pansion in balloon-resistant lesions. It has been effective for PCI of complex lesions, including stent restenosis, calcified lesions, and chronic total occlusion. It is both safe and effective for plaque modification. Ichimoto et al conducted a clinical study to investigate the outcomes after treatment with ELCA for ISR of des. The study showed that acute luminal gain was greater in PCI with the ELCA group than without ELCA. There was slightly less TLR in patients with ELCA for ISR compared to those without, and there was no significant difference in cardiovascular events between patients with and without ELCA (48).

Rotational Atherectomy (RA)

RA is an atheroablative technology that enables PCI for complex, calcified coronary lesions. The principal indication for RA is a modification of severely calcified de novo coronary stenoses which are unlikely to expand adequately with balloon angioplasty to allow for complete stent expansion (49). The randomised PREPARE-CALC Trial compared high-speed RA and modified balloons (MB) before DES implantation in severely calcified coronary lesions. After complete clinical follow-up over 9 months, the overall mortality was 2% in both groups (P = 1.00), spontaneous myocardial infarction occurred in 2 patients in the MB group and in none in the RA group, and TLR was twice as high in the MB group. It showed that there was no significant difference in clinical outcomes at 9 months between the MB and RA groups (50).

Coronary Artery Bypass Graft (CABG)

In patients with symptomatic recurrent diffuse ISR with an indication for revascularisation, CABG can be advantageous over repeat PCI to reduce recurrent events (Level of recommendation 2a) (18). In a previous study, patients who underwent CABG had a significantly lower incidence of target vessel revascularisation (8%) and MACE (23%) before PCI (51, 52). Reports on the incidence of CABG due to restenosis after BMS or DES and the clinical outcomes are scarce in the literature.

Adjunctive Medical Therapy

Systemic treatments have targeted different mechanisms that have been identified as potential factors in the development of restenosis. Platelets and thrombi were first attributed to the cascade of events leading to neointimal proliferation. However, antiplatelets and anticoagulants did not reduce neointimal hyperplasia and restenosis rates (53). Sirolimus or cilostazol may be of benefit in patients who had restenosis more than twice in the same area. They may reduce the amount of restenosis tissue that builds up. The double-blind, randomised, placebo-controlled Oral Sirolimus to Inhibit Recurrent In-stent Stenosis (OSIRIS) trial showed that restenosis can be reduced by short-term treatment with sirolimus. There was a significant correlation between sirolimus blood concentration on the day of the procedure with the late lumen loss at follow-up (P < 0.001) (54).

Current Guidelines

The 2018 ESC/EACTS guidelines for myocardial revascularisation recommend either DES or DCB for both BMS-ISR and DES-ISR (Class I, Level of Evidence A). Intracoronary imaging such as IVUS and/or OCT should be considered to determine the most appropriate procedure prior to revascularisation (24).

Different guidelines by ACC/AHA/SCAI from 2021 propose DES implantation as the leading revascularisation method if anatomic factors are appropriate, and the patient can comply with and tolerate antiplatelet therapy (Class I, Level of Evidence A). Additionally, the guidelines suggest the use of vascular brachytherapy for patients with an artery that is unfavourable to receive another DES and who are not good candidates for bypass surgery (Class 2 b, Level of Evidence B-NR) (18).

Moreover, in patients with recurrent episodes of diffuse ISR in large vessels, multivessel disease, or in the presence of other complex lesions such as chronic total occlusions, both European and American guidelines suggest performing CABG over PCI (18, 24).

The 2022 EuroIntervention publication „Management of in-stent restenosis" proposes an ISR treatment algorithm. This algorithm is based primarily on the type of stent used in the initial procedure and the mechanical issues of ISR. If no mechanical issue is found, or IVI is unavailable, the recommendation is to focus on routine predilatation of ISR lesions such as POBA, RA, ELCA, IVL, cutting, and scoring balloons.

When mechanical issues are present, the operator can decide on the best approach to address the problem and how to treat the lesion. DCBs and DESs are used to treat the lesion in the majority of cases. When the type of stent is unknown and in DES-ISR, DES appears to be moderately more effective than DCB (5).

Conclusion

Restenosis is much less common due to technical breakthroughs in stents and drugs. Nevertheless, ISR does still occur and remains a significant issue. Contrary to the lower incidence of ISR in DES, patients with DES-ISR display worse clinical outcomes than those with BMS-ISR after revascularisation.

While DES and DCB appear to provide the most benefit for ISR, the optimal strategy for managing ISR must be determined on a case-by-case basis. The underlying mechanisms of the lesion, patient profile, and prior treatment characteristics should always be considered before deciding on ISR therapy. Intravascular imaging aids in refining clinical decision-making strategies through a more detailed anatomical assessment of lesions.

Further research is needed to identify other possible clinical and anatomical predispositions and alternative therapies that can help improve selection and tailor treatment in each individual patient.

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