Abstract

Background: Portal vein (PV) stenosis is sometimes seen in pediatric living donor liver transplantation (LDLT). PV stents have been attempted in adults with persistent stenosis. However, long-term usefulness of PV stenting is unknown because stents do not expand with growth. We investigated the effect and long-term outcome of PV stenting for stenosis after pediatric LDLT.

Methods: Patients aged <18 years who underwent LDLT from 1998 to 2020 and who underwent PV stenting for stenosis were included. Age at procedure, stent complications, and long-term outcomes were assessed.

Results: Five patients underwent PV stent placement. The median age at LDLT was 10 years (range 0.8–18.1 years). The median interval between LDLT and stent placement was 25 months. The median age at stent placement was 16 years (range 3–20 years). The median body weight was 38 kg (range 13–63 kg). The median stent diameter was 8 mm. The median observation period after stent placement was 8 years. On average, body weight increased 1.6 times. One complication associated with stent placement was PV thrombosis, which resulted in stent failure, but no portal hypertension was observed. In the other 4 patients, the stent has remained functioning and there was no clinical evidence of portal hypertension.

Conclusions: PV stents are effective for intractable PV stenosis in children. PV stents were

successfully placed in children as young as 3 years old and weighing 13 kg. Our data suggested that a stent placed in young children does not cause portal hypertension as patients grow.

Long-term outcome of portal vein stenting after pediatric living donor liver transplantation

Introduction

Portal vein (PV) stenosis is sometimes seen in patients after pediatric living donor liver transplantation (LDLT). The rate of PV stenosis after adult deceased donor transplantation has been reported [1-3]. However, the rate of PV stenosis in patients who underwent pediatric LDLT can be higher than in adult patients who underwent deceased donor liver transplantation [4, 5].

PV stenosis may result in graft failure. Treatments for PV stenosis after liver transplantation include surgical treatment and radiological intervention, including percutaneous balloon dilation and stent placement [6]. However, surgical treatment is more invasive and difficult. Therefore, PV stenosis has been treated with percutaneous balloon dilation and stent placement, like hepatic artery stenosis [7-9]. PV stenting has been attempted in adults for persistent stenosis. However, long-term usefulness of PV stenting is unknown because the stent does not expand with growth. Therefore, we investigated the effect and long-term outcome of PV stents for stenosis after pediatric LDLT.

Methods

Patients under 18 years of age who underwent LDLT between 1998 and 2020 at our

institution and who underwent stenting for PV stenosis were included in the study. Patients received a standard tacrolimus formulation with a steroid taper. PV flow after LDLT was followed with routine doppler ultrasound (DUS). When PV stenosis was suspected, computed tomography (CT) was performed.

All procedures were performed under general anesthesia by an experienced interventional radiologist. A typical procedure is described below. Under sonographic guidance, a 19-gauge percutaneous transhepatic cholangial drainage needle was used to puncture the peripheral branches of the PV. Next, a 4-Fr angio sheath was advanced over a 0.035-inch guidewire using the Seldinger technique. A vascular self-expandable metallic wall stent (7-10mm with viable length; Cook Medical, Bloomington, IN, USA) was deployed after balloon dilatation with a balloon catheter. This approach could be performed in the operating room or the interventional radiology suite.

An oral antiplatelet drug (dipyridamole 5 mg/kg/day) was administered after stent placement and maintained for 1 year. A continuous infusion of heparin (1000 IU/h) was given with activated partial thromboplastin time maintained at approximately 1.5 times above the upper limit of normal range until warfarinization. Warfarin therapy aimed to keep prothrombin time at twice the upper limit of normal range. Stent patency was measured with DUS just after stent placement and annually thereafter.

Patients' medical records were reviewed retrospectively to collect the following data: procedure type, age at procedure, stent complications, clinical improvement, stenosis recurrence, and long-term outcomes. Data are expressed as median with range.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki Congress and the Istanbul declaration regarding donor source regarding donor source. Donors must not be from prisoners, or from those individuals who are coerced or paid.

Results

Five patients had a PV stent placed. The median age at LDLT was 10 years (range 0.8–18.1 years). The original diseases were biliary atresia (n=5) and auto immune hepatitis (n=1). The median interval between LDLT and stent placement was 25 months (range 9–41 months). The median age at stent placement was 16 years (range 3–20 years). The median body weight was 38 kg (range 13–63 kg). The median stent diameter was 8 mm (range 7–10 mm).

Anticoagulation was administered for 3 months after stent placement and then discontinued for all patients. No patient experienced any complication with anticoagulation therapy such as bleeding. PV flow was followed with DUS according to patient development.

The median observation period after stent placement was 8 years (range 7–14 years). On average, body weight increased 1.6 times (range 1.0–3.0 times). However no re balloon dilation was not required after PV stenting. One complication associated with stent placement was PV thrombosis, which resulted in stent failure, but portal hypertension was not observed. In the other 4 patients, the stent remained functional and there was no clinical evidence of portal hypertension. A summary of the patients is provided in Table 1.

A typical case is shown in Fig 1. Patient 3 underwent percutaneous balloon angioplasty for PV stenosis. At 12 days after balloon dilation, PV flow was undetectable with DUS and CT. Percutaneous angioplasty and PV stent placement (8 mm in dimeter and 60 mm in length) were performed. The stent remained patent 8 years after stent placement.

Discussion

PV stenosis can result in portal hypertension, eventually leading to splenomegaly or gastrointestinal bleeding without treatment. PV stent placement has been used to treat PV stenosis. Good results have been reported in adult liver transplantation [10, 11]. In recent years, PV stent placement has generally been accepted as an effective procedure for treating PV stenosis associated with pediatric liver transplantation [7, 12, 13].

However, the timing of stent placement is controversial. In general, primary stent

placement should be avoided in pediatric PV stenosis because a metallic stent is not expandable, which might cause relative PV stenosis with patient development. Other problems associated with pediatric PV stent placement should also be considered. Anastomosis at re-transplantation might be difficult because stent placement might interfere with PV anastomosis. Complications after stent placement, such as stent migration and stent thrombosis, might occur. Such complications result in PV thrombosis, which worsens PV stenosis. Therefore, in our program, stent placement has been performed for patients who do not respond to repeated balloon dilation or patients who had PV thrombosis after balloon dilation (Patient 3).

The long-term patency of metallic stents is unknown. Carnevale et al [14] stated that no recurrent PV stenosis was seen after stent placement in pediatric patients. Some studies have reported the efficacy of stent placement in small children with long term follow-up [12, 13, 15]. Among our patients, PV stent placement was possible for children aged 3 years and weighing 13 kg. To date, a stent placed in a young child weighing 20 kg or less has not caused portal hypertension.

There is no agreement on the optimal size of the stent to be inserted because the PV graft might grow. Yeh et al reported that stent diameter after pediatric liver transplantation increased with time [16]. Stent growth might be caused by the ability of self-expandable stents

to adjust to the PV with patient development, as observed in vessels with coronary and peripheral arterial stents [17, 18]. The advantage of using stents whose diameters are as large as possible has been recognized. Indeed, Choi et al reported that using a relatively large stent for pediatric patients would contribute to long-term stent patency and preventing stent migration [19]. Similarly, Ko et al reported that placing a PV stent with a diameter greater than 8 mm is not likely to result in functional stenosis in pediatric patients [20].

We should not hesitate to place stents because long-term patency has been observed in pediatric patients after PV stenting. We recommend PV stenosis that does not respond to balloon dilation as an appropriate indication for stent placement to avoid PV thrombosis.

Conclusions

PV stents are effective for intractable PV stenosis in children. A PV stent was successfully placed in a child as young as 3 years old and weighing 13 kg. Our data suggested that stent placement in young children does not cause portal hypertension as patients grow.

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