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Comparison of thermal damage of the internal thoracic artery using ultra high radiofrequency and monopolar diathermy

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ABSTRACT

Background: The internal thoracic artery (ITA) has been accepted worldwide as a first choice conduit for myocardial revascularisation. It still remains questionable what is the best method for ITA harvesting in a skeletonized fashion according to structural integrity of artery, as a risk factor of early and late graft failure. The purpose of this study was to determine the impact of the ultra-high radiofrequency energy used for ITA harvesting on arterial structural integrity, in particular on the endothelial layer.

Methods: Seventy-four ITA specimens were divided into two groups depending on device used for harvesting (radiofrequency-knife (RF) or electrocauter (EC)). Thermal damage on arterial structural integrity was measured using light microscope, morphometric imaging analysis and immunohistochemical methods.

Results: Thermal damage of endothelium was 2.8 times higher in EC than in RF group ($p = 0.041$) and 5 times higher in patients older than 66 years of age ($p = 0.002$). Extent of endothelial damage (graded from 0 to 3) was significantly higher in EC group ($p = 0.03$). Also, in EC group, in patients older than 66 years of age higher proportion of extent of endothelial damage was found ($p = 0.027$).

Conclusions: The endothelial damage was more often in EC than in RF group as in the patients older than 66 years of age. Demonstrated results suggest that the radiosurgery in

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comparison to conventional electrocautery is safe and effective method, and significantly reduces thermal damage to endothelial layer of artery.

Introduction

The effectiveness of the internal thoracic artery (ITA) for coronary artery bypass grafting (CABG) has been well established. The gold standard in a left anterior descending branch coronary arteries surgery is performing an ITA bypass.[1] Skeletonization techniques of harvesting have been suggested for maximizing the utility of ITA grafts, and the benefits of such techniques have increasingly been reported.[2] However, skeletonization techniques are not commonly used because they are difficult to perform and time consuming. The risk of ITA damage has commonly been reported.[3,4] The coronary artery bypass graft surgery success in general is related to structural integrity of the grafts used. The damage of the ITA graft and an especially of the endothelium during the preparation is considered to be of prime importance for early and late graft failure.[5–7] Therefore, techniques which preserve the endothelium should be utilized when harvesting the ITA. An ultra-high frequency energy (2.0–4.0 MHz) (radiosurgery) has been used extensively in many different medical applications and specialties because of its ability to achieve a precise and controlled thermal cutting and coagulation of soft tissue.[8,9] Using an ultra-high frequency energy, the targeted tissue temperatures are localized at a range of 60–90 °C (radiofrequency "cold" knife) thus limiting heat dissipation and lateral thermal tissue damage zone up to 75-μm.[10,11] After confirmation of the safety of the radiosurgery in other specialties, this technique has been considered in our institution for ITA harvesting.

The purpose of this study was to analyze thermal damage of arterial wall and in particular damage of the endothelial layer when the ITA was skeletonized using radiofrequency knife as a new method of harvesting.

Materials and methods

Patients

Seventy-four consecutive patients submitted to elective coronary artery bypass grafting at the Department of Cardiac Surgery, Split University Hospital Centre, from June 2012 to January 2013, were enrolled in the study. Urgent, emergency or salvage procedures were excluded from this study. Informed consent was obtained from all the patients and the Ethical Committee of Split University Hospital approved study protocol. Patients were randomly assigned into two groups depending on device used for ITA harvesting. The first group (RF) included 34 patients where the ITA was dissected with radiofrequency knife and the second group (EC) included 40 patients where conventional electrocauter was used. The patient characteristics are presented in Table 1.

Dissection instruments

In our study for ITA harvesting, the electrosurgical unit (The Surgi-Max Plus, Elliquence, USA) at a power setting of 35 W in a bland mode was used. In control group, a conventional electrocauter (The Force FX-8C Electrosurgical Generator, Valleylab, USA) at coagulation power setting of 35 W was used.

Operative technique

A standard median sternotomy was performed, the left pleura was opened for all its length, the internal thoracic vessels were visualized for their entire course and ITA was dissected in skeletonized fashion.[12] All ITA's for bypass grafting were dissected by the same experienced surgeon (C. B.) who used the same operative technique in all cases. After that, terminal portion of the ITA, segment of conduit judged unnecessary to myocardial revascularisation, was harvested in skeletonized fashion with RF or EC. The dissection was

Table 1 – Comparison between risk factors, median of age and ejection fraction of left ventricle in relation to ITA harvesting technique.

	Groups (harvesting technique)		Total	p
	RF ($n = 34$)	EC ($n = 40$)		
Age (years) mean (min–max)	64 (49–81)	72 (46–85)	66 (46–85)	0.055[a]
Sex (men) n (%)	29 (85%)	32 (80%)	61 (82%)	0.551[b]
EF LV (%) mean (min–max)	63 (30–84)	65.5 (21–80)	65 (21–84)	0.831[b]
Smoking (yes) n (%)	13 (38%)	6 (15%)	19 (26%)	0.064[b]
Hypertension (yes) n (%)	23 (68%)	36 (90%)	59 (80%)	0.036[b]
Dyslipidemia (yes) n (%)	25 (73%)	31 (77%)	56 (76%)	0.901[b]
Diabetes (yes) n (%)	9 (26%)	19 (47%)	28 (38%)	0.106[b]
CKD (yes)	0	0	0	
COPD (yes) n (%)	2 (6%)	1 (2.5%)	3 (4%)	
Gout (yes) n (%)	3 (9%)	6 (15%)	9 (12%)	

EF LV – ejection fraction of left ventricle; CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; EC – electrocauter; RF – radiofrequency knife.
a Mann–Whitney test.
b χ^2 test.