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Organizing and Practicing the Skill of Tendon Suturing in Orthopedic Postgraduate Training

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**Abstract.**

The authors proposed using simulants (training models) to practice the methods of tendon suturing during the pedagogical process. During practical classes training model allows orthopedists to master and improve their skills in suturing the ends of the ruptured tendon independently. The existing models for practicing tendon suturing are discussed in details. The description of the simulant is presented. The advisability of its application during thematic practice-oriented classes is justified.
**Introduction**

Modern requirements for quality performance of surgical interventions in traumatology and orthopedics need constant improvement of professional skills which is based on deep knowledge in fundamental sciences as well as in topographic anatomy and pathophysiology [1]. The understanding of the biomechanical characteristics of the musculoskeletal system functioning under the guidance of an experienced teacher allows mastering basic surgical skills required to perform orthopedic interventions and manipulations independently.

However, the process of learning is not simple in terms of transfer of knowledge from a teacher to students. It is the result of personal growth and self-improvement of future specialist by continuous acquisition of new knowledge and skills according to chain algorithm: theoretical training – consolidation of knowledge using practical skills – control of the skill level – assessment - comments and corrections made by the teacher. Clinical thinking is formed during the process of continuous theoretical training and reasonable analysis of clinical cases. Professional skills directed to practical simulation of complex surgical interventions and manipulations should be modeled, simulated and practiced using visual aids, simulants, and devices, with the physician’s active participation.

Having graduated from higher education institution and obtaining specialization medical specialist must find employment, perform the employment duties according to the requirement of healthcare facility, and possess major practical skills. Further development as a specialist involves continuous laborious self-improvement. The World Federation for Medical Education (WFME) states that the main emphasis in the postgraduate education should be placed on training open-minded physicians possessing comprehensive skills [3, 4].

Modern medical technologies require in-depth preparation of orthopedists possessing modern complex technological methods. It necessitates narrow thematic specialization and individualization of the learning process [2].

Internet resources allow us to visualize different stages of surgery using photo and video materials accompanied by professional comments. However, visual perception of the information is not able to replace practical mastering of skills on the basis of theoretically acquired knowledge and skills on own initiative. In other words, professional materialization of theoretical knowledge should occur continuously.

**The objective** of the research was to implement the process of practicing the skill of tendon suturing by physicians during post-diploma training, thematic lesson “Traumatology and Orthopedics” in particular.

**Discussion**

The possibility to create conditions for direct participation of interns or trainees in assistance when suturing tendon is offered relatively rare. Therefore, the objective was realized by the development, implementation and regular practical application of simulant (training model) during practical part of thematic lesson.

Practicing the skill of tendon suturing by means of its simulant made of PVC pipes is well known [5]. However, during practical implementation of this process some difficulties occur. Significant disadvantage is the roughness of the material being recommended to use. The difficulties occur every time when you try to puncture the area of the solid cross section of the tube with atraumatic round needle. There is a discrepancy and significant dissonance between perceptive contact and the material being too remotely similar to tendon in terms of its elastic properties. In addition, the needle, which is fixed in the needle holder, repeatedly slides down from the smooth and rough surface resulting in needle bending or even its fracture. In most cases the attempts to suture the lateral surface of the tube are foredoomed to failure, as the tangent direction of suturing axis toward simulant (modeling of loop-shaped suture) is accompanied by rotating of the tube around its
axis and requires stronger external fixation. The difficulties increase when you try to model a locking-loop tendon suture.

Training models made of foam strips also have some disadvantages; they are too soft and weak. Their structure is not suitable for simulation of tendon suture when modelling the finger flexor tendons of normal thickness. Tubular material of silicone adapter of the transfusion system the thickness and elastic properties of which resemble those of tendons more nearly has noticeably better properties. However, to objectively assess the results of tendon suture simulation in its cross section is difficult, as the material is non-transparent.

To simulate practical skills of suturing the ends of the ruptured tendon more realistically we have proposed the production of tendon simulant (rationalization proposal No 3247/14).

To produce tendon simulant transparent industrial silicone packed in the syringe with a nozzle having cone-shaped (tapered) contact surface was used. After cutting off the tapered end of the syringe, a conical nozzle (tubus) was screwed into the syringe. The tip of tapered nozzle was previously cut off at a desired distance forming the required thickness of simulant cross section: the closer to nozzle tip, the thinner thickness is (Fig. 1). We received an oval or round simulant through tapered nozzle placed at an angle to non-adhesive surface (for example, polyvinylchloride (PVC) film) when pushing the syringe plunger touching and sliding on the surface. Its length was limited by the amount of silicone in the syringe only.

Fig. 1. Tapered nozzle. Cutting off levels

After complete silicone solidification (about 24 hours) it was intersected transversely being fixed in the holders (Fig. 2).

Fig. 2. Silicone simulant fixed in holders

So, the simulant was ready to be used in practicing skills of tendon suturing or plasty according to the selected method (Fig. 3, 4).
Fig. 3. One of silicone simulant ends sutured with atraumatic braided material

Fig. 4. Simulant ends are sutured (locking-loop suture)

Significant advantage of this simulant includes its transparency which allows us to control the correctness of needle puncture and ligature direction. Mechanical properties of roughness and, in the other hand, elasticity and flexibility allow us to hold the simulant with forceps safely and easy as in case of tendon holding as well as to puncture transversely and tangentially. Particularly, elastic simulant properties allow us to observe cutting of material with ligature almost like in case of natural tendon. Such phenomena are observed when manipulations are performed with jerky movements; the needle is pressed or punctured sideward; the ligature is moved sharply and pulled. Silicone simulant responds to using barbed or cutting needle adequately cutting through at the site of the puncture. Special attention should be paid to the skill of knot tying. If simulant ends placed adequately – the knot is tightened without exerting any tension – cutting off is not observed. And vice versa – if the knot is tightened with considerable tension it leads to silicone destruction and simulant rupture.

The locking loop tendon suture also deserves attention. Monofilament ligature makes a contrast on the sutured simulant ends after placement of the main suture.

To increase the longitudinal strength and flexibility of the simulant liquid silicone should be applied on stretched and previously fixed ligatures. Transparent fishing line can also be used as the reinforcing material. Thus, after hardening, silicone simulant reinforced with ligatures acquires more strength which can be checked up, if necessary, comparing different suturing methods.

If the simulant with larger cross section is needed tapered nozzle should be cut off more proximally. For example, to produce the Achilles tendon simulant and form flat cross section silicone you should wrap it with PVC film and apply force with your fingers to achieve desired profile.

The proposed simulant allows practicing the technique of placing tendon suture of any type and complexity. Tendon thickness and form are also considered.

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control the correctness of suture placement. Moreover, the application of elastic ligatures of different colour allows us to control the stages of tendon suturing as well as to assess the final results. If necessary, you may organize several working areas to practice practical skill, simulate the operating room process using surgical gloves maximally complying with the rules of asepsis and antisepsis. The results of working in "surgical teams" can be timed, evaluated, visually compared, stored for a long period of time and demonstrated to visualize the learning process. The method is safe for the learning process and informative in terms of objective assessment of the results of preparation for tendon suturing.

**Conclusions**

An important direction of pedagogical work in terms of formation of professional level of an orthopedist is realistic situational simulation of narrowly specialized practical skills under routine clinic conditions.

The proposed simulant used for practicing the skill of tendon suturing allows mastering the method of tendon suturing, assessing the correctness of suture placement and, to a certain extent, determining the reliability of suture connection. This simulant is safe and available being a significant addition to the overall program of training orthopedists-traumatologists.

The application of training models promotes deeper mastering of professional manipulations according to established standards as well as improving training effectiveness.

**References**

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