ΔΙΑΚΡΑΤΙΚΟ ΜΕΤΑΠΤΥΧΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΣΠΟΥΔΩΝ:

«Ενδαγγειακές Τεχνικές»

ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ΙΑΤΡΙΚΗ ΣΧΟΛΗ ΣΕ ΣΥΕΡΓΑΣΙΑ ΜΕ ΤΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΤΟΥ ΜΙΛΑΝΟΥ BICOCCA

ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

Open conversion repair after EVAR

ΠΑΠΠΑΣ Α. ΕΥΑΓΓΕΛΟΣ

ΑΘΗΝΑ

ΙΑΝΟΥΑΡΙΟΣ, 2013

ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
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ΠΡΑΚΤΙΚΟ ΚΡΙΣΕΩΣ

ΤΗΣ ΣΥΝΕΔΡΙΑΣΗΣ ΤΗΣ ΤΡΙΜΕΛΟΥΣ ΕΞΕΤΑΣΤΙΚΗΣ ΕΠΙΤΡΟΠΗΣ ΓΙΑ ΤΗΝ ΑΞΙΟΛΟΓΗΣΗ ΤΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

Του Μεταπτυχιακού Φοιτητή Ευάγγελου Α. Παππά

Εξεταστική Επιτροπή

- Καθηγητής Χρήστος Λιάπης Επιβλέπων
- Επ. Καθηγητής Ιωάννης Κακίσης
- Επ. Καθηγητής Χρήστος Κλωνάρης

Η Τριμελής Εξεταστική Επιτροπή η οποία ορίσθηκε απο την ΓΣΕΣ της Ιατρικής Σχολής του Παν. Αθηνών Συνεδρίαση της . . . . . .για την αξιολόγηση και εξέταση του υποψηφίου κ. Ευάγγελου Α. Παππά, συνεδρίασε σήμερα . . . . . .

Η Επιτροπή **διαπίστωσε** ότι η Διπλωματική Εργασία τ. Κ. Ευάγγελου Α.Παππά με τίτλο ***Open conversion repair after EVAR*,** είναι πρωτότυπη, επιστημονικά και τεχνικά άρτια και η βιβλιογραφική πληροφορία ολοκληρωμένη και εμπεριστατωμένη.

Η εξεταστική επιτροπή αφού έλαβε υπ' όψιν το περιεχόμενο της εργασίας και τη συμβολή της στην επιστήμη, με ψήφους ..... προτείνει την απονομή στον παραπάνω Μεταπτυχιακό Φοιτητή την απονομή του Μεταπτυχιακού Διπλώματος Ειδίκευσης (Master's).

Στην ψηφοφορία για την βαθμολογία ο υποψήφιος έλαβε για τον βαθμό «ΑΡΙΣΤΑ» ψήφους ....., για τον βαθμό «ΛΙΑΝ ΚΑΛΩΣ» ψήφους ....., και για τον βαθμό «ΚΑΛΩΣ» ψήφους ..... Κατά συνέπεια, απονέμεται ο βαθμός «.....».

Τα Μέλη της Εξεταστικής Επιτροπής

- Καθηγητής Χρήστος Λιάπης Επιβλέπων (Υπογραφή) _____
- Επ. Καθηγητής Ιωάννης Κακίσης (Υπογραφή) _____
- Επ. Καθηγητής Χρήστος Κλωνάρης (Υπογραφή) _____

Περίληψη

Σκοπός: Η ανασκόπηση της συχνότητας, των αιτιών, της θνητότητας και των χειρουργικών τεχνικών της ανοιχτής χειρουργικής μετατροπής μετά από ενδαγγειακή αποκατάσταση ανευρύσματος κοιλιακής αορτής.

Μέθοδοι: Πραγματοποιήθηκε σύνθετη έρευνα στις ηλεκτρονικές βάσεις δεδομένων που περιελάμβανε το PubMed, Medline και EMBASE, για την ανεύρεση όλων των άρθρων που δημοσιεύθηκαν από τον Ιανουάριο του 2002 ως τον Δεκέμβριο του 2012 και περιελάμβαναν τουλάχιστον 100 ασθενείς που υποβλήθηκαν σε ενδαγγειακή αποκατάσταση ανευρύσματος κοιλιακής αορτής, με μέσο χρόνο μετεγχειρητικής παρακολούθησης μεγαλύτερο του ενός έτους και ανέφεραν τη συχνότητα της πρώιμης και απώτερης ανοιχτής χειρουργικής μετατροπής.

Αποτελέσματα: Η συχνότητα της ανοιχτής μετατροπής κυμαίνεται από 0.9% ως 28% στα άρθρα που ανασκοπήθηκαν. Από τις 13522 ενδαγγειακές αποκαταστάσεις που περιλαμβάνουν καταγράφηκαν 485 (3.4%) ανοιχτές μετατροπές από τις οποίες 203 (1.5%) ήταν πρώιμες αντιπροσωπεύοντας το 42% των συνολικών μετατροπών. Η καταγραφόμενη θνητότητα των πρώιμων μετατροπών κυμαίνεται από 0 εως 35% με μέση υπολογιζόμενη θνητότητα 12.7%. Επιπρόσθετα καταγράφηκαν 282 (2%) απώτερες ανοιχτές μετατροπές που αντιπροσωπεύουν το 58% των συνολικών ανοιχτών μετατροπών με συχνότητα και θνητότητα από 0.4% εως 22% και 0% εως 20% αντίστοιχα.

Συμπεράσματα: Η συχνότητα των δευτερογενών παρεμβάσεων μετά από ενδαγγειακή αποκατάσταση ανευρύσματος κοιλιακής αορτής έχει μειωθεί τα τελευταία χρόνια. Παρόλα αυτά οι επανεπεμβάσεις συμπεριλαμβανομένων και των

ανοιχτών μετατροπών αποτελούν το βασικό μειονέκτημα της ενδαγγειακής τεχνικής. Αυτό οδηγεί στην αναγκαιότητα για εφόρου ζωής μετεγχειρητική παρακολούθηση των ασθενών που υποβλήθηκαν σε ενδαγγειακή αποκατάσταση ανευρύσματος κοιλιακής αορτής αλλά και στην υποχρέωση των αγγειοχειρουργών για εκπαίδευση στις σύνθετες τεχνικές της ανοιχτής μετατροπής της.

Abstract

Purpose: To review the incidence, causes, mortality and surgical techniques of conversion to open surgery after endovascular aneurysm repair (EVAR) of abdominal aortic aneurysm (AAA).

Methods: A multiple electronic health database search was performed, including PubMed, Medline and EMBASE, on all articles published between January of 2002 and December of 2012 that included at least 100 EVAR patients with a median follow-up >1 year and reported the incidence of early and late open conversion. The search yielded 16 articles with sufficient data to analyze.

Results: The rates of open conversion vary from 0.9% to 28% in the reviewed articles. Among a total of 13522 EVAR 485 (3.4%) open conversions were reported with 203 (1.5%) early conversions, reflecting 42% of the overall open conversions. The reporting mortality of early open conversions ranged from 0% to 35% and the estimated average mortality was 12.7%. In addition 282 (2%) late conversions were reported, representing 58% of total open conversion with an incidence and mortality rate varying from 0.4% to 22% and 0% to 20% respectively.

Conclusions: The incidence of secondary interventions after EVAR has decreased in recent years. Despite this fact reinterventions including open surgical conversion is still the basic disadvantage of EVAR making life-long follow-up basic part of the method. The vascular surgeon should be familiar with the complex open conversion procedures.

Introduction

Since the first successful endovascular treatment of an abdominal aortic aneurysm (AAA) in 1991 by Parodi(1) , this procedure accounts today for more than half of the AAA repairs annually(2), because it is associated with rapid recovery and lower short and mid-term morbidity and mortality than other types of repairs(3-6). Despite this fact, there remains a subset of patients submitted to endovascular aneurysm repair (EVAR), as high as 20%, who will experience endoleaks, device migration, stent fractures, graft deterioration, graft infections, or aneurysm growth that might require a reintervention(7-9). Most of the above complications can be successfully addressed with endovascular techniques but there is a minority of patients who will require open surgical conversion with or without explantation of the endograft.

This thesis reviews the literature regarding the etiology, incidence and surgical management of open conversion after EVAR failure.

Materials end Methods

Definition

Open conversion after EVAR is defined as any transperitoneal or retroperitoneal intervention for aneurysm-related complication, with or without endograft explantation.

Early open conversion is defined as any transperitoneal or retroperitoneal intervention for aneurysm-related complication, with or without endograft explantation taking place during EVAR intervention or during the first 30 post-operative days.

Late open conversion is defined as any transperitoneal or retroperitoneal intervention for aneurysm-related complication, with or without endograft explantation taking place beyond the first 30 post-operative days.

Search Strategy and results

A multiple electronic health database search was performed, including PubMed, Medline and EMBASE, on all articles published between January of 2002 and December of 2012 that included at least 100 EVAR patients with a median follow-up >1 year and reported the incidence of early and late open conversion. Articles published outside the English language literature, case series with <100 patients or <1 year median follow-up, case reports and articles reporting only early or late conversion rates were excluded from this review. All articles were assessed by the reviewer and the full text of the articles was retrieved. The search yielded a total of 16 articles meeting the predefined criteria **(Fig. 1)**

Open conversion

The rates of open conversion vary from 0.9% to 28% in the reviewed articles. Among a total of 13522 EVAR 485 (3.4%) open conversions were reported **(Table 1)**. According to the US Lifeline Registry predictors of the need for surgical conversion were female gender, coronary artery disease/myocardial infraction and larger preoperative aneurysm size with women having a threefold higher likelihood of needing surgical conversion than men(16).

Early Conversion

Despite adequate preoperative imaging, correct sizing of prostheses, and appropriate case selection, EVAR may fail and require immediate or during the first postoperative days conversion to open repair. In a total of 13,522 EVAR reviewed 203 (1.5%) early conversions were reported reflecting 42% of the overall open conversions (485) with a reporting mortality ranging from 0% to 35% and an estimated average mortality of 12.7% **(Table 1)**. The incidence of early conversions seems to decline over time as new devices are available. Other factors could explain this finding such as surgical team experience, better understanding of materials, better patient selection and better ability to manage complications with an endovascular approach.

The most common cause of EVAR early conversion is access problems due to severe calcification, stenosis, or tortuosity of the iliac arteries leading to inability of device progression inside the native vessel, for endograft misplacement, or arterial injury(17). The second most frequent failure mode is inability to catheterize the

contralateral limb(23). Aorto uni-iliac converters have played a significant role in reducing the incidence of conversion in such scenarios (26). The third and fourth most frequent causes related either to poor technique (inaccurate graft deployment) or aortic morphology is renal artery occlusion and graft migration (23). Pour quality of aortic neck is the main reason for renal artery occlusion secondary to coverage by endograft main body or proximal extensions and along with severe angulations and aortic tortuosity may lead to type I endoleak and graft migration(20).

Other less frequent causes of early conversion that have been described include, graft's modular parts disconnection, balloon malfunction, aortic rupture, graft thrombosis and incorrect deployment of the stent graft within the aorta (10, 13, 14) **(Table 2)**.

Late conversion

The incidence and mortality rate of late conversion varies from 0.4% to 22% and 0% to 20% respectively in the reviewed literature. With a total of 13,522 endovascular AAA repairs, 282 (2%) late conversions were reported in the reviewed articles, representing 58% of total open conversion **(Table 1)**. Despite this, late conversion rate is difficult to estimate and strongly depends on the follow-up (23) **(Table 3)**.

Re-interventions due to endoleaks are the Achilles' heel of EVAR, with an incidence ranging from 8% to 42%, depending on the graft type and individual series (5, 15, 27, 28). Although most of the causes leading to EVAR failure (**Table 4)** and the need of an intervention can be sufficient treated with endovascular techniques there

is a small proportion of patients who will require open conversion either primary or after failed endovascular interventions.

The most frequent cause of late open conversion is aneurysm expansion with or without diagnosed endoleak (20, 24, 29, 30). Type I endoleak is the most commonly associated with late conversion in the literature. Along with type III endoleak, type I endoleak should be immediately treated when diagnosed during follow-up because of the tendency they have to lead to rapture (31, 32). On the other hand the management strategy of type II endoleak is conservative if the aneurysm is shrinking or remains stable and open conversion is performed for an increase in aneurysm size(9, 15).

Stend-graft migration is most commonly associated to endoleaks but it can also be related to aortic systolic-diastolic rotational movements, aortic neck remodeling, proximal aortic aneurysm disease progression, material fatigue and may require open conversion(9, 13, 20, 29).

One of the most troublesome indications for late conversion after EVAR is aneurysm rapture. In spite of the immediate successful exclusion of aortic aneurysm at the time of implantation of the endograft, reports on rupture of AAA after EVAR show a risk ranging from 0.5% to 1% per year (33, 34).

Endoprosthesis infection and fistula formation after EVAR is another cause for late open conversion. A meta-analysis of graft infections after EVAR noted an endograft infection rate of 0.16% at 2 years (35). The exact etiology of graft infection and the pathophysiology of fistula formation have not been elucidated. Graft infection is probably caused by the hematogenous spread of remote infections (24). The proposed hypothesis on the fistula formation is that local infection may result in

intestinal necrosis and fistula formation between the aneurysm and the intestinal wall (35).

Surgical technique

Surgical conversion of EVAR represents a unique array of technical challenges. Among these, the endograft itself and any associated secondary endovascular salvage devices, such as embolization coils and proximal or distal cuffs, increase the difficulty of dissection and the establishment of adequate vascular control(20, 29, 30).

The exact approach to the late removal of endografts depends on several factors, including the type and the condition of the endograft as well as the presence of suprarenal stents and/or hooks or barbs, the presence of any additional grafts, cuffs, or coils, the condition of proximal and distal fixation points and how intact they are, the presence of periaortic scarring or inflammation and importantly, the urgency of the repair (12).

The standard technique involves surgical exposure of the aneurysm through a midline transperitoneal (12) or retroperitoneal (11) approach, proximal and distal control of the aorta, removal of the failed endograft and replacement with o prosthetic aortic graft. There is no superiority among both types of incision and the main criterion in performing one or the other is surgeons experience and preference(11).

The paramount issue in safe removal of endograft is control of the aorta above the proximal fixation site(36). Endografts with proximal fixation problems are more likely to be approached from the side and require a suprarenal clamp. Once

the graft is removed the clamp can be moved to the infrarenal location, limiting the renal and visceral ischemic insult (29).

The traditional method of endograft removal called the ‘‘clamp and pool’’ technique is preferred for endografts without barbs or hooks. Other described methods include removing suprarenal fixation using metal cutters (37), collapsing the proximal fixation into a 20 mL syringe (38), and pouring iced saline on nitinol stents to help reduce size and ease removal.

Although complete removal of the graft is always the goal, incomplete removal is sometimes necessary. Partial resections of the endograft (iliac stents or proximal aortic stuts and suprarenal stents left in situ) or even complete endograft preservation (selective ligation of the culprit arteries causing type II endoleak or proximal neck banding) have been described (39).

Conclusions

EVAR is established as a first-line treatment for many patients with AAA, with reduced short-term mortality and morbidity compared to conventional open surgery. However, there is a significant and growing rate of secondary interventions after EVAR including and early or late conversion to open repair. It is evident that the literature on open conversion is difficult to interpreter and the results are difficult to compare. This results to the need of a life-long follow-up strategy for patients treated with EVAR and the obligation of the vascular surgeons to be familiar with the complex techniques required for these interventions.

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Fig 1 Study flow chart

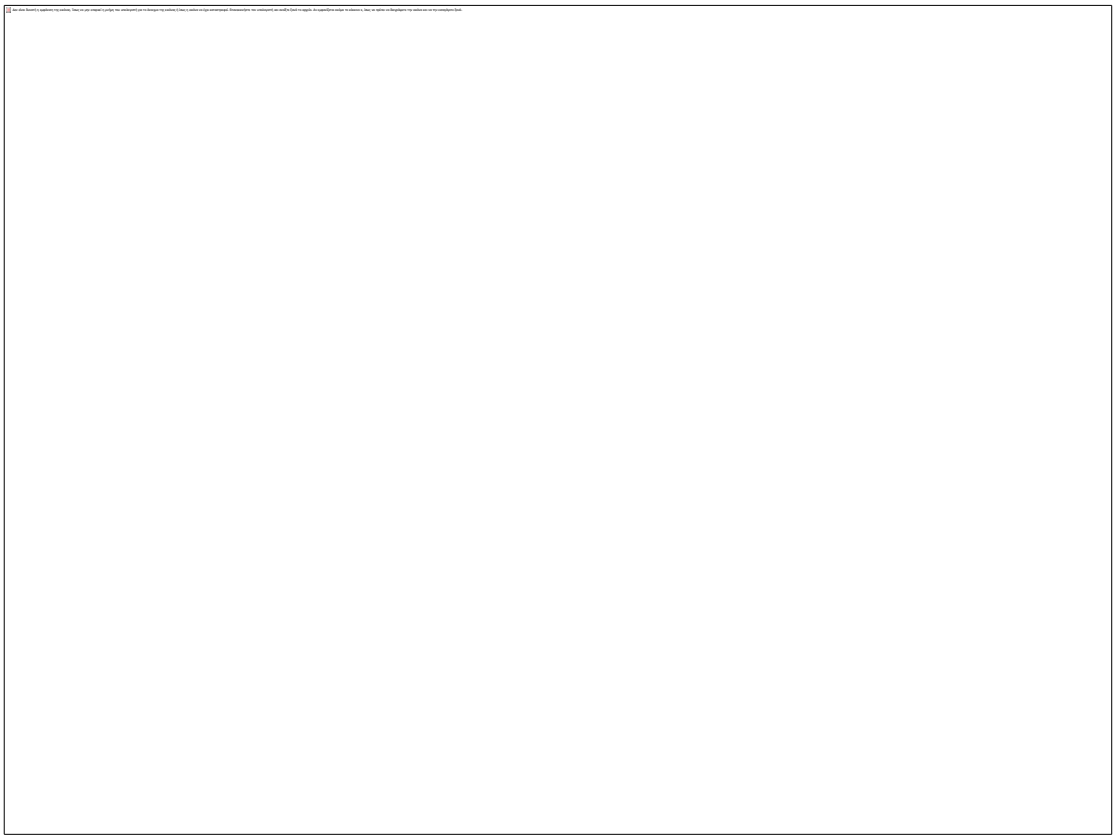

Table 1 Eligible studies included in the review

Author	Year	Patients	Conversion	Early Conversion	Mortality of Early Conversion	Late Conversion	Mortality of Late Conversion
Dattilo(10)	2002	362	13 (3.5%)	5 (1.4%)	1 (25%)	8 (2.2%)	0 (0%)
Lyden(11)	2002	110	8 (7.2%)	3 (2.7%)	0 (0%)	5 (4.5%)	NA
Lipsitz(12)	2003	386	14 (3.6%)	3 (1.0%)	NA	11 (0,4%)	2 (18%)
Terramani(13)	2003	319	20 (6.3%)	11 (3.4%)	NA	9 (2.8%)	1 (11%)
Verhoeven(15)	2004	308	10 (3.2%)	1 (0.3%)	0 (0%)	9 (3.2%)	0 (0%)
Dalainas(14)	2004	186	8 (4.3%)	4 (2.1%)	1 (25%)	4 (2.1%)	0 (0%)
EUROSTAR(19)	2004	4613	71 (1.5%)	45 (1.0%)	6 (13%)	26 (0.7%)	2 (7.7%)
Lifeline Registry(16)	2005	2664	96 (3.6%)	68 (2.5%)	5 (7.4%)	28 (1.1%)	0 (0%)
Verzini(20)	2006	649	38 (5.9%)	9 (1.4%)	2 (22%)	29 (4.5%)	0 (0%)
Tiesenhausen(18)	2006	117	33 (28%)	7 (5.9%)	2 (28.5%)	26 (22.0%)	3 (14%)
Jimenez(17)	2007	574	17 (2.9%)	5 (0.9%)	2 (12%)	12 (2.1%)	0 (0%)
Coppi(21)	2008	205	8 (3.9%)	3 (1.5%)	0 (0%)	5 (2.4%)	NA
Pitoulias(25)	2009	625	44 (7.0%)	5 (0.8%)	0 (0%)	39 (6.3%)	4 (10.2%)
Millon(23)	2009	1588	34 (2.1%)	14 (0.9%)	5 (35%)	20 (1.3%)	5 (20%)
Gambardella(22)	2010	285	11 (3.9%)	1 (0.4%)	NA	10 (3.5%)	0 (0%)
Phade(24)	2010	531	5 (0.9%)	0 (0%)	0 ()%)	5 (0.9%)	NA
Total		13522	485 (3.4%)	203 (1.5%)	24 (12.7%)	282 (2%)	17 (7.35%)

NA: Not Available

Table 2 Causes of failure leading to early conversion

Causes of failure leading to early conversion
Access problems
Inability of contralateral limb catheterization
Renal Occlusion
Migration - Type I endoleak
Aortic rupture
Balloon malfunction
Deployment of the stent graft within the aorta
Endograft Thrombosis
Graft's modular parts disconnection

Table 3 Mean patient follow-up

Author	Year	Late Conversion	Mortality of Late Conversion	Follow-up, Mean Time (months)
Dattilo	2002	8 (2.2%)	0 (0%)	22
Lyden	2002	5 (4.5%)	NA	32
Lipsitz	2003	11 (0,4%)	2 (18%)	30
Terramani	2003	9 (2.8%)	1 (11%)	24
Verhoeven	2004	9 (3.2%)	0 (0%)	44
Dalainas	2004	4 (2.1%)	0 (0%)	17
EUROSTAR	2004	26 (0.7%)	2 (7.7%)	32
Lifeline Registry	2005	28 (1.1%)	0 (0%)	NA
Verzini	2006	29 (4.5%)	0 (0%)	33
Tiesenhausen	2006	26 (22.0%)	3 (14%)	NA
Jimenez	2007	12 (2.1%)	0 (0%)	27
Coppi	2008	5 (2.4%)	NA	NA
Pitoulias	2009	39 (6.3%)	4 (10.2%)	NA
Millon	2009	20 (1.3%)	5 (20%)	41
Gambardella	2010	10 (3.5%)	0 (0%)	36
Phade	2010	5 (0.9%)	NA	29
Total		282 (2%)	17 (7.35%)	

NA : Not Available

Table 4 Causes of failure leading to late conversion

Causes of failure leading to late conversion
Endoleak
Endotension
Migration
Stent-graft disconnection
Graft infection
Graft thrombosis
Rapture

Appendix

AAA: abdominal aortic aneurysm

EVAR: endovascular aneurysm repair