

FOLLOW-UP OF RENAL AND MESENTERIC ARTERY REVASCULARIZATION WITH DUPLEX ULTRASONOGRAPHY

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OBJECTIVE: To evaluate the long-term anatomic results of renal revascularization procedures using duplex ultrasonography.

DESIGN: A case series.

SETTING: A university-affiliated hospital.

PATIENTS: Twenty-five patients who had undergone renal percutaneous transluminal angioplasty (PTA) (18 arteries), renal bypass (10 arteries) and mesenteric bypass (6 arteries). The mean follow-up was 22 months (range from 3 to 48 months) for those who underwent renal PTA, 23 months (range from 1.5 to 70 months) for those who underwent renal bypass and 34 months (range from 8 to 144 months) for those who underwent mesenteric bypass.

MAIN OUTCOME MEASURES: Patency rates for the three procedures as assessed by duplex ultrasonography.

RESULTS: Duplex ultrasonography demonstrated patency without stenosis after renal and mesenteric artery revascularization in 14 arteries subjected to renal PTA, 9 arteries subjected to renal bypass and 6 arteries subjected to mesenteric bypass. Three arteries that had renal PTA had recurrent vessel stenosis and one had occlusion. One artery that had renal bypass showed occlusion.

CONCLUSIONS: Renal PTA, renal bypass and mesenteric bypass are durable procedures at 2 years of follow-up, and duplex ultrasonography is a valuable method for assessing the patency of arteries after renal and mesenteric revascularization.

OBJECTIF : Évaluer par ultrasonographie duplex les résultats anatomiques à long terme d'interventions de revascularisation rénale.

CONCEPTION : Étude de cas.

CONTEXTE : Hôpital affilié à une université.

PATIENTS : Vingt-cinq patients qui ont subi une angioplastie rénale transluminale percutanée (ATP) (18 artères), un pontage rénal (10 artères) et un pontage mésentérique (6 artères). Le suivi moyen a été de 22 mois (fourchette de 3 à 48 mois) dans le cas de ceux qui ont subi une ATP, 23 mois (fourchette de 1,5 à 70 mois) dans le cas de ceux qui ont subi un pontage rénal et 34 mois (fourchette de 8 à 144 mois) dans celui des sujets qui ont subi un pontage mésentérique.

PRINCIPALES MESURES DES RÉSULTATS : Taux de perméabilité pour les trois interventions évalué par ultrasonographie duplex.

RÉSULTATS : L'ultrasonographie duplex a révélé une perméabilité sans sténose après la revascularisation des artères rénales et mésentériques dans le cas de 14 artères sur lesquelles on a pratiqué une angioplastie rénale, de 9 artères sur lesquelles on a pratiqué un pontage rénal et de 6 artères sur lesquelles on a pratiqué un pontage mésentérique. Trois artères qui avaient subi une ATP rénale présentaient une sténose récurrente et une était bloquée. Une artère sur laquelle on avait pratiqué un pontage rénal présentait des signes d'occlusion.

CONCLUSIONS : L'ATP rénale, le pontage rénal et le pontage mésentérique sont des interventions durables après 2 ans de suivi et l'ultrasonographie duplex est une bonne façon d'évaluer la perméabilité des artères après revascularisation des artères rénales et mésentériques.

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Renal and mesenteric artery revascularization is widely used to treat patients with renovascular hypertension, with renal dysfunction from renal artery stenosis and with chronic mesenteric ischemia. The indications for revascularization in most cases are well defined,¹⁻⁴ and what is the most appropriate technique for revascularization (percutaneous transluminal angioplasty [PTA] or surgical bypass) is becoming better defined.^{5,6}

Although the long-term clinical results of renal revascularization have been studied in terms of cure of hypertension and improvement in renal function, little has been done to look at the long-term patency of the arteries treated or technical and anatomic results of these procedures.

Traditionally, follow-up of bypass patency of PTA restenosis within these intra-abdominal vessels requires angiography.^{7,8} This is expensive, invasive and associated with some risk when done repeatedly for regular follow-up.⁹ Duplex ultrasonography is now available to assess these arteries accurately. It provides a noninvasive method of assessing the anatomic results of revascularization on a regular basis.¹⁰⁻¹²

The purpose of this study was to use duplex ultrasonography to assess vessel patency after renal and mesenteric artery revascularization.

PATIENTS AND METHODS

We reviewed all patients at the Vancouver General Hospital who had renal or mesenteric revascularization by percutaneous transluminal angioplasty (PTA) or surgical bypass between January 1987 and June 1991. Criteria for inclusion in the study were adequate serial duplex ultrasonography and clinical follow-up at least 1 month after the revascularization procedure. Approximately half of the patients who underwent revascularization were

available for the study. Most patients also had undergone duplex ultrasonography of their renal and mesenteric vessels before revascularization.

All patients underwent angiography before revascularization and all underwent immediate post-renal PTA angiography. Follow-up duplex ultrasonography was performed in most cases every 6 months.

Duplex ultrasonography was performed from an anterior abdominal approach with a 3-MHz scanhead (Accuson Inc., Mountain View, Calif.). Doppler waveforms were recorded from the proximal and distal renal arteries, the celiac and superior mesenteric arteries and the aorta adjacent to the renal arteries. Kidney length was measured with B-mode ultrasonography. In the case of bypass grafts, Doppler signals were recorded from the proximal and distal anastomoses and the mid-graft. Renal artery stenosis or renal bypass graft stenosis of 60% to 99% was diagnosed if the ratio of the renal artery peak systolic velocity to the aortic peak systolic velocity (renal-aortic ratio [RAR]) was 3.5 or more (Table I).¹¹ Celiac or superior mesenteric artery stenosis or mesenteric graft stenosis greater than 50% was diagnosed if there was a localized velocity increase (more than 200 cm/s in the celiac artery and more than 275 cm/s in the superior mesenteric artery) with associated post-stenotic turbulence.¹³ The diagnosis of artery or graft occlusion was based on an ab-

sence of flow in an adequately visualized vessel.

RESULTS

Mesenteric revascularization

Six mesenteric artery bypasses were done in three patients (three superior mesenteric, three celiac) for symptoms of mesenteric ischemia. On duplex ultrasonography, all bypasses remained patent without stenosis (Table II), with a mean follow-up of 34 months (range from 8 to 144 months).

Renal PTA

Eighteen renal PTA procedures were done in 14 patients (4 bilateral PTAs). All patients had technically successful PTA. The mean follow-up was 22 months (range from 3 to 48 months). Duplex ultrasonography demonstrated that in 14 cases of renal PTA the vessels remained patent without stenosis, stenosis recurred in 3 cases and occlusion occurred in 1 case. Of the patients with recurrent stenoses, one underwent repeat renal PTA and two had renal bypass.

Renal bypass

Renal bypass was performed on 10 renal arteries in eight hypertensive patients (two bilateral bypasses). All patients had technically successful bypass. The mean follow-up was 23 months

Table I

Duplex Criteria for the Diagnosis of Renal Artery Stenosis

Stenosis, %	Criterion
0-59	RAR < 3.5, usually without localized velocity increase or poststenotic turbulence
60-99	RAR ≥ 3.5, with localized velocity increase and poststenotic turbulence
Occlusion	No flow signal from renal artery, low amplitude velocity signal from the renal parenchyma and a small (< 9 cm) kidney

RAR = renal-aortic ratio

(range from 1.5 to 70 months). Duplex ultrasonography demonstrated patency in 9 of 10 renal bypasses without stenosis with graft occlusion in one patient at 14 months. The patient with bypass graft occlusion had had bilateral renal bypass grafts and the contralateral bypass remained patent at last follow-up (31 months).

DISCUSSION

Renal and mesenteric artery bypasses are widely used to treat stenosis or occlusion of those vessels.^{1,4} Although a more recent technique, PTA of renal artery stenosis is a well established procedure.⁶ The indications for treating renal artery lesions are renovascular hypertension and renal dysfunction.^{2,5} There remains some controversy about which patients with renovascular disease are better treated with PTA or surgical bypass.⁵ The clinical syndrome of chronic mesenteric ischemia is the major indication for mesenteric revascularization.⁴

The clinical results of renal and mesenteric revascularization have been well studied. Cure or improvement of hypertension after renal bypass for renal artery stenosis ranges from 82% to 92% and after PTA 53% to 93%.^{5,6} Renal bypass in most cases is more durable. Mesenteric bypass shows similar results to renal bypass.

The long-term results in terms of restenosis or occlusion of renal bypass or PTA are less well studied. Careful

anatomic assessment and follow-up show a significant number of abnormalities. Stanley, Ernst and Fry,⁷ using routine angiographic follow-up of 100 aortorenal vein grafts, reported a 10% thrombosis rate with a 9% restenosis rate. They also showed graft expansion or aneurysmal dilatation in over half of the grafts. Dean and associates,⁸ in a similar study, reported an 11% thrombosis rate and a 14% restenosis rate. Tegtmeier, Kellum and Ayers⁶ found a 40% rate of restenosis after renal PTA, as assessed by follow-up angiography. The late restenosis or occlusion rate of mesenteric bypass is unknown.

There is clearly a significant rate of late restenosis or occlusion after renal bypass and PTA that may not be detected except by some method of anatomic follow-up of artery patency. The noninvasive nature of duplex ultrasonography makes it ideal for such long-term follow-up. It has been widely used to follow up patients after carotid endarterectomy¹⁰ and has become important in the follow-up care of femorodistal bypass grafts. We believe it may have a similar role after renal or mesenteric artery revascularization. With our technique¹¹ duplex ultrasonography had an accuracy of 93% in the assessment of renal artery stenosis. In a previous study,¹⁴ in which our group used duplex ultrasonography to assess the postoperative results of renal bypass or PTA, we showed the feasibility of this ap-

proach, but the follow-up period was short. Eidt, Fry and Clagett,¹⁵ in a follow-up of 49 patients who underwent renal revascularization, showed that duplex ultrasonography accurately assessed the technical results of PTA or bypass at a mean follow-up of 32 months. Hansen and associates¹⁶ also showed that duplex ultrasonography may be helpful in the intraoperative evaluation of renal vessel reconstruction. In this study we used duplex ultrasonography to study the long-term anatomic results of renal and mesenteric revascularizations.

The long-term patency rate (without stenosis) in this study of renal PTA (78%), renal bypass (90%) and mesenteric bypass (100%) shows that these are durable procedures at approximately 2 years of follow-up. This study also demonstrates the ease with which renal artery reconstruction may be assessed with duplex ultrasonography.

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Table II

Findings on Follow-up of Renal Percutaneous Transluminal Angioplasty (PTA), Renal Bypass and Mesenteric Bypass as Assessed by Duplex Ultrasonography

Procedure	Vessel status		
	Patent, no stenosis	Patent, recurrent stenosis	Occlusion
Renal PTA	14	3	1
Renal bypass	9	0	1
Mesenteric bypass	6	0	0

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Notices

Avis

Foot and ankle symposium

The 2nd annual Foot and Ankle Symposium, sponsored by the Canadian Orthopaedic Association and the Department of Surgery, University of Toronto, will be held from Apr. 12 to 14, 1996, at the Estates of Sunnybrook, Vaughan Estate, Toronto. Study credits: MOCOMP, Type II and AMA Category I. For further information contact: Continuing education, Faculty of Medicine, University of Toronto, 101 College St., Room 121, Toronto ON M5S 1A8. Tel.: 416 978-2719; fax: 416 971-2200.

Update in General Surgery 1996

Sponsored by the Faculty of Medicine, University of Toronto, "Update in General Surgery 1996" will be held at the Sutton Place Hotel, Toronto from Apr. 25 to 27, 1996. Study credits: MOCOMP and AMA Category I. For further information contact: Continuing education, Faculty of Medicine, University of Toronto, 101 College St., Room 121, Toronto ON M5S 1A8.

Tel.: 416 978-2719; fax: 416 971-2200.

Controversies in the etiology, detection and treatment of breast cancer

The Faculty of Medicine, University of Toronto, is sponsoring a conference entitled "Controversies in the Etiology, Detection and Treatment of Breast Cancer: 1996" on May 2 and 3, 1996. The conference will be held at The Old Mill, Toronto. Study credits: MOCOMP and AMA Category I. For further information contact: Continuing education, Faculty of Medicine, University of Toronto, 101 College St., Room 121, Toronto ON M5S 1A8. Tel.: 416 978-2719; fax: 416 971-2200.

Conference on pain

Sponsored by the International Association for the Study of Pain (IASP), the 8th World Congress on Pain will be held Aug. 17 to 22, 1996, in Vancouver. All aspects of acute and chronic pain will be covered, including cancer pain, basic research and clinical management. For information

contact: IASP Secretariat, 909 NE 43rd St., Suite 306, Seattle WA 98105. Tel.: 206 547-6409; fax: 206 547-1703; email: IASP@locke.hs.washington.edu

Magnetic resonance imaging course, Saudi Arabia

The departments of radiology, medical physics and medical studies of the Riyadh Armed Forces Hospital, Riyadh, Saudi Arabia, will sponsor their fifth international course on magnetic resonance (MR) imaging, Oct. 27 to 30, 1996. The course will provide an overview of MR technology, basic principles and current and future applications of MR imaging in the entire body. Current and potential applications of MR spectroscopy will also be discussed. The program will feature small-group workshops in basic physics and MR applications in the neurologic, musculoskeletal and genitourinary systems. The course chairman is Aabed Al Thagafi. The course fee is SR 1500 for physicians, SR 750 for medical staff in training and SR 400 for technicians. For information contact:

Department of Medical Studies, Riyadh Armed Forces Hospital, PO Box 7897, Riyadh 11159, Saudi Arabia. Tel.: 966-1-477-7714, ext. 4933 or 4937; fax: 966-1-476-0853.

Congress on Ambulatory Surgery

The 2nd International and 4th European Congress on Ambulatory Surgery will be held in at the Queen Elizabeth II Conference Centre, Westminster, London, England, from Apr. 15 to 18, 1997. Held under the patronage of the European Commission, the Council of Europe, the World Health Organization and the United Kingdom Department of Health, the congress will run in conjunction with the 8th annual scientific meeting of the British Association of Day Surgery. The working language will be English, with simultaneous translation in French, German and Spanish. For further information contact: Kite Communications, The Silk Milk House, 196 Huddersfield Rd., Meltham, W Yorks HD7 3AP, England. Tel.: 44 1484 854575; fax: 44 1484 854576.