The use of human umbilical cord in Microsurgical Training

Thesis

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Abstract

Microsurgery is an important surgical technique. Many models were used in the past years for microsurgical training. Our study aimed to check the efficiency of microsurgical training using the umbilical cord. Fourty anastomoses were done using different techniques of anastomosis. The study showed that microsurgical training using the umbilical cord is cheap and practical.

Key Words :

Human Umbilical – Microsurgical Training .

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Introduction

Microsurgery is a surgical technique that is utilized in many disciplines including hand surgery, plastic surgery, orthopedic surgery, gynecology, ophthalmology, neurosurgery, cardiovascular surgery, gastrointestinal surgery, urology, otolaryngology, pediatric surgery, and fetal in utero surgery. Therefore it is essential for any residency and fellowship teaching program. One of the most important and fundamental prerequisites for successful microsurgery is serious and adequate training.[**Oelsner et al., 1985; Ari et al.,1997; HUI et al.,2000**]

Practical training courses are important for medical students and young doctors aspiring to become skillful microsurgeons. These courses enable them to avoid some of the problems faced by young surgeons.**[Scholz et al., 2006]**

Microsurgical techniques are the 5 Ms: microsurgical laboratory, microsurgical training, magnification, micro-instruments, and micro-sutures **[Rayan et al.,2006]**. Microsurgical training can be utilized for three purposes: first, for general microsurgical training that includes microdissection and microinstrumentation; second, microneural repair; and third, microvascular repair. Microsurgical instruction requires training material that encompasses synthetic substances, cadaver tissue, or animals. The cadaver tissue and live animals are costly and may not be available for the trainee in certain settings. Utilizing synthetic models for microsurgery training is attainable, economic, and can be useful for acquiring the basic principles for beginners and to sharpen the skills of the experienced micro-surgeons. **[Oelsner et. al. 1985; Rayan et al.,2006]**

The human umbilical cord is characterized by the presence of many vessels of different diameters and that it can be freely obtained from any nearby obstetric unit. **[Mcgregor et al., 1983]**

Aim of work

The study aims to offer a reasonable, cheap and readily available material for Microsurgical Training.

CHAPTER 1

ANATOMY OF THE UMBILICAL CORD

Umbilical cord development

The umbilical cord is the lifeline between the fetus and placenta. It is formed by the fifth week of development and it functions throughout pregnancy to protect the vessels that travel between the fetus and the placenta. Compromise of the fetal blood flow through the umbilical cord vessels can have serious deleterious effects on the health of the fetus and newborn.**[Pauli 1993; Kliman at el.,1998]**

The umbilical cord is formed as a result of folding of the disc and expansion of the amniotic cavity. Which cause the following changes:

1. Folding of the disc brings the following changes :

- The connecting stalks together with the Allantois come to lie ventrally in direct contact with the vitello-intestinal duct.
- The umbilical orifice is formed ventrally and is bounded by 4 folds.

2. Expansion of the amniotic cavity results in the following changes :

- The vetillo-intestinal duct and the connecting stalk elongate.
- The extra-embyonic coelom is completely obliterated except for a few clefts left at the umbilical orifice.

- The wall of the amniotic cavity is reflected onto the outer aspect of the umbilical cord, to form a sheath around the umbilical cord.[Gaballah & Badawy, 1997]

The umbilical cord at term measures about 59-60cm in length but a cord shorter than 35cm or longer than 85 is still considered to be normal. It is 1-2cm in diameter. The umbilical cord contains two umbilical arteries carrying the deoxygenated blood from the fetus to the placenta and a single umbilical vein which carries the oxygenated blood to the fetus. It attaches to the placenta near its center. Usually they immediately divide to provide a very rich blood supply on the fetal side, which, coupled with the maternal blood in the intervillous spaces, gives it its colour. [Miller & Hanretty, 1997]

Leonardo DaVinci was the first to study the length of the umbilical cord, concluding that its length equaled the length of the fetus throughout gestation. [Pauli, 1993]

Umbilical Cord Length by Gestational Age [Pauli, 1993]

Normal Range of (weeks)	Cord Length (cm)	Umbilical Cord Length (cm)
20-21	32	15-50
22-23	36	18-55
24-25	40	20-60
26-27	42	22-63

28-29	45	24-66
30-31	48	25-70
32-33	50	27-73
34-35	52	29-76
36-37	56	30-80
38-39	57	32-83
40-41	60	35-85
42-43	60	35-85
44-45	60	35-85

Table 1.1

The two arteries and single vein of the umbilical circulation lie in a supporting myxomatous tissue derived from the mesoderm and is termed "Wharton's Jelly". This jelly acts as a buffer, attenuating any pressure on the vessels, resisting occlusion and preventing kinking of the cord **[Pauli, 1993; Gaballah & Badawy, 1997; Miller & Hanretty, 1997]** .figure (1,1) .**[Miller & Hanretty, 1997]**

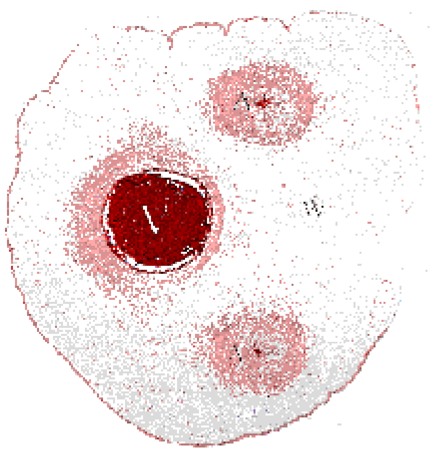

Figure 1.1 Cross section of normal umbilical cord. Embedded within a spongy, proteoglycan rich matrix know as Wharton's jelly (W) are normally two arteries (A) and one vein (V).

Figure (1,1) .[Miller & Hanretty, 1997]

Structures of the umbilical cord:

Structures before full-term: the cord consists of the following :

- Wharton's jelly : which forms the main bulk of the cord and is the substitute of adventitia in other arteries **[Pauli, 1997]**
- Vitello-intestinal duct : connects the yolk sac with the midgut.
- Allantois : a duct which opens into the hindgut.
- Umbilical Vessels : These are 2 umbilical arteries and 2 umbilical veins which run in the connecting stalk to reach the placenta. The right umbilical vein rapidely degenerates completely.
- Vitelline vessels : run in the mesoderm around the vitello-intestinal duct, and drain the wall of the yolk sac.
- Clefts of the extra-embryonic coelom : lie in the proximal part of the cord close to the umbilical orifice and receive the loop of midgut which herniates into these clefts. **[Gaballah & Badawy, 1997]**

The allantois and the vitello-intestinal duct are the only endodermal structures in the cord; all other structures are mesodermal structures. **[Gaballah & Badawy, 1997]**

Structures at full-term: the cord has the following features :

- It reaches the length of 50cm.
- It is normally attached to the foetal surface of the placenta, near its centre.
- It shows disappearance of the right umbilical vein and the vitello-intestinal duct.
- The cord always shows spiral torsion which may be due to unequal growth of the umbilical vessels. **[Gaballah & Badawy, 1997]**

Changes after birth :

At birth the cord is cut, and its constituents which lie in the body of the child becomes transformed into ligaments as follows:

- Left umbilical vein: becomes the ligamentum teres of the liver.
- Umbilical Arteries: become obliterated to form the lateral umbilical ligaments (one on each side).
- Allantois : forms the urachus which becomes fibrosed to form the median umbilical ligament. **[Gaballah & Badawy, 1997]**

Abnormalities of the umbilical cord

A- Abnormal length

- Too long : predispose to prolapse, true knots and coils of the cord around the neck.
- Too short : predispose to accidental haemorrhage due to premature separation of the placenta , and may predispose to prolonged 2nd stage of labour or even inversion of the uterus **[salem, 2001]**

B- Single umbilical artery: it may be associated with other congenital abnormalities in the fetus. Approximately 1% of all umbilical cords contain only one artery–rather than the normal two. Although many infants born with a single umbilical artery have no obvious anomalies, single umbilical artery has been associated with cardiovascular anomalies in 15-20% of such cases. While these anomalies could be the result of genetic factors alone, environmental factors may also play a part. For example, Naeye has shown an association between a single umbilical artery and maternal smoking during pregnancy. **[Kliman, 1998; salem, 2001]**

Umbilical cord function

While superficially simple in both structure and function, the umbilical cord, of course, serves as a critical lifeline to the developing fetus. Its importance is obtained from two functions: the first one is that it forms a link between the fetus and the placenta, through which the umbilical vessels pass. The second one is that it gives the fetus full freedom to move within the amniotic fluid. [Pauli 1993; Kliman,1998]

Pathological conditions affecting the umbilical cord

As with any organ or tissue, the umbilical cord can be subjected to both intrinsic and extrinsic pathological processes. Intrinsic processes include inflammation, knots and torsion, while extrinsic damage can occur iatrogenically following invasive, diagnostic procedures.[Kliman,1998]

The most common pathological finding in the umbilical cord is funisitis. Funisitis is cord inflammation and it is the result of neutrophils being chemotactically activated to migrate out of the fetal circulation towards the bacterially infected amnionic fluid. Since the ability of neutrophils to respond to chemokines and endotoxin is dependent on cellular maturation, it is not surprising to note that funisitis is only seen commonly after 20 weeks of gestation.[Kliman, 1998]

CHAPTER 2

MICROSURGICAL TRAINING

Microsurgery is not just surgery under the operating microscope.[Fox, 1976] To perform microsurgery correctly, exact knowledge of the operating microscope, microinstruments, suture materials, bipolar coagulator, armrest, and the operating table and stool is needed. They must be handled smoothly and effectively to take advantage of the magnification and good illumination, which in turn enable good discrimination. This knowledge, the basic experience needed in using these tools, and the associated new mode of hand-eye-brain coordination can be systematically acquired only in the laboratory through practice of tissue and organ dissection. [Yasuhiro et al., 1999]

Microsurgery should be learned in the laboratory and not on patients[Yasuhiro et al., 1999] .The techniques are very exacting and at first may seem extraordinary difficult. However, with a reasonable amount of practice one can develop a great deal of facility with the basic techniques. Then when approaching the more involved problems of clinical microsurgery, confidence, which come from a good laboratory background, will allow the operation to proceed much more smoothly. A clinical microvascular case should not be attempted until the surgeon feels quite confident from his laboratory practice that he will have no difficulty anastomosing almost any vessel down to 0.5 mm in diameter. If one does not have access to a small animal laboratory in his hospital or medical center, and is only interested in doing non-vascular microsurgery