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Hugging balloons dilatation by noncompliant balloons to successfully dilate a stent refractory to routine peripheral transluminal renal angioplasty

Zastosowanie niepodatnych balonów techniką *hugging balloons* do skutecznego rozprężenia stentu po niepowodzeniu rutynowej przezskórnej śródnaczyniowej angioplastyki tętnic wieńcowych

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Abstract

A small proportion of lesions are refractory even when very high pressures are used to deploy the stent. Here, we report the case of a 7-year-old boy referred for evaluation of refractory hypertension. There was a bruit on auscultation on the back in the lumbar region. Renal angiogram revealed bilateral renal artery stenosis. Right and left renal arteries were stented with a 7 × 23 mm and a 7 × 19 mm Hippocampus bare metal stent (Medtronic, Minneapolis, MN, USA). Despite delivering the stent in the left renal artery at 10 atm pressure, it didn't open up properly. We successfully attempted the technique of hugging balloons. This involved two noncompliant balloons of 4 × 10 mm each, inflated simultaneously side by side at 20 atm to successfully dilate the stent. This technique enables success as the geometry of two 'kissing' balloons is different from that of one balloon. This altered geometric configuration may be important in successfully dilating a stent refractory to standard dilating techniques. Higher pressures can be attained with two smaller balloons because the burst pressure is higher in smaller balloons compared to larger balloons.

Key words: burst pressure, hugging balloon inflation, kissing balloon inflation, refractory hypertension, renal artery stenosis

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Introduction

Takayasu's arteritis (TA) is a chronic inflammatory disease that involves the aorta, its branches and the pulmonary arteries, causing varying degrees of stenosis, dilatation, or both. Although the third most frequent vasculitis occurring in childhood, the occurrence of juvenile TA is rare, although the youngest to have been reported was a 6-month-old baby [1]. It is the commonest cause of renovascular hypertension in Asian children as the thoraco-abdominal aorta is mainly involved in patients from Korea and India [2]. The usual symptoms are due to hypertension, heart failure or a neurological event, whereas claudication, bruit or a missing pulse in an asymptomatic child are quite uncommon, leading to delays in its early diagnosis and consequently resulting in serious complications. TA in children is associated with higher morbidity and mortality than in adults [3]. Hypertension in Takayasu's arteritis results from renal

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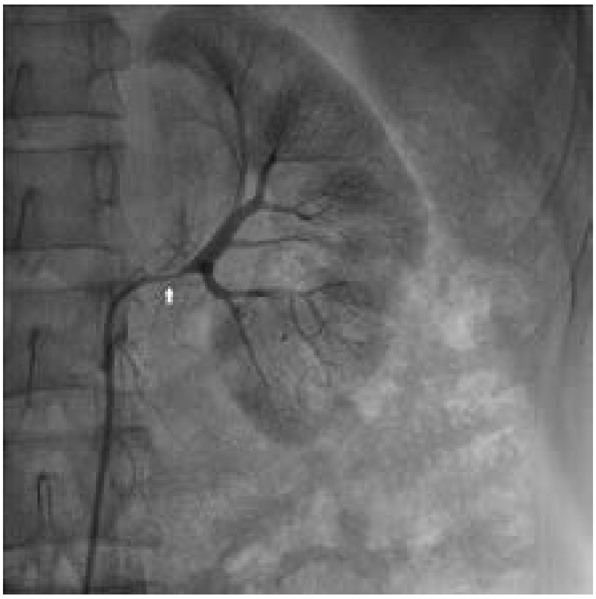


Figure 1. Left renal angiogram showing osteo-proximal critical stenosis (white arrow)

artery stenosis which can be either unilateral or bilateral [4]. Percutaneous transluminal renal angioplasty (PTRA) has a high success rate. The inability to dilate a lesion that has been successfully stented is often due to fibrotic and eccentric lesions which may require extremely high pressures in order to be dilated. Yet, despite the deployment of a stent at higher pressure than rated burst pressure, not all lesions are successfully dilated. We describe the use of two **hugging balloons** inflated to high pressures. This process successfully dilated a lesion which could not be dilated using one balloon.

Case report

A 7-year-old boy was admitted for evaluation of refractory hypertension. There was no history of valvular heart disease. Blood pressures on right arm, left arm and both legs were 136/86, 106/82 and 158/86 mm Hg respectively. There was a faint bruit on the lower back. Other examination findings were unremarkable. Therefore, blood pressure was labelled as stage II hypertension for this child [5]. The difference in blood pressure of ≥ 20 mm Hg between the arms suggested juvenile TA. Laboratory investigations showed mild anaemia with haemoglobin 11.1 mg/dl, normal erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). Chest skiagram and ophthalmological evaluation were normal. Aortography revealed osteo-proximal stenosis of 90% of both renal arteries (Figure 1). Based on comprehensive evaluation, he was diagnosed as suffering from Takayasu's arteritis with hypertension as per EULAR (European League Against Rheumatism)/PRES (Paediatric Rheumatology European Society) criteria [6]. The patient was prepared for PTRA after proper consent. The right femoral artery was accessed with a 7F sheath. The right renal artery was stented in the usual fashion with a 7 × 23 mm Hippocampus bare metal stent (Medtronic, Minneapolis, MN, USA). The left renal artery (LRA) was cannulated with a 7F renal double curve (Cordis Corp., Hialeah, FL, USA) guiding catheter. A runthrough 0.014" wire (Terumo, Japan) was parked in the upper branch of the renal artery (Figure 2A). The lesion was sequentially predilated with a 3 × 10 mm and a 3.5 × 10 mm Maverick semicompliant balloon (Boston Scientific, Natick, MA, USA) (Figure 2B). The LRA was stented with a 7 × 18 mm Hippocampus bare metal stent positioning across the lesions with 1–2 mm of stent overhanging in the aorta to ensure ostial coverage and was deployed at 10 atms pressure (Figure 3A). The stent balloon was deflated and further pulled into the aorta and inflated at 14 atms to flare the ostia. A further angiogram revealed malposition of the stent in the distal part (Figure 3B; white arrow). To obtain the optimal result, we parked another runthrough 0.014" wire in the lower branch of the upper part of the renal artery. The stent was further post dilated by two Quantum Maverick noncompliant balloons of 4.5 × 10 mm and 4.5 × 8 mm at very high (22–25 atm) pressure using the technique of hugging balloons dilatation (Figures 4, 5A). The final angiogram revealed an optimally deployed stent (Figure 5B), also confirmed on multi detector computed tomography imaging (Figure 6). The patient was discharged on aspirin 75 mg, amlodipine 10 mg and hydrochlorothiazide 12.5 mg once daily. At 6 months' follow-up, blood pressure was stable at 80/60 mm Hg.

Discussion

Takayasu's arteritis is predominantly a disease of young adults (aged 10–30). The onset of illness may be earlier, including in childhood, but rarely in infancy [3]. Although commoner among females, with a ratio varying from 9:1 to 1.3:1, it is less obvious in children [3]. Patients with juvenile TA generally present below the age of 8 years with non-specific systemic symptoms such as fever and weight loss. This is in contrast to adult patients who usually present with hypertension, decreased peripheral artery pulsations, or claudication of the extremities. Vascular involvement in our case included narrowing of the thoraco-abdominal aorta and proximal left subclavian artery, consistent with other studies of juvenile TA.

Endovascular treatment of renal artery stenosis (RAS) using either balloon angioplasty or stent placement has resulted in control of hypertension and to some extent in halting progressive renal dysfunction [7]. For ostial lesions, which are encountered most frequently, stenting is

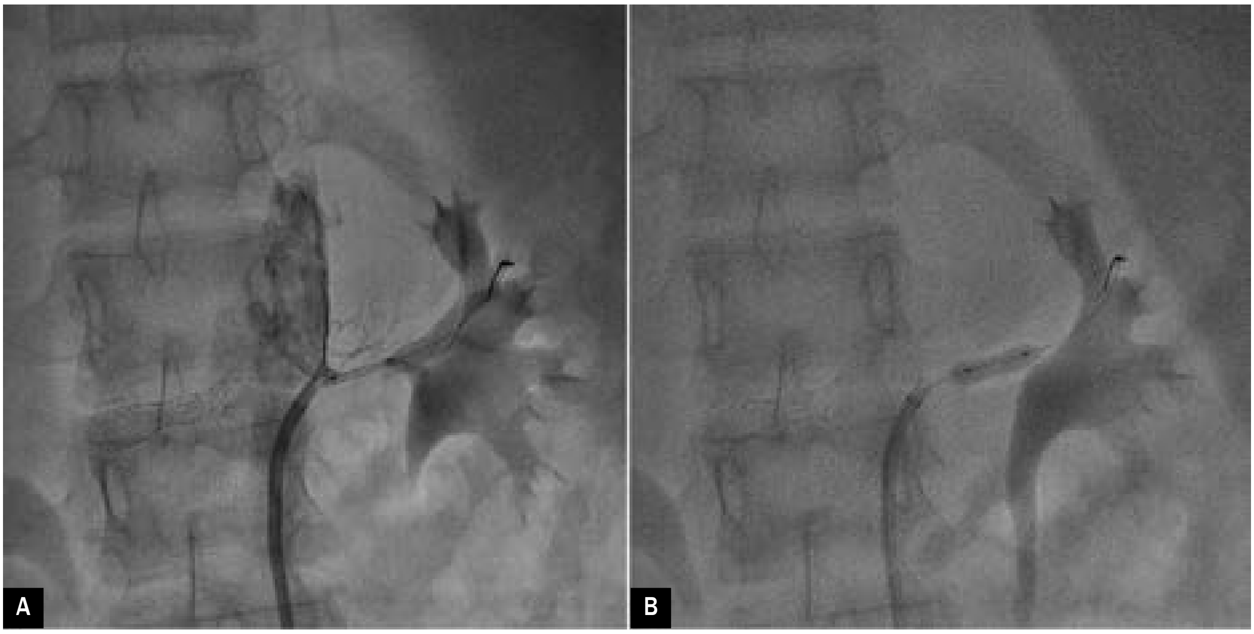


Figure 2A, B. Runthrough wire was parked in upper branch of left renal artery (LRA) after being cannulated with renal double curve (RDC) guiding catheter (**A**). Lesion was sequentially predilated with 3 × 10 mm and 3.5 × 10 mm Maverick semicompliant balloons (**B**)

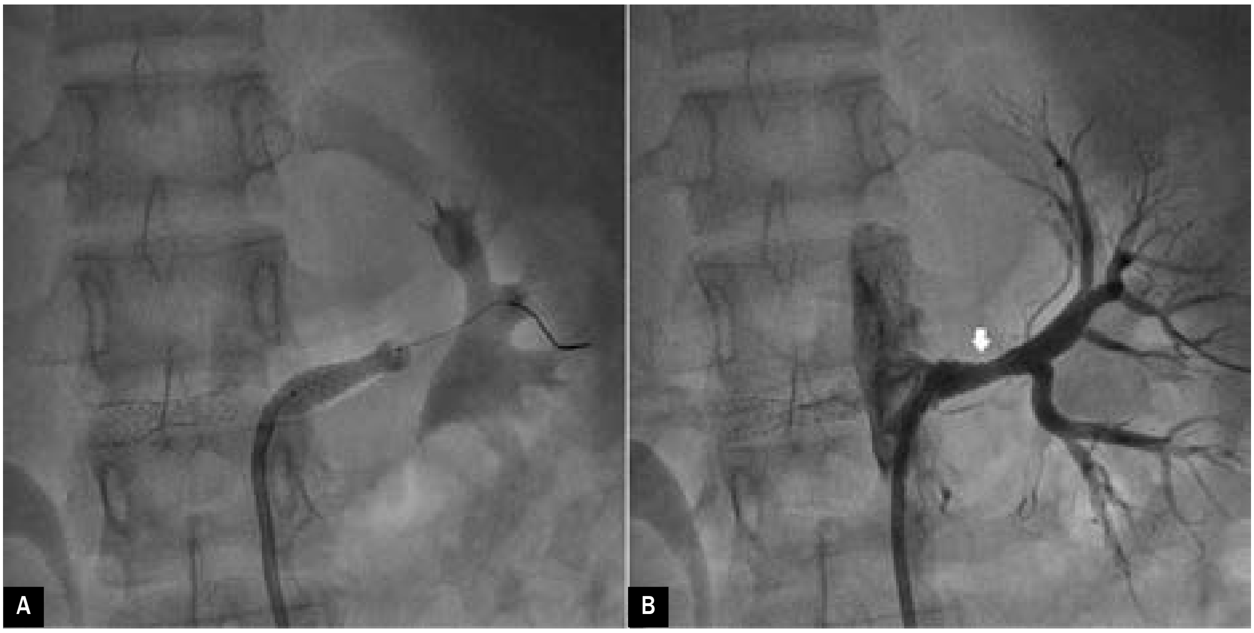
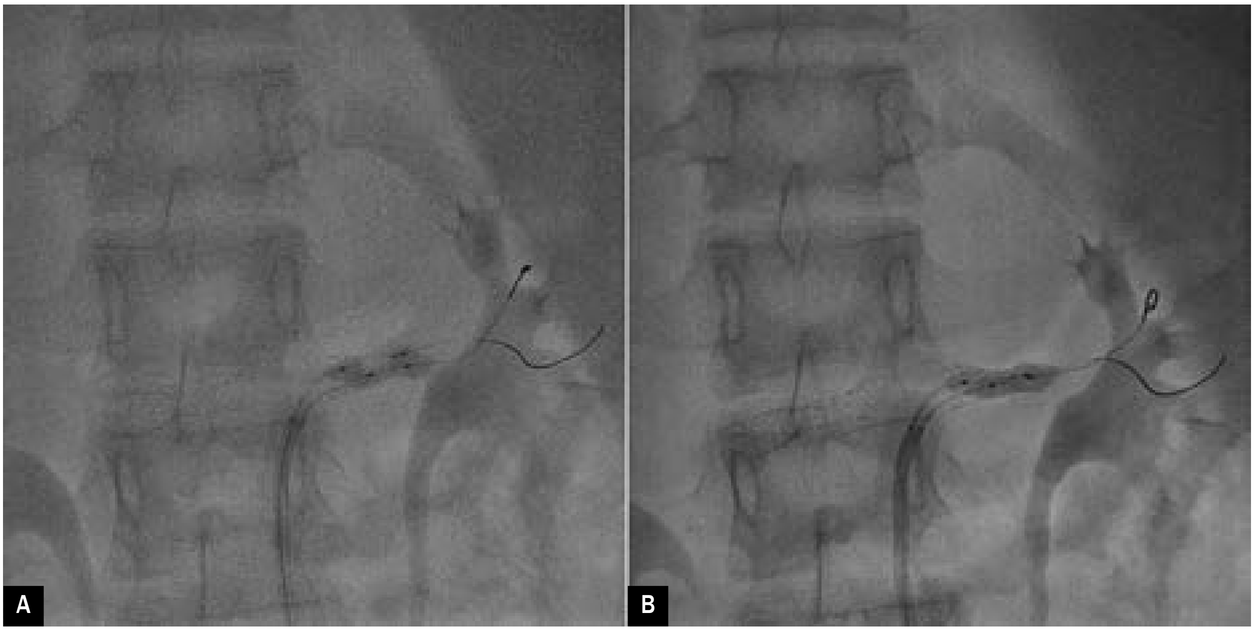


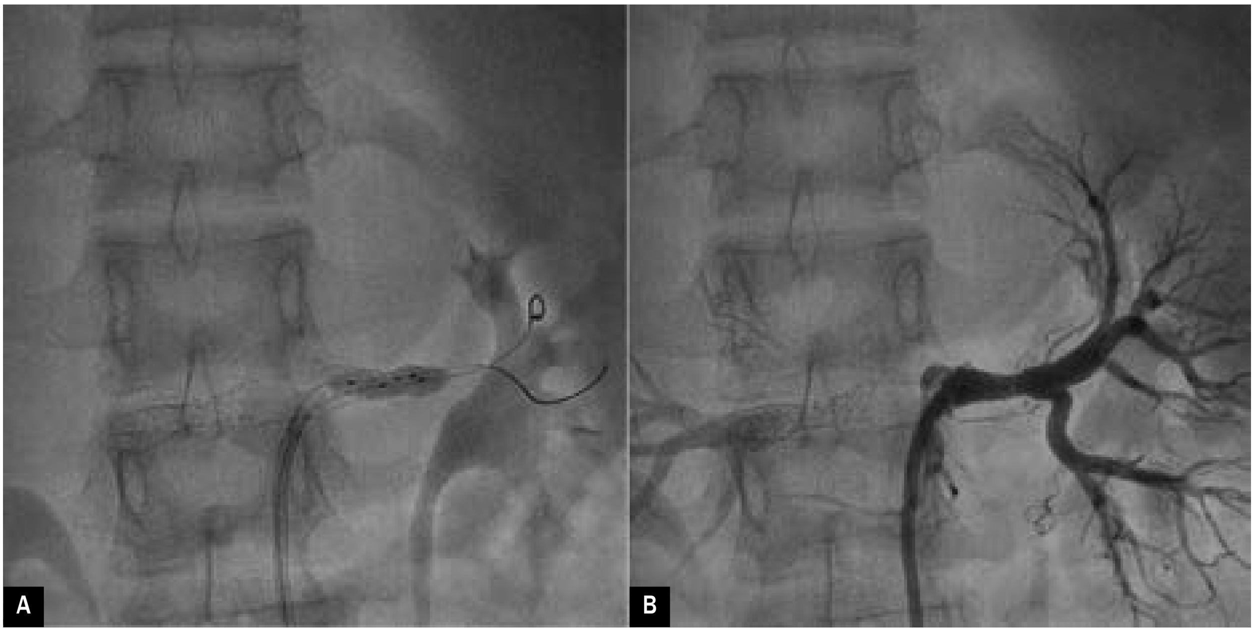
Figure 3A, B. Left renal artery (LRA) was stented with a 7 × 18 mm Hippocampus bare metal stent at 10 atm pressure with little protrusion into aorta (**A**); Post deployment angiogram showing malposition of stent in distal part (**B** — white arrow)

preferred to balloon dilatation because these lesions are elastic and respond poorly to balloon dilatation only, and are associated with a higher procedural success rate (98% vs.77%) and a lower rate of restenosis (17% vs. 26%) [8].

Most stents are successfully deployed at nominal pressure, but some may require higher pressures for successful dilatation. A small percentage continue to be refractory even at these very high pressures because of underlying fibrosis or calcification. Therefore, optimal results may be obtained using a noncompliant balloon delivering higher pressure. However, this occasionally fails because a single balloon requires much higher



Figures 4A, B. Hugging balloons dilatation of stent with 4.5 × 10 mm and 4.5 × 8 mm noncompliant balloons after parking another wire in lower branch of left renal artery. Post stented right renal artery stent visible on the right



Figures 5A, B. Final angiogram revealed optimally deployed stent after hugging balloons dilatation

pressure to achieve the desired diameter. Our case demonstrates a new technique of hugging balloons, using two noncompliant balloons inflated simultaneously side by side which successfully dilated a lesion which would not dilate using standard techniques. Because the burst pressure varies inversely with balloon size, the smaller the radius of the balloon, the higher the pressure necessary to burst that balloon material. Besides increasing the inflation diameter, the geometry of two balloons inflated side by side is different from that of one balloon. The final diameter attained is governed by the Finnet formula: $D = 0.67 \times (D1 + D2)$, where D is the final diameter achieved while D1 and D2 are the diameters of the individual balloon used.

Therefore, this altered geometric configuration may be important in successfully dilating a lesion refractory to

Figure 6. me rendered reconstruction of multi-detector computed tomography (MDCT) showing well deployed left renal artery stent

standard dilating techniques. The final diameter occupied by two balloons of 4.5 × 10 mm and 4.5 × 8 mm at high pressure was 6.7 mm, almost identical to the diameter of the deployed stent. Also, no single peripheral/coronary balloon is available in this diameter. Therefore, when routine single balloon inflation to high pressures fails to dilate a lesion, two side-by-side noncompliant balloons may be considered as an alternative approach. In this particular case, we were able to use two over-the-wire systems since a 7F guiding catheter was placed which could easily accommodate two balloons.

Our case report highlights the procedural challenge and excellent clinical outcome achieved in a patient with renal artery stenosis with juxtaposed aortic involvement.

Conflict of interest

The authors declare no conflict of interest.

Streszczenie

W przypadku niewielkiego odsetka zmian nie udaje się poszerzyć światła naczynia nawet po zastosowaniu bardzo wysokiego ciśnienia do rozprężenia stentu. Autorzy przedstawili przypadek 7-letniego chłopca skierowanego do ich ośrodka w celu oceny nadciśnienia tętniczego opornego. W badaniu osłuchowym stwierdzono szmer w okolicy lędźwiowej. Angiogram tętnic nerkowych uwidocznił dwustronne zwężenie tętnic nerkowych. W prawej i lewej tętnicy nerkowej założono stenty niepowlekane *Hippocampus* 7 × 23 mm i 7 × 19 mm (Medtronic, Minneapolis, MN, Stany Zjednoczone). Mimo wprowadzenia stentu do lewej tętnicy nerkowej i zastosowania ciśnienia 10 atm nie udało się całkowicie rozprężyć stentu. Zastosowano więc z powodzeniem technikę *hugging balloons*. Polegała ona na wykorzystaniu dwóch niepodatnych balonów, każdy o rozmiarze 4 × 10 mm, i jednoczesnym napełnieniu ich pod ciśnieniem 20 atm w celu całkowitego rozprężenia stentu. Ta technika umożliwia powodzenie zabiegu, ponieważ geometria dwóch wprowadzonych jednocześnie balonów (*kissing ballons*) jest inna niż w przypadku użycia jednego balonu. Zmieniona konfiguracja geometryczna może mieć istotne znaczenie dla skutecznego rozprężenia stentu w przypadku niepowodzenia standardowych technik rozprężania. W przypadku użycia dwóch mniejszych balonów można uzyskać wyższe ciśnienie, ponieważ ciśnienie rozrywające jest wyższe w przypadku mniejszych balonów.

Słowa kluczowe: ciśnienie rozrywające, inflacja, technika *hugging balloons*, technika *kissing balloons*, nadciśnienie tętnicze oporne, zwężenie tętnic nerkowych

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