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Original Article / Оригинални рад

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Angiogenic capabilities of omentomyelopexy for injured spinal cord revascularization

Ангиогенетски потенцијал оментомијелопексије у реваскуларизацији повређене кичмене мождине

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SUMMARY

Introduction/Objective Increasing incidence of spinal cord injuries presents a very important issue. These patients are usually very young, treatment is very tough, long, expensive and, in general, of little success rate.
The aim of this study was to evaluate the angiogenic potential of the omental graft in spinal cord revascularization after the injury.
Methods The study included 19 patients, who underwent recurrent surgical procedure for pain syndrome or surgical complication, and one patient in whom angiography revealed no flow in distal part of omental graft.
Results Our study confirmed angiogenic capabilities of omental graft placed in the course of omentomyelopexy for the injured spinal cord revascularization, macroscopically and histopathologically. Study results are limited due to inclusion of patients, only when the postoperative period was complicated.
Conclusion Our study provides some insight into the angiogenic capabilities. Although, further (likely less invasive) studies are needed to provide more insight into omental angiogenesis and to include patients in whom the procedure went well.
Keywords: omentum; omentomyelopexy; spinal cord injury; angiogenesis; revascularizations

САЖЕТАК

Увод/Циљ Повећање учесталости повреда кичмене мождине је велики проблем. Повређени су обично врло млади, лечење је врло тешко, дуго, скупо и генерално безуспешно.
Циљ овог рада је био да процени ангиогенетски потенцијал транспонираног оментума у реваскуларизацији кичмене мождине после повреде.
Методе Истраживање је обухватило 19 болесника који су подвргнути поновном хируршком захвату због болног синдрома, хируршке компликације и код једног после ангиографије која није показала проток у дисталном делу режња оментума.
Резултати Студија је потврдила ангиогенетске способности оменталног трансплантата за реваскуларизацију повређене кичмене мождине, макроскопски и хистопатолошки. Резултати студије су лимитирани укључивањем само оних са компликованим постоперативним током и реоперацијом.
Закључак Наша студија пружа одређени увид у ангиогенетске способности оментума, иако су потребне даље мање инвазивне студије како би се пружио бољи увид у оменталну ангиогенезу и укључили испаници код којих је цео поступак прошао без компликација.
Кључне речи: оментум; оментомијелопексија; повреда кичмене мождине; ангиогенеза; реваскуларизација

INTRODUCTION

Injuries of the vertebral column, spinal cord and cauda equina are present in 0.7-4% of all traumatic injuries, and 6.3% of traumatic injuries of the skeletal system, and their frequency increases mainly due to traffic accidents [1]. According to the data from the Viet Nam, missile caused injuries of these structures were considered to appear in only 1%, although more current results suggest a far more frequent incidence at about 17% of missile injuries during the global war on terrorism [2, 3]. Although increasing incidence of spinal cord injuries (SCI) presents a very important issue, the most important issue is the very nature of the injury. These patients are usually very young (20 year approximately), treatment is very tough, long, expensive and, in general, of little success rate [4, 5].

Development of spinal fusion enabled vertebral column to be stabilized after the injury, but very little to none improvement was achieved in SCI treatment [6]. Recently, the debate raised up once again, as numerous treatment options have been developed recently, although their impact on spinal cord recovery after injury remained questionable [7].

The role of omental transposition for brain, and spinal cord vascularization was first mentioned in the mid-70´s, by Goldsmith [8, 9], and, since then, many authors have suggested various implementations of the omentum in both SCI, and degenerative disease of the spine [10-12].

Due to omental richness in blood and lymphatic vessels, and the ability to coalescence the injured area, with capillary ingrowth during the first 4-6 hours, the omentum presents theoretically ideal tissue to revascularize the damaged spinal cord [13]. Omentopexy is a surgical procedure to connect the great omentum with the nearby organ, which induces the arterial circulation in the omental graft, thus causing the arterial circulation improvement in the target organ [14, 15]. Herewith, we have tried to encourage omental transposition for SCI through omentomyelopexy, by evaluating the angiogenic potential of the omental graft in spinal cord revascularization after the injury.

METHODS

Study group and inclusion criteria

The study included 19 patients, who underwent recurrent surgical procedure for pain syndrome or surgical complication (infection, mieloomentocoela or cerebrospinal fluid (CSF) fistula), and one patient in whom angiography revealed no flow in distal part of omental graft. Initial group of patients consisted of 100 patients (89 males and 11 females), treated with omentomyelopexy due to the missile caused SCI neurological deficit in the Department of neurosurgery of Military Medical Academy in Belgrade, Serbia, during the five-year period (1993–1997).

Patients included in the study fulfilled all the criteria: decompressive surgery performed for missile caused spinal cord injury; omentomyelopexy performed for stabile neurological deficit, after initial decompressive surgery; pecurent surgery for pain syndrome or complication of omentomyelopexy.

The purpose of omentomyelopexy is angiogenesis of the damaged spinal cord, using the multipotent organ of the abdominal cavity, to provide revascularization, and to create adequate conditions for damaged spinal cord remyelization. This would all lead to nerve impulse propagation reestablishment, and consequent neurological improvement [16].

Postoperative pain syndrome was present in 7 patients, and it appeared 2–5 years after the surgery. All patients suffered to missile injuries of the spinal cord ranging between T10–L2 spinal levels. After the injury initial treatment included decompressive laminectomy and evacuation of bony fragments from the spinal canal, which was followed by omentomyelopexy 4–17 months after initial surgery. The treatment option for these patients was DREZ-otomy [17].

Meningoomentocoela developed in 5 patients, CSF fistula developed in 3, and the infection of the neurosurgical site occured in 3 patiens. Reoperation was indicated to resolve these complications [18].

RESULTS

Direct intraoperative observation

Surgical treatment of complications also allowed a look into the surgical site to observe and evaluate the omentomyelopexy angiogenesis in-vivo. Macroscopic photos were taken, while the small part of the grafted omentum was excised, and reffered to hystopathological analysis to assess the viability and vasculature of the grafted omentum [19].

Splenic artery angiography

Selective angiography of splenic artery was performed durring the early postoperative period (10^{th} day after the surgery), in three patients to determine the vascular competency, and evaluate early angiogenic capabilities of the omental graft. Anastomosis between omental flap's arteries and vertebral and spinal artery was confirmed in one patient, which confirmed angiogenic capabilities of the transposed omentum [16]. One patient´s angiography revealed only abdominal blood vessels, although no signs of graft necrosis were present, revision was performed only to confirm the graft vitality and blood flow persistence.

Macroscopic appearance

In patients reoperated due to infection, omental graft appeared pale, volume was reduced to about 50% of initial (mainly due to fatty tissue reduction, while the vascular structures were not significantly changed, and the active bleeding from the graft surface was noted. On the other hand, reoperation revealed that CSF fistula or meningoomentocoela induced no significant changes in the graft macroscopic appearance.

Omental graft in patients who underwent DREZ-otomy due to painful syndrome was also evaluated, and the results are presented in the Table 1.

Table 1. Characteristics of patients in whom a DREZ-otomy was performed for painful syndrome after the omentomyelopexy for SCI [17].

Age	Sex	ASIA assesment result	Time from injury to omentomyelopexy (months)	Time to DREZ-otomy after omentomyelopexy (months)	Omental graft vitality
35	M	(C) sensory level T12	4	30	Vital
35	M	(B) sensory level T12	9	26	Atrophic
27	M	(D) sensory level T12	10	33	Vital
25	M	(A) sensory level T12	14	60	Dezintegrated
29	M	(C) sensory level T12	14	34	Vital
31	M	(B) sensory level L2	17	36	Atrophic
41	M	(B) sensory level T12	14	42	Dezintegrated

Hystopathologic changes in omental graft

Mixoid changes were present in omental graft adipose tissue, the connective tissue in the mature lobular adipose tissue, the merging of the fiber striated musculature, isles of lymphocytic infiltration due to inflammation, as well as histological changes of vascular structures. Newly formed, thin-walled blood vessels of irregular diameter and proliferation of the intima were present. Perivascular connective tissue expansion was present [19].

DISCUSSION

There is no definitive treatment for SCI. None of treatment options have shown any significant influence to functional outcome of these patients. Numerous techniques, including stem cells, collagen implants and electric devices were proposed by authors, although not many studies were performed in human population [20-22].

Functional outcome is the only parameter significant for the patient, but scientific interest is broader, and any indication of notable positive effect on the spinal cord repair and regeneration is considered of to be of greatest importance.

Our study is unique for it's two-way confirmation of the successful implantation of transposed omentum, the angiographic, and direct intraoperataive observation [16, 17, 19].

MRI study of Goldsmith et al. was performed in cats, but also in one patient, suffering from SCI, who had omental-collagen bridge reconstruction that connects the proximal and distal ends of the transected spinal cord. of her cord and has clinically progressed to the point where she can ambulate with the use of a walker. Spinal cord defect of 4 cm in length showed MRI signs of development of a spinal cord connection in the area of the omental-collagen bridge [23].

This study provides some insight into the interaction of transposed omentum and injured spinal cord. Although functional recovery is not exclusively in relation to the observed and noted changes, the hystopathologic and angiogenic capabilities are the basis of the recovery development.

CONCLUSION

Our intraoperative study confirmed angiogenic capabilities of omental graft placed in the course of omentomyelopexy, for the injured spinal cord revascularization, although study results are definitely decreased due to inclusion of patients, only when there were complications or pain syndrome present.

Further (likely less invasive) studies are needed to provide more insight into omental angiogenesis in SCI, and also include patients where the procedure went well.

NOTE

The article is a part of PhD thesis of Dr Ljubodrag Minić, M.D.

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