracil hepatic arterial infusion chemotherapy versus sorafenib alone in patients with advanced hepatocellular carcinoma (SILIUS): a randomised, open label, phase 3 trial. Lancet Gastroenterol Hepatol 2018;3:424-32.
5. Lyu N, Kong Y, Mu L, et al. Hepatic arterial infusion of oxaliplatin plus fluorouracil/leucovorin vs. sorafenib for advanced hepatocellular carcinoma. J Hepatol 2018;69:60-9.
6. Lyu N, Lin Y, Kong Y, et al. FOXAI: a phase II trial evaluating the efficacy and safety of hepatic arterial infusion of oxaliplatin plus fluorouracil/leucovorin for advanced hepatocellular carcinoma. Gut 2018;67:395-6.
7. Liu J, Zhang J, Wang Y, et al. HAIC versus TACE for patients with unresectable hepatocellular carcinoma: A systematic review and meta-analysis. Medicine (Baltimore) 2022;101:e32390.
8. Kondo M, Morimoto M, Kobayashi S, et al. Randomized, phase II trial of sequential hepatic arterial infusion chemotherapy and sorafenib versus sorafenib alone as initial therapy for advanced hepatocellular carcinoma: SCOOP-2 trial. BMC Cancer 2019;19:954.
9. Abdelmaksoud AHK, Abdelaziz AO, Nabeel MM, et al. Hepatic arterial infusion chemotherapy in the treatment of advanced hepatocellular carcinoma with portal vein thrombosis: a case-control study. Clin Radiol 2021;76:709.e1-6.
10. He MK, Liang RB, Zhao Y, et al. Lenvatinib, toripalimab, plus hepatic arterial infusion chemotherapy versus lenvatinib alone for advanced hepatocellular carcinoma. Ther Adv Med Oncol 2021;13:17588359211002720.
11. Zhou J, Sun H, Wang Z, et al. Guidelines for the Diagnosis and Treatment of Hepatocellular Carcinoma (2019 Edition). Liver Cancer 2020;9:682-720.
12. Kudo M, Kawamura Y, Hasegawa K, et al. Management of Hepatocellular Carcinoma in Japan: JSH Consensus Statements and Recommendations 2021 Update. Liver Cancer 2021;10:181-223.
13. 2022 KLCA-NCC Korea practice guidelines for the management of hepatocellular carcinoma. Clin Mol Hepatol 2022;28:583-705.
14. Lyu N, Wang X, Li JB, et al. Arterial Chemotherapy of Oxaliplatin Plus Fluorouracil Versus Sorafenib in Advanced Hepatocellular Carcinoma: A Biomolecular Exploratory, Randomized, Phase III Trial (FOHAIC-1). J Clin Oncol 2022;40:468-80.
15. Li QJ, He MK, Chen HW, et al. Hepatic Arterial Infusion of Oxaliplatin, Fluorouracil, and Leucovorin Versus Transarterial Chemoembolization for Large Hepatocellular Carcinoma: A Randomized Phase III Trial. J Clin Oncol 2022;40:150-60.
16. Chen S, Zhang K, Liu W, et al. Hepatic arterial infusion of oxaliplatin plus raltitrexed in patients with intermediate and advanced stage hepatocellular carcinoma: A phase II, single-arm, prospective study. Eur J Cancer 2020;134:90-8.
17. Chen YY, Liu P, Wu YS, et al. Transradial vs transfemoral access in patients with hepatic malignancy and undergoing hepatic interventions: A systematic review and meta-analysis. Medicine (Baltimore) 2018;97:e13926.
18. Watkinson AF, Hartnell GG. Complications of direct brachial artery puncture for arteriography: a comparison of techniques. Clin Radiol 1991;44:189-91.
19. Grollman JH Jr, Marcus R. Transbrachial arteriography: techniques and complications. Cardiovasc Intervent Radiol 1988;11:32-5.
20. Heenan SD, Grubnic S, Buckenham TM, et al. Transbrachial arteriography: indications and complications. Clin Radiol 1996;51:205-9.
21. Treitl KM, König C, Reiser MF, et al. Complications of transbrachial arterial access for peripheral endovascular interventions. J Endovasc Ther 2015;22:63-70.
22. Knowles M, Nation DA, Timaran DE, et al. Upper extremity access for fenestrated endovascular aortic aneurysm repair is not associated with increased morbidity. J Vasc Surg 2015;61:80-7.
23. Armstrong PJ, Han DC, Baxter JA, et al. Complication rates of percutaneous brachial artery access in peripheral vascular angiography. Ann Vasc Surg 2003;17:107-10.
24. Alvarez-Tostado JA, Moise MA, Bena JF, et al. The brachial artery: a critical access for endovascular procedures. J Vasc Surg 2009;49:378-85; discussion 385.
25. Kaluski E, Shah A, Bianco M. Brachial artery access: Easy way in…..But cautious way out. Cardiovasc Revasc Med 2020;21:1274-5.
26. Franz RW, Tanga CF, Herrmann JW. Treatment of peripheral arterial disease via percutaneous brachial artery

access. J Vasc Surg 2017;66:461-5.
27. Moran A, Ramos LF, Picado O, et al. Hepatocellular carcinoma: resection with adjuvant hepatic artery infusion therapy vs resection alone. A systematic review and meta-analysis. J Surg Oncol 2019;119:455-63.
28. Madden NJ, Calligaro KD, Zheng H, et al. Outcomes of Brachial Artery Access for Endovascular Interventions. Ann Vasc Surg 2019;56:81-6.
29. Stavroulakis K, Usai MV, Torsello G, et al. Efficacy and Safety of Transbrachial Access for Iliac Endovascular Interventions. J Endovasc Ther 2016;23:454-60.
30. Walker FO, Cartwright MS, Alter KE, et al. Indications for neuromuscular ultrasound: Expert opinion and review of the literature. Clin Neurophysiol 2018;129:2658-79.
31. Obi S, Sato S, Kawai T. Current Status of Hepatic Arterial Infusion Chemotherapy. Liver Cancer 2015;4:188-99.
32. Mirza AK, Oderich GS, Sandri GA, et al. Outcomes of upper extremity access during fenestrated-branched endovascular aortic repair. J Vasc Surg 2019;69:635-43.
33. Kret MR, Dalman RL, Kalish J, et al. Arterial cutdown reduces complications after brachial access for peripheral vascular intervention. J Vasc Surg 2016;64:149-54.
34. Hamon M, Lipiecki J, Carrié D, et al. Silent cerebral infarcts after cardiac catheterization: a randomized comparison of radial and femoral approaches. Am Heart J 2012;164:449-454.e1.

Cite this article as: Xiong J, Zhou Y, Tan K, Liu H, Cao Y, Liu J, Wu W, Du X, Luo Z. The feasibility and safety of the brachial artery approach in the treatment of hepatic artery infusion chemotherapy: a retrospective study. J Gastrointest Oncol 2023;14(4):1830-1836. doi: 10.21037/jgo-23-523

