Percutaneous Transluminal Stenting for Superior Vena Cava Syndrome Caused by Malignant Tumors: A Single Center Retrospective Study

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Research article

Keywords: tumor, superior vena cava syndrome, angiography, stent, retrospective analysis

DOI: https://doi.org/10.21203/rs.3.rs-96027/v1

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Abstract

Objectives To evaluate the efficacy of percutaneous stent placement in the treatment of superior vena cava syndrome caused by malignant tumors.

Methods To retrospectively analyze the clinical data of 32 patients with superior vena cava syndrome who underwent percutaneous endovascular stent treatment in our department from 2015 to 2019 due to malignant tumors, and summarize the patient’s gender, age, tumor type, endovascular treatment plan, complications and postoperative follow-up.

Results All patients successfully underwent percutaneous intraluminal stent placement with digital subtraction angiography (DSA). Thirty seven endovascular stents were implanted in 32 patients, including 21 Eluminexx stents, 12 Wallstent stents, and 4 covered stents. The technical success rate was 100%, and there were no serious surgery-related complications. The remission rate of clinical symptoms was 53.1% (17 / 32) in 24 hours and 84.4% (27 / 32) in 48 hours. The follow-up period was 1.5-24 months, with an average follow-up period of 6.5 months. During the follow-up, 3 patients had restenosis and 1 patient had secondary thrombosis in the stent. The symptoms were relieved after the second treatment.

Conclusion: For superior vena cava syndrome caused by malignant tumors, percutaneous endoluminal stent therapy can quickly and effectively relieve the clinical symptoms of patients, and the incidence of complications is low. It should be used as a first-line treatment.

Background

The superior vena cava syndrome (SVCS) is a disease in which the superior vena cava and its main branches are completely or incompletely blocked, resulting in obstruction of the blood return of the superior vena cava system, and the formation of collateral circulation as the main pathological feature. SVCS can be secondary to exogenous compression, central venous catheter thrombosis, upper limb arteriovenous fistula, infection or fibrosis after radiotherapy, etc. [1]. The most common cause is exogenous compression of malignant tumors or invasion of bronchial lung cancer[2]. The main symptoms of SVCS are wheezing, dysphagia, swelling, venous dilatation in the head and upper body, and some of them may cause brain edema, which may lead to nervous system related symptoms [3, 4].

SVCS caused by malignant tumor is mainly to actively treat the primary disease and restore the blood flow of superior vena cava as soon as possible to relieve clinical symptoms. Palliative treatment is the most suitable for such patients. Maurizi et al. reported the use of en bloc resection and conduit reconstruction to treat malignant thymoma invading the superior vena cava; The study by Sato et al. showed that it is feasible to perform superior vena cava resection after radiotherapy for patients with non-small cell lung cancer, but complications such as empyema, bronchial fistula, and superior vena cava reocclusion also occurred [5, 6]. In the past, it was believed that the main cause of the superior vena cava syndrome caused by tumor was tumor compression. Hinton et al. reported a case of non-small cell lung
cancer patient who received chemotherapy and the tumor was reduced by more than 50%, but the superior vena cava stenosis was not relieved [7]. Lanciego recommends Wallstent endoprostheses as the first choice for palliative treatment of superior vena cava syndrome [8]. In this study, we retrospectively analyzed the case data of patients with malignant superior vena cava obstruction who underwent stent placement in our hospital to verify its effectiveness, safety and efficacy.

**Methods**

**Patient selection**

Retrospective analysis of the data of 32 patients with superior vena cava syndrome who underwent percutaneous endovascular stenting in the First Affiliated Hospital of Zhengzhou University from 2015 to 2019, including the general information of the patient, the primary disease, the surgical indications, and the surgical status, Postoperative efficacy, complications and follow-up. The general conditions of the patients are shown in Table 1. All included patients had malignant tumors confirmed by pathology, including lung cancer, esophageal cancer, lymphoma, thymoma and mediastinal metastasis. This study was approved by the Ethical Review Committee of the First Affiliated Hospital of Zhengzhou University. All biological samples and images were obtained with the patient's written informed consent.

**Interventional therapy**

Before the operation, blood routine, coagulation function, blood and urine biochemical tests were completed, and the superior vena cava vessels were reconstructed by chest computed tomography angiography to evaluate the location, scope and degree of superior vena cava stenosis. Evaluate the patient's general condition, vital signs and surgical indications, and formulate a surgical plan.

The DSA instrument used during the operation was Siemens Artis Zeего, Germany, and the parameters of the high-pressure syringe were set to flow rate 8 ml/s, flow rate 20 ml, and pressure 300psi. All operations were performed under local anesthesia. Venous access was established first and then electrocardiographic monitor was connected. The right femoral vein approach was usually used. After successful puncture, the vascular sheath is inserted. The super-smooth guide wire and catheter are matched to the proximal end of the superior vena cava stenosis, and superior vena cava angiography is performed to determine the length of the superior vena cava disease, the degree of stenosis, the speed of blood flow, the diameter of normal blood vessels, and whether there is collateral circulation. When the superior vena cava is completely occluded, catheter and guide wire should be used to open the occluded part bluntly or sharply. After excluding the contraindications for stent placement and confirming the position by angiography, the intravascular stent is placed. Single stent placement: introduce the stent along the stiffened guide wire to cross the lesion, and the two ends protrude about 1 ~ 2 cm into the normal lumen. After the positioning is accurate, it will be released. After the stent is placed, review the angiography to confirm the stent position, stent deployment, and stenosis recovery and blood flow through. If the stent expands poorly, a balloon dilatation catheter needs to be introduced to expand the poorly expanded area. "Y"-shaped double stent placement: first release the stent in the brachiocephalic
vein on one side, then select the guide wire through the stent mesh to the other brachiocephalic vein, introduce a balloon dilatation catheter to narrow the stent mesh and brachiocephalic vein expand, introduce another stent through the stiffened guide wire, pass through the stent mesh, adjust the position and release, and expand the stent connection again if necessary. The patients were treated with antiplatelet drugs after operation, and the bleeding was closely observed.

Table 1
General Information of Patients

| Characteristic                                      | Value                          |
|-----------------------------------------------------|-------------------------------|
| Age (years)                                         | 57 ± 12.3(29–80)              |
| Sex                                                 |                               |
| Male                                                | 25                            |
| Female                                              | 7                             |
| Causes of SVC syndrome                              |                               |
| Lung cancer                                         | 21                            |
| Esophageal cancer                                   | 5                             |
| Lymphoma                                            | 3                             |
| Mediastinal metastases                              | 1                             |
| Thymoma                                             | 2                             |
| Stenosis                                            |                               |
| Superior vena cava stenosis                         | 19                            |
| Superior vena cava occlusion                        | 6                             |
| Superior vena cava + brachiocephalic vein stenosis  | 7                             |
| Preoperative ECOG score                             |                               |
| 0                                                   | 3                             |
| 1                                                   | 7                             |
| 2                                                   | 19                            |
| 3                                                   | 3                             |
| 4                                                   | 0                             |
| 5                                                   | 0                             |

ECOG: performance status made by Eastern Cooperative Oncology Group
Results

In this study, 32 patients were successfully completed percutaneous transluminal stent implantation, the technical success rate was 100%. Most patients (29 cases) used the right femoral vein approach, 2 patients used the right subclavian vein approach, 1 patient used the right femoral vein combined with the right basilic vein two-way approach. 16 patients only underwent stent implantation, 15 patients underwent stent implantation combined with balloon dilation (Fig. 1), and 1 patient was implanted stent after thrombus aspiration. Two stents were implanted in 5 patients, 2 of them were covered stents combined with bare metal stents, while the other 2 patients were treated with stent drilling mesh technique, showing "Y" release, taking into account the superior vena cava and brachiocephalic vein (Fig. 2). A total of 37 stents were used, including 21 eluminexx stents, 12 Wallstent stents and 4 covered stents. The length of stents ranged from 4 cm to 12 cm and the diameter ranged from 12 mm to 22 mm (Table 2).
| Variable                        | Value |
|--------------------------------|-------|
| Stent type                     |       |
| ELuminexx                      | 21    |
| Wallstent                      | 12    |
| Covered stent                  | 4     |
| Stent number                   |       |
| 1                              | 27    |
| 2                              | 5     |
| Stent length (mm)              |       |
| 40                             | 3     |
| 60                             | 7     |
| 70                             | 2     |
| 80                             | 8     |
| 90                             | 8     |
| 100                            | 5     |
| 120                            | 4     |
| Stent diameter (mm)            |       |
| 12                             | 3     |
| 14                             | 24    |
| 16                             | 7     |
| 18                             | 1     |
| 22                             | 2     |
| Whether combined with balloon expansion |   |
| Yes                            | 15    |
| No                             | 17    |

The clinical symptom relief rate at 24 hours after operation was 53.1% (17/32); the clinical symptom relief rate at 48 hours was 84.4% (27/32). One patient had low back pain and one patient had right upper limb and shoulder pain. After symptomatic treatment, the pain gradually disappeared after 3–5 days.
Postoperative follow-up: the follow-up time was 1.5–24 months, with an average of 6.5 months. Symptoms recurred in 4 patients at 2.5, 6, 8.5 and 16 months, respectively. After stent implantation in 3 patients, the stenosis was relieved (Fig. 3); 1 patient underwent balloon dilation and catheter thrombolysis, and the symptoms improved 3 days after thrombolysis. The patency rates of stents were 91.7%, 80.2% and 64.2% respectively at 3, 6 and 12 months after operation. The patency time curve of stent is shown in Fig. 4.

Discussion

Superior vena cava syndrome often occurs in malignant diseases, especially bronchial cancer, lymphoma and metastatic tumor [9]. Reconstruction of the superior vena cava and bypass grafting can be used as adjuvant treatments for malignant superior vena cava syndrome. However, due to the large trauma, the high risk of anesthesia, and the general inability of patients to tolerate it, they have been rarely used [10, 11]. At present, medical radiotherapy and chemotherapy are still the main treatment options for patients with tumors combined with superior vena cava syndrome, because they can treat the primary tumor, reduce the lesion area and reduce the compression of the superior vena cava, thereby alleviating the patient’s clinical symptoms. In recent years, the treatment of malignant superior vena cava obstruction by stent placement has been frequently reported. Kuo et al. pointed out that stent placement should be used as the first-line treatment for malignant superior vena cava obstruction, rather than reserved for rescue treatment after radiotherapy or chemotherapy [12]. Wei et al. believe that although stents combined with targeted drugs as secondary SVCS treatment for lung cancer cannot prolong the survival of patients, they can benefit patients [13]. In this study, the success rate of stent implantation technology was 100%, and all patients' clinical symptoms were significantly relieved after surgery, which is similar to the results reported by Mokry, Maleux and Fagedet [14, 15, 16].

In this study, we observed that the restenosis of the superior vena cava in patients with Wallstent stent (3/12) was higher than that in the ELuminexx stent group (2/18). There is no research showing that two stents are effective in the treatment of superior vena cava syndrome. The advantages and disadvantages of the Wallstent stent, we believe that it may be related to the Wallstent stent wire is thinner and the mesh is large, which may easily lead to endothelialization of the stent, and its supporting force is relatively weak, which is also one of the reasons that easily cause restenosis. Gwon et al. found that the cumulative stent patency rate of the covered stent group was significantly higher than that of the non-covered stent group, but there was no significant difference in the survival rate between the covered stent group and the non-covered stent group [17]. In this study, 2 patients underwent stent graft implantation, and there were no complications related to stent implantation. However, stent graft placement may block collateral circulation, and the risk of stent displacement is higher and the cost is higher. Therefore, we believe that the clinical use should be carefully selected according to the disease.

Regarding the choice of puncture approach, puncturing the right femoral vein is more common. Because of its simple and convenient puncture, the angle from the femoral vein to the bilateral brachiocephalic vein is small, and it is easy to selectively intubate or open the superior vena cava. For those who have
difficulty in opening the superior vena cava or whose lesions simultaneously involve the subclavian vein and internal jugular vein on the same side, the upper limb vein combined with the femoral vein two-way approach should be adopted to improve the efficiency of opening. For patients with indwelling central venous access, there is no need to re-puncture without affecting subsequent operations. In this study, 1 patient had lesions involving the right subclavian and right internal jugular vein, and the two-way approach was adopted for the right main vein and the right femoral vein to successfully open the occluded blood vessel; 2 patients were under the right subclavian CVC (Central venous catheter) was placed in the vein, so we did not choose to re-puncture the femoral vein.

Related literature reports that intravascular stent placement treatment has complications such as stent displacement, secondary thrombosis in the stent, restenosis, pulmonary thromboembolism, acute right heart insufficiency, and superior vena cava rupture, with an average incidence of 3.2% To 7.8% [18, 19]. Usually superior vena cava restenosis is the most important complication, because tumor progression will increase the compression of the superior vena cava, and even grow into the cavity through the stent network. Takahara et al. believe that even in patients with poor general conditions, additional superior vena cava stent placement is an option for the treatment of restenosis [20]. For patients with recurrent stenosis after stent placement, interventional therapy can be performed again, balloon dilation of the stenosis segment or another placement of a stent to restore brachiocephalic venous return. For tumorous lesions, reinsertion of a stent can achieve a longer-term patency rate and better clinical efficacy than balloon dilatation. Another common complication of stent placement is secondary thrombosis in the stent. Therefore, patients in our center routinely use anticoagulant drugs after stent placement. For patients with acute thrombosis in stents, balloon dilation and indwelling catheter thrombolytic therapy can also achieve better results. Under normal circumstances, there is no need to re-stent. Fagedet et al. found that stents with a diameter of more than 16 mm are more likely to cause thrombosis in the stent [16]. At the same time, small stent diameter, long stent length, and superior vena cava endothelial injury are high-risk factors for superior vena cava restenosis. In this study, most patients use stents with a diameter of 16 mm or less (34/37), with low complications and no serious complications related to surgery.

Although stent placement can effectively alleviate related symptoms caused by superior vena cava obstruction, follow-up treatment for the primary cause cannot be ignored. In this study, all patients received anti-tumor therapy after stent placement. After stent placement, combined with active anti-tumor therapy, such as radiotherapy, chemotherapy and molecular targeted drugs, is a more appropriate choice.

This study has certain limitations. First of all, this is a retrospective study with a limited number of cases. Secondly, due to the poor prognosis of malignant tumors, the follow-up time is limited, and the long-term patency rate is unknown. Further randomized controlled experiments are needed to confirm this conclusion.

**Conclusion**
In a word, percutaneous transluminal stent implantation can quickly and effectively relieve the clinical symptoms of patients with superior vena cava syndrome caused by malignant tumor, and the incidence of complications is low, so it should be used as the first-line treatment.

**Abbreviations**

DSA
Digital subtraction angiography; SVCS:Superior vena cava syndrome; CVC:Central venous catheter

**Declarations**

**Acknowledgements**

Not applicable.

**Authors’ contributions**

LH, LY and HX were responsible for the conception and design of the study. LH, WY and ZP were responsible for data collection and analysis. All authors read and approved the final version of the manuscript.

**Funding**

Not applicable.

**Availability of data and materials**

The datasets used are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

This study was conducted with approval from the Ethics Committee of The First Affiliated Hospital of Zhengzhou University.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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