Research Journal of Biological Sciences 8 (5): 129-132, 2013
ISSN: 1815-8846

Guiding-Needle Tissue-Forceps: Features and Application

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Abstract: Surgeon dexterity plus proper surgical tools are of the main determinants of optimal incision/wound closure and proper postsurgical healing. Methods of placing surgical sutures vary. Guiding-Needle Tissue-Forceps (GNTF), a new tissue forceps was invented and used to introduce its applicability to set several types of surgical sutures. GNTF was used on phantom models to set several types of conventional sutures as simple interrupted, continuous, continuous lock, horizontal mattress and vertical mattress. GNTF leads the operator mandatorily follow the basic principles of suturing. It can be applied in areas with difficult visibility and poor tool access. All needle types and shapes such as round body, reverse cutting, straight, 1/2, 3/8 and 5/8 circle with standard chord lengths were well compatible with GNTF.

Key words: Guiding-needle tissue-forceps, tissue forceps, suture principles, innovative surgery, incision/wound closure

INTRODUCTION

Most of the ancient civilized nations were accomplished rope makers. Through the ages, the tying of knots has played an important role in the life of man. Because rope could have served few useful purposes unless it could be attached to objects by knots, man's conception of the rope and the knot must have occurred concomitantly. Knotted ropes played many important roles in the ancient world, being used in building bridges and in rigging ships. Because rope and knots have been two of man's most useful tools since the dawn of history, it is very probable that they have acted as main models for surgical knots (Sachs, 1996).

Throughout the development of surgery, it was believed that wounds healed more rapidly when the bandages which bound them were tied with a square (reef) knot. This mythology of knots may have contributed to some surgeon's perception of surgical knots more as an art form than as a science. For those artisans, the use of methods and materials for suturing is usually a matter of habit, guesswork or tradition. This analogical approach may contribute to surgical knot construction employed by many early surgeons. The oldest known suture is in a mummy from 1100 BC and the earliest reports of surgical suture date back to 3000 BC in ancient Egypt. Suturing the skin together has been a part of medicine for hundreds of years (Michel *et al*., 2008; Beer *et al*., 2011). Surgical tissue forceps are important instruments that are used in most surgeries. The last step of a surgical operation is represented by sutures that allow the wound lips edges approximation and their stabilization, to promote haemostasis and allow the first intention healing (Minozzi *et al*., 2009). In the last 4 decades, several modifications in tissue forceps have been reported to perform more specialized maneuvers. Siegel (1976) introduced sustained-grip, pressure-release tissue forceps. Smith (1976) modified sliding lock of standard tissue forceps to increase its usefulness in many surgical procedures. Thorlakson (1986) designed a set of double-angled needle holders and long, angled tissue forceps and presented it for use in surgery of the abdomen. He showed that multiple variables in use provided by his instruments, particularly when used together, enhanced surgical control at sites such as pelvis, subdiaphragmatic area and in large and obese patients. Frankel (1988) developed Frankel-Adson forceps as a new instrument. It was a combination of skin hook and tissue forceps for dermatologic surgery. He claimed that by using his instrument the surgeon can further reduce the risk of tissue trauma during surgery. Freistadt (2000) modified tissue forceps for use during umbilical laparoscopic entry and closure. It was a modification of the common tissue or thumb forceps which facilitated initial transumbilical entry into the peritoneal cavity at the start of a laparoscopic procedure and at closure of that umbilical port. The modification consisted of placement of teeth on the outside and inside of the forceps jaws. The instrument used to hold tissue and also as a spring retractor to hold open the umbilical crater. Macht and Krizek (1978) evaluated their "tissue welding forceps" effectively in a number of surgical procedures including blood vessel harvesting and tonsillectomy. Their initial evaluation suggested that use of tissue welding forceps was safe in superficial parotidectomy and may help reduce the development of

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postoperative facial paresis. Minozzi *et al*. (2009) developed pressure-release tissue forceps which its jaws are serrated for nonslip retention of vessels, so it cannot damage tissue while holding firm. Breslin *et al*. (2010) built a new needle catching instrument for suturing simple wounds in the emergency department. The instrument comprises a tissue forceps at one end with a piston and barrel system which acts as a needle grasper at the other end of the instrument. They showed that it minimized exposure of the needle during suturing and reduced risk of injury.

Techniques of surgical suturing, thread materials and skill of surgeon ensure the optimal clinical results (Michel *et al*., 2008; Silverstein *et al*., 2009). Guiding-Needle Tissue-Forceps (GNTF) was invented and used to introduce its performance to set versatile types of surgical sutures. In this regard, GNTF was used on phantom models to reach such a goal. However, it lets the operator mandatorily follow the basic principles of suturing. This study will discuss its usefulness and feasibility in suturing techniques to help the clinician attain uniform closure of incisions and wounds, hence better prognosis of healing during post operation period.

MATERIALS AND METHODS

Guiding-Needle Tissue-Forceps (GNTF): GNTF is a unique tissue forceps because of its tip structure. The tip assembly was built from silver and soldered on terminals of conventional pincets. It was then implemented to set various types of sutures on phantom models using appropriate needles and threads. In all cases, needle holders used to conduct the needles though tip cones.

Needles and threads: Several needle types including round body, reverse cutting, straight, 1/2, 3/8 and 5/8 circle and thread types were examined while evaluating GNTF.

Types of sutures applied by GNTF: To fulfill the main goal of the study, GNTF capability was examined on performing most common types of sutures. In this regard, similar to conventional suturing procedure, by aid of needle and needle holder, versatile suture types applied on phantom models by using GNTF.

RESULTS

GNTF tip assembly: The structural specification of GNTF tip is represented in Fig. 1. The parts and their functions are as follows:

- Tip cones conduct the needle to ducts
- Ducts conduct the needle to enter the tissue in perpendicular angle

When, the tissue is in GNTF hold, ducts form a mandatory passage in such a way that needle is conducted through without deviation (Fig. 2). This type of passage conduction provides uniform entry and exit of the needle throughout all sutures, hence resulting in a uniform set of sutures:

- Each tip cone bears a slit in its upper side. Tip slit allows threat get freely released from tip assembly after needle and thread passed through tissue

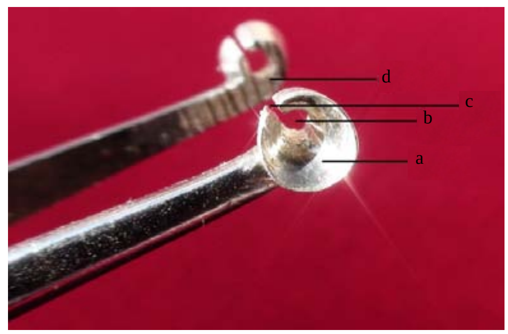

Fig. 1: Main parts of GNTF tip: a) Tip cone; b) Duct; c) Tip cone slit; d) Contact ridges

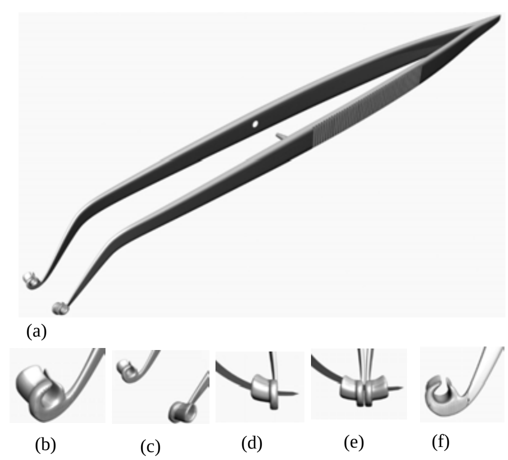

Fig. 2: Schematic use of needle and thread with GNTF: a) Full view of GNTF; b) Tip view of GNTF bearing cone and slit; c) Both tips of GNTF; d) Needle conduction through one tip cone; e) Needle passing through the tip cones while grasping wound lip in between. It enters the tissue in perpendicular angle; f) Tip contact ridges which provide better contact and minimize slippage. Other maneuvers and techniques of suturing follow similar to conventional tissue forceps

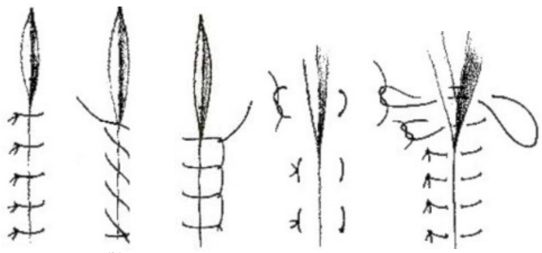

Fig. 3: Suture types applied on phantom models by use of GNTF. Suture types include: a) Simple interrupted; b) Continuous; c) Continuous lock; d) Horizontal mattress; e) Vertical mattress

- Contact surfaces: GNTF's tip contact surfaces bear contact ridges and have such a design that they hold the cut-edges tight together. They help the passage of suture needles perpendicularly through the ducts

Suture knots: GNTF had capability to set versatile suture knots on phantom models. Its maneuver in process of suturing is simple and quite comprehensive to handle. GNTF offered uniformity in suturing in many types of surgical knots as simple interrupted suture, continuous suture, continuous lock suture, horizontal mattress and vertical mattresses indicated in Fig. 3.

DISCUSSION

Methods of placing sutures vary and run the gamut from simple running sutures to intricate sutures (Beer *et al*., 2011). All needle types and shapes such as round body, reverse cutting, straight, 1/2, 3/8 and 5/8 circle with standard chord lengths were well compatible with GNTF. In other words, the proper application of GNTF depends primarily on appropriate needle and thread diameters. GNTF performance proved to set several types of sutures including; simple interrupted, continuous, continuous lock, horizontal mattress and vertical mattress on phantom models successfully.

If GNTF proves its feasibility in human sutures, it may then be considered as a new surgical tool. Surgical related features and GNTF applicability seems to bear the following advantages:

- GNTF lowers chance of suture rapture or tearing apart of the two lips of the suture enforced by post- operational inflammation-strains
- GNTF may be qualified to replace some of conventional pincets
- GNTF can be applied in areas with difficult visibility and poor tool access as posterior areas in oral surgeries
- GNTF's grasping tip-ridges may help the surgeon for better anchorage of slippery tissues
- GNTF's application may help the surgeon to perform more precise sutures, faster suturing and less need of an aid during suturing

Establishing optimal incision/wound closure is paramount for proper postsurgical healing. GNTF criteria ensure uniformity in needle entrance-angle, thickness of grasped tissue and spatial similarities of the suture knots throughout the procedure.

CONCLUSION

This study discusses GNTF's usefulness and feasibility in suturing techniques with the hope that it will help the clinician attain uniform closure of incisions and wounds; hence better prognosis of healing during post operation period. Its application ensures uniformity in needle entrance-angle, thickness of grasped tissue and monotony of the suture knots throughout the procedure and enhanced aesthetics. If GNTF proves its feasibility in human surgical incision/wounds, it may then be considered as a new surgical tool.

ACKNOWLEDGEMENTS

Researchers like to express the deepest thanks to: Dr. A. Khojasteh, H. Behnia, M. Moezzi, F. Poordanesh, M. Kadkhodazadeh, H. Mortazavian, E. Vahid Dastjerdi, O. Dianat, F. Mashadi Abbas, M. Jafarian, M. Eghbal, H. Mirmohammad Sadeghi, M. Nouri, A. Showkatbakhsh, M. Rahimi, M. Kharazifar and Mr. R. Ghasemi for their help, scientific advice and support throughout this study.

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