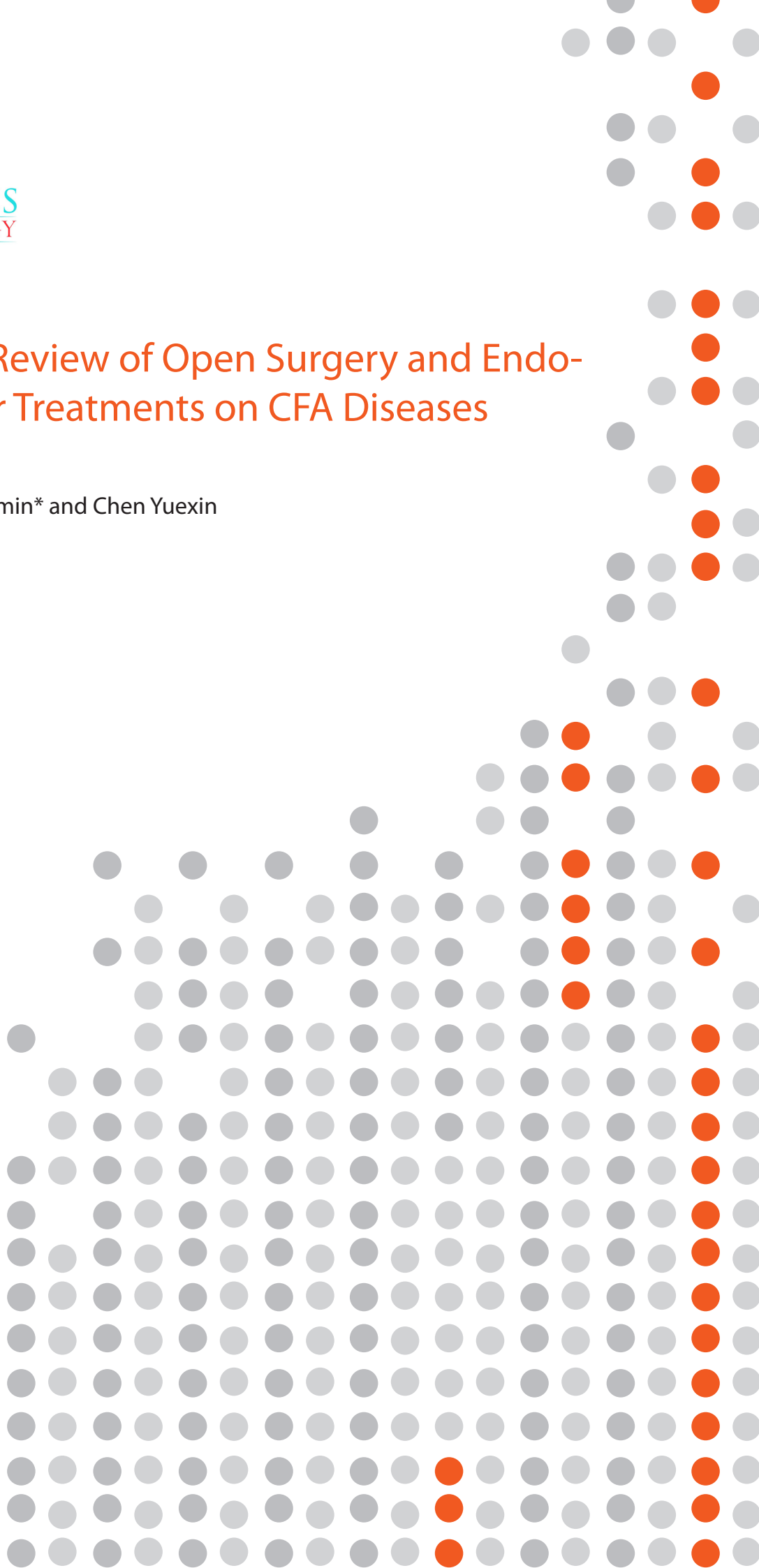


Review Article

A Brief Review of Open Surgery and Endovascular Treatments on CFA Diseases

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ABSTRACT

Common femoral arteries are the key regions for peripheral arterial disease. Because of its “no-stent” characteristic due to transarticulation, endarterectomy has long been the golden choice for first-line therapy. However, with the development of endovascular methods and devices, endovascular treatment is becoming increasingly popular for its acceptable outcomes and less damage to the patient. In this review, we include several studies to show the development status of open surgery and endovascular technologies and compare their differences.

Keywords: Common femoral arteries; Endarterectomy; Endovascular treatments

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INTRODUCTION

Common femoral arteries (CFA) are highly focused for a long time because of their “no-stent” characteristics. CFA is flexible, easy to transform due to dynamic interactions, and involves bifurcation, making CFA an unfriendly environment for endovascular treatments to perform [1]. Also, the occlusive diseases of CFA always have moderate/heavy calcification, which increases the difficulty of endovascular treatments on this vessel. For a long time, the open surgery of endarterectomy has been the only efficient therapy for CFA occlusive diseases. Nowadays, however, with the evolvement of endovascular technologies, more and more endovascular solutions for CFA diseases show better results than traditional endarterectomy.

Along with endarterectomy, the endovascular treatment strategies can be divided into compressing and debulking. The compressing treatments mainly refer to stent implantation, and the debulking treatments focus on different ways to break down the thrombi or calcification plaques. Both treatments can effectively increase the volume of CFA lumen and improve the prognosis of CFA occlusive diseases. In practice, the two strategies and their combinations are being performed more and more widely, so we want to demonstrate a brief review of the different treatments for CFA diseases now and compare their therapeutic effects. We included several studies from the last decade to show more recent practices on this topic.

Open surgery

Endarterectomy is the golden standard of CFA disease treatment. As a reliable therapy, it still shows a solid therapeutic effect on CFA occlusions. According to a 713-patient cohort studied by Wieker et al., in 2016 [2], endarterectomy on CFA and related occlusion diseases can perform a primary patency (PP) rate of 96.5% for 1-year follow-up and 78.5% after 7 years. The overall survival rate is 93.9%, 83.0%, 74.1%, and 60.1% at 1, 3, 5, and 7 years. They also find a significant difference in the survival rate between intermittent claudication (IC) and critical limb ischemia (CLI) patients (73.4% vs. 36.3%; $P < .001$), although the PP rates seem close (79.4% vs 76.3%; $P = .32$). This result may indicate some limitations of endarterectomy on certain patients. In another 118-patient cohort in 2016 [3], Kuma et al., also found

out that between IC and CLI patients, the 1-year and 5-year PP rates were 100% and 100% towards 95% and 95%, and the survival rate for the two groups were 97% vs. 69% in 1 year and 89% vs. 33% in 5 years, which is consistent with the findings of Wieker's research. For long-term results, Hashimoto and colleagues found a significant difference between IC (n=50) and CLI (n=39) patients in survival rate and limb salvage rate in a ten-year time scale [4]. The difference in survival rate can be over 20% ($p=0.0010$), and the difference in limb salvage rate can be near 50% ($p=0.0002$). This difference in outcome may suggest that endarterectomy is somehow inadequate for CLI patients. However, it is more likely due to the severity of ischemia in CLI patients, which would often be complicated with cardiovascular and cerebrovascular symptoms.

Endovascular treatments

Angioplasty and Stenting

Angioplasty, one of the most traditional endovascular treatments for artery occlusive diseases, once been a sub-optimal selection for CFA occlusions. According to Bonvini et al, [5], the angioplasty would have a higher 1-yr TLR rate compared with newer atherectomy treatments (20.9% vs 4.8%, OR=0.18, 95% CI, 0.02-1.42, $p=0.090$), and the restenosis rate of angioplasty would also be higher (28.7% vs 11.8%, OR=0.35, 95% CI, 0.07-1.48, $p=0.160$). The patency rate of angioplasty would also be lower than normal endarterectomy. This result may be why traditional angioplasty needs further modification for better outcomes. However, this study also shows angioplasty has a lower complication rate than endarterectomy. Nowadays, in medical practice, drug-coated balloons (DCB) are being used more and more widely as an adjuvant treatment after atherectomy, which we will discuss below. Stenting is not very favored in the CFA region because of the complicated anatomical structures and dynamic conditions. However, with the development of the material and drug-coated technology, stent treatments are showing better outcomes and fewer fractures in the CFA region. Thiney et al, [6], studied a 53-patient cohort and 95% of patients were treated with stent implantation. Among the cohort, 67% of patients showed clinical improvement, while only 9% (four cases) had stent fractures. This means stenting is getting more promising as the outcome is acceptable, and the fracture rate decreases as technology develops. We may see stents becoming a first-line therapy choice for CFA occlusion in the near future. Additionally, although the articles mentioned different stent types, such as self-expanding stents and balloon-expandable stents, they didn't compare the outcomes of different stents. So, further investigation is still needed to determine the choice of stents under various circumstances.

Atherectomy

As a mainstream endovascular debulking method, atherectomy has been recognized as a solid treatment for CFA occlusions, not only for its good outcome but the reduction of stent bailout [7]. Now, we have many different types of atherectomy, such as directional atherectomy, orbital atherectomy, Jetstream atherectomy, and laser atherectomy. Those different technologies slightly differ in outcomes and potential injuries to the normal tissue. For example, the directional atherectomy has more precise plaque excision, and the orbital atherectomy is more suitable for more calcified

hard plaques [8]. The laser atherectomy, or the excimer laser ablation, is the only treatment proved by the FDA for ISR, but it still has the risk that tearing the vessel wall and causing dissection [9]. All those atherectomy treatments have a good outcome for CFA occlusions compared with angioplasty and even the endarterectomy. According to a 116-patient cohort published by Shammass [10], 106 out of the 116 patients received different types of atherectomy, and the total outcome shows a rate of freedom from TLR of 72.2% in two years, which is very satisfying. Also, this study shows that the orbital atherectomy has a significantly lower TLR rate compared with PTA ($p=0.0037$) and other atherectomy methods ($p<0.05$) but is similar to the Jetstream ($p>0.1$). This may indicate the suitability of the two methods for the harder calcified plaques in CFA. Also, the atherectomy is easier to perform compared with the endarterectomy, and it is cheaper [11], so the outcome is better considering all of these factors.

Although all the atherectomy treatments can work well in the CFA region, the most popular choice for CFA occlusions is directional atherectomy (DA). Maybe it is because DA is more suitable for the complicated anatomical structure of CFA when performing. Guo et al. [11], found out that in some subgroups, such as bifurcated lesions and claudicated patients, DA has a better outcome compared with angioplasty, with primary patency of 82.6% vs. 57.6% in the bifurcated group and 92.3% vs. 72.2% in claudication group (both $p=0.048$). Picazo et al. [12] The outcomes of 25 patients who underwent DA were also used to show that DA is an effective and reliable procedure for the treatment of CFA occlusions, but they pay attention to the complications of DA as well. They suggest a combined use of previous CTA, focused USS, and/or intravascular USS to minimize the risk of potential complications caused by over-excision of the media, such as pseudoaneurysm and perforation.

To achieve longer-term effectiveness, DA is always followed by DCB or other similar compressing endovascular treatments, which is called DAART (Directional Atherectomy + Anti-Restenotic Therapy) in total. DAART combines the advantages of both therapies and has an outstanding potency in CFA treatments. In DAART, different anti-restenotic therapies seem to have the same effectiveness as those of Imran et al. [13], founded in their study. In their study, 34 patients underwent DA+angioplasty, and 36 patients underwent DA+DCB. The result indicated a similar 1-year primary patency in both groups. Böhme et al. [14], included 250 patients who underwent DAART and found the rate of freedom of major adverse events of 99.6% in 30 days, and the clinically driven TLR (cdTLR)-free survival in mild, moderate, and severe calcified lesions groups were 94%, 87.9%, 80.6% ($p=0.02$). They also found that there was no significant difference in TLR-free survival between CLI and IC patients, which proves the wide applicability of DAART. Cioppa et al. performed a 1-year [15] and a 3-year [16] follow-up and found the primary patency was 90.0% after 1 year and 84% after 3 years. The safety outcome was also stable and reliable, which supports the efficacy of DAART. However, different results can also be found in other studies. For example, in the study of Wischmann et al. [17], they also performed a 3-year follow-up, and they found the patency rate (3-year patency 83% vs. 87%, $p=0.576$) and the safety outcomes (cdTLR rate 20% vs. 14%, $p=0.377$) were basically the same between DAART and DCB alone groups. This raises the importance of further random studies to evaluate the efficacy of DAART.

Intravascular lithotripsy

For some highly calcified plaques in CFA, atherectomy and angioplasty may not have a good outcome or are hard to perform. In this case, intravascular lithotripsy (IVL) is preferred. IVL vaporizes the fluid in the vessel to form a bubble to generate the sonic pressure wave, which will crack the calcification on the vessel wall. This method does less harm to the vessel and increases the compliance of the vessel for further treatment [18]. In CFA occlusions, Brodmann et al. [19], performed IVL in 6 moderate and 15 severe calcified patients, whose pretreatment mean diameter stenosis was 72.3%. After IVL treatment, the mean diameter stenosis was decreased to 21.3% and basically had no adverse complications. For the IVL combined with the DCB strategy, Stavroulakis et al. [20], included 33 patients, and the primary patency after 1-year follow-up was 72% (95% CI, 49%-86%), and the rate of freedom of TLR was 94% (95% CI, 78%-98%). The safety outcomes were also acceptable. This evidence shows the reliability of IVL as a severe calcification treatment in CFA.

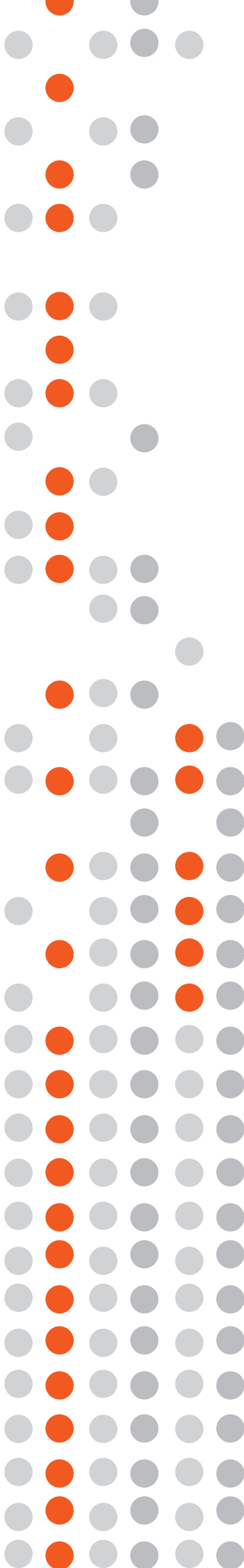
DISCUSSION

Although the endarterectomy is still the best treatment for CFA occlusions, its limitations urge us to find better solutions. The high cost and large range of injuries are also not good for patients. In recent clinical practice, we can find alternatives to open surgery under certain circumstances; for example, for patients who have CLI and severe calcification of CFA, IVL may have similar or even better results than endarterectomy. However, all the endovascular challengers including angioplasty, atherectomy and IVL seem to be not able to fully take the role of endarterectomy, although they do have some promising outcomes. The efficacy and safety of endovascular treatments still need more solid evidence to support them. Besides the prospective and retrospective studies and reviews, random trials are needed for the last piece of the puzzle. Also, for the latest technology like IVL, the potential complications still need further research. Although it's difficult, it's believed that there will surely be a treatment with better outcomes and less harm for CFA occlusions in the future.

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