KINKING DE RAMO DE EVAR – DIAGNÓSTICO INTRA-OPERATÓRIO

POST-EVAR LIMB GRAFT KINKING – INTRA-OPERATIVE DIAGNOSIS

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Recebido a 06 de junho de 2019
Aceite a 02 de abril de 2020

RESUMO

Introdução: O *kinking* de ramo de endoprótese subsiste como uma das principais causas de intervenções secundárias e re-hospitalização após a reparação endovascular de aneurisma abdominal. No entanto, a importância de otimizar a permeabilidade dos ramos é pouco abordada na literatura. A própria definição de *kinking* não é clara, com considerável variabilidade na literatura relativamente à apresentação clínica e história natural.
O objetivo deste trabalho é realizar uma revisão da literatura focada no diagnóstico intraoperatório de *kinking* de ramo.

Métodos: Uma revisão de literatura foi realizada na base de dados MEDLINE.

Resultados: Existem diversos métodos de imagem descritos na literatura para diagnóstico de *kinking* de ramo, com vantagens e desvantagens.
A angiografia final é realizada por rotina após a remoção de fios-guia rígidos, mas é considerada um método inadequado de determinar ramos de endoprótese em risco de *kinking*/trombose. A tomografia computadorizada de feixe cónico demonstrou ser uma opção viável tanto para planeamento de EVAR como para avaliação final intraoperatória para detetar complicações desvalorizadas na angiografia final. O EcoDoppler, a medição de gradiente de pressão e a ultrassonografia intravascular também foram propostas como adjuvantes na avaliação intraoperatória de ramos de endoprótese.

Discussão: A padronização dos critérios para o diagnóstico de *kinking* hemodinamicamente significativo é necessária para definir os doentes que poderão beneficiar de intervenções adicionais para reduzir o risco de trombose de ramo. São necessários mais estudos para aumentar a consciencialização para esta complicação, que pode levar à trombose de ramo de EVAR e à perda de membro, a fim de estabelecer um diagnóstico e um protocolo de *follow-up* adequados.

Palavras-chave
Aneurisma da aorta abdominal; Procedimentos endovasculares; Oclusão de enxerto vascular

ABSTRACT

Introduction: *Endograft limb kinking remains one of the major causes of secondary interventions and rehospitalisation after Endovascular aneurysm repair (EVAR). However, the importance of improving limb patency has received little focus. Endograft limb kinking also remains ill-defined, with considerable variability in the literature concerning its clinical presentation and natural history.*
The purpose of this paper is to search for an appropriate definition for limb graft kinking as well as intra-operative and follow-up approaches for a timely diagnosis.

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Methods: *A literature review was performed in the MEDLINE database.*

Results: *Several imaging methods have been reviewed, and they all present advantages and drawbacks. Completion Angiography (CA) is routinely performed after removal of stiff guidewires, but it is considered an inadequate means of determining high-risk limb grafts. Cone Beam Computed Tomography (CBCT) has been shown to be feasible both in EVAR planning and as completion imaging to detect complications missed by CA. Duplex Ultrasound, pressure measurement and intravascular ultrasound have also been proposed as adjuncts for intraoperative evaluation of limb grafts.*

Discussion: *Standardizing criteria for hemodynamically significant kinking diagnosis is necessary in order to define patients that may benefit from re-interventions to reduce the risk of limb occlusion. Further studies are necessary in order to raise awareness for this complication which can lead to limb graft thrombosis and limb loss and in order to establish an appropriate diagnosis and follow up protocol.*

Keywords

Aortic Aneurysm; Abdominal [MeSH Terms] Endovascular procedures [MeSH Terms] Graft Occlusion; Vascular [MeSH Terms]

INTRODUCTION

Endovascular abdominal aneurysm repair (EVAR) is currently considered first line of treatment for infra-renal abdominal aortic aneurysms (AAA). Endograft limb kinking remains one of the major causes of secondary interventions and rehospitalisation after EVAR, with incidence rates ranging from 0-7%[1-3]. However, the importance of improving limb patency has received little focus.

Comparing limb occlusion between open and endovascular aneurysm repair, it is more frequent in the latter. In a review of 1047 open aneurysm repairs with long-term follow-up, only 1 limb occlusion was identified (0.096%). In the Mayo Clinic experience, the risk of graft limb occlusion after open aneurysm repair was reported at 2%. During open aneurysm repair, the surgeon can ensure a straight unimpeded lie of the graft material, which is impossible with EVAR. In addition, aneurysm remodelling may create narrowing and/or occlusion of the endograft limbs over time[4, 5].

Endograft limb kinking remains ill-defined, with considerable variability in the literature concerning its clinical significance and natural history. It has been previously defined as a doubling of peak systolic velocity (PSV) throughout the limb in Duplex ultrasound evaluation, confirmed with subsequent pressure measurement on angiography[6].

The purpose of this paper is to search for a unanimous definition for limb graft kinking as well as intra-operative and follow-up approaches for a timely diagnosis.

METHODS

Literature review was performed in the MEDLINE database with the following query: ((“extremities”[MeSH Terms] OR “limb”) AND (“occlusion”) AND (endovascular repair) AND (“aortic aneurysm, abdominal”[MeSH Terms]) AND (“diagnosis”)). Additionally, backward citation was used to identify additional articles.

RESULTS

Completion Angiography (CA)

CA should be routinely performed after removal of stiff guidewires as the latter can cause significant deformation of the common iliac arteries during EVAR with the aortic bifurcation being more cranial and the common iliac arteries shorter[7]. Bianchini Massoni et al showed that endograft kinks or stenosis are not diagnosed and thereby are left untreated on a single-projection CA compared with a three-projection protocol in approximately 30% of EVAR cases[8]. Still, even appropriate three-projection CA is considered an inadequate means of determining high-risk limbs[9].

Pressure Measurement

Pressure measurement can identify hemodynamically significant lesions. According to Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II) severity assessment and treatment of equivocal stenosis in the aortoiliac territory are better diagnosed using invasive pressure measurements[10].

However, in post-endograft implantation management it is an insensitive test, even after arterial flow has been restored in the femoral arteries[11].

Cone Beam Computed Tomography (CBCT)

Multiplanar reconstructions of the contrast enhanced CBCT images in any required orientation allow a precise evaluation of the endograft's position with respect to the renal and hypogastric arteries and might improve detection and determination of endoleaks, limb stenosis, and intraluminal thrombi[12].
CBCT has been shown to be feasible both in EVAR planning and as completion imaging to detect complications missed by CA[13].
In one study, stent graft compressions and kinks were found more often with CBCT than with CA alone and could thus be treated intraoperatively[13].
CBCT can reliably detect all endograft-associated complications during EVAR. It offers the chance for immediate correction of remediable problems in a relevant ratio of EVAR patients and can thereby help reduce early re-intervention rates. It has the potential to replace early follow-up CTA and thus to reduce in-hospital use of contrast media[12].
The main drawback of routine CBCT is increased radiation exposure, which ranged from 7 Gym2 (5.25–8) to 70.6 Gym2 (34.9–126.5) in published studies[12, 13].

Intravascular Ultrasound (IVUS)

IVUS imaging has long been described as useful in assessing the accuracy of deployment after device placement in EVAR in order to prevent endoleaks and maintain luminal patency[14]. However, routine IVUS is associated to extra time and additional expense, with unknown predictive value, leading to reservations in its widespread use[15].
In one study, IVUS led to the detection of graft infolding that was not noted on angiography, which prompted prophylactic stent placement with virtual elimination of graft limb occlusion[15].

Duplex Ultrasound (DU)

Duplex Ultrasound has been increasingly used in EVAR follow up, for being an innocuous diagnostic tool, avoiding exposure to ionizing radiation and nephrotoxic contrast, when compared to computed tomography angiography (CTA) with good reliability in diagnosing endoleaks and graft thrombosis[16] However, DU is limited in detecting structural problems with an endograft, such as kinks, migrations, and fractures[17].
Even considering DU limitations in endograft kinking diagnosis, it has been defined as a doubling of peak systolic velocity (PSV) throughout the limb, confirmed with subsequent pressure measurement on angiography[18].
A large series of DU EVAR surveillance identified PSV> 300 cm/s within the stentgraft and PSV ratios <3.5 as predictors for hemodynamically significant kinking (the first criteria with 100% sensitivity and 98% specificity)[19].
A threshold of 2.5-fold increase in PSV was defined as a criterion for hemodynamically significant kinking, with serial increases in the PSV recorded during duplex surveillance of EVAR stent-graft limbs being associated with an increased risk of stent-graft limb complication[20].
DU is better suited for post-operative surveillance after EVAR, but it can be easily performed intraoperatively when considered appropriate.

Computed Tomography Angiography (CTA)

Currently, CTA is the standard surveillance method after EVAR[21]. Follow up imaging in post-EVAR surveillance allows a straightforward diagnosis of kinking. However, the main limitation in this setting is it´s unsuitability for intraoperative diagnosis and treatment of kinking.

DISCUSSION

Despite all the potential advantages of EVAR compared to open repair, with emphasis on lower perioperative mortality, it is associated with a higher rate of reintervention. Lifelong surveillance is considered mandatory in order to diagnose complications such as limb graft kinking, compression and thrombosis, but the protocol remains controversial[22].
Limb graft kinking timely diagnosis is especially important, and it is estimated as the underlying cause for up to 56% of limb graft occlusions[23].
With the exception of CTA, all diagnostic methods for limb graft kinking can be performed intraoperatively. This is especially important, as intraoperative diagnosis can lead to intraoperative adjunctive stenting which has been shown in several studies to reduce the risk of limb graft occlusion or secondary intervention[11, 13, 15, 19, 24–26].
Standardizing criteria for hemodynamically significant kinking diagnosis is necessary in order to define patients that may benefit from re-interventions to reduce the risk of limb occlusion. Further studies are necessary in order to raise awareness for this complication which can lead to limb graft thrombosis and limb loss and in order to establish an appropriate diagnosis and follow up protocol.

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