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Clinical Paper
TMJ Disorders

Validation of a simulator for temporomandibular joint arthroscopy

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Abstract. The traditional method of surgical training has followed the ‘observe, practice, and teach’ model, which is useful for open surgery, but is insufficient for minimally invasive surgery. This study presents the validation of a new simulator designed for TMJ arthroscopy training. A group of 10 senior maxillofacial surgeons performed an arthroscopy procedure using the simulator. They then completed a questionnaire analyzing the realism of the simulator, its utility, and the educational quality of the audiovisual software. The mean age of the 10 surgeons was 42.6 years, and they had performed a mean 151 arthroscopies. With regard to the realism of the simulator, 80% reported that it was of an appropriate size and design and 70% referred to the very realistic positions and relationships between the internal structures. Regarding its educational potential, 80% reported the simulator to be very useful for acquiring the basic skills and to acquire the sensation of depth during access to the TMJ. Finally, 90% reported the prototype to be very useful for TMJ arthroscopy training. These preliminary results showed a high degree of approval. The general opinion of the group of experts was that the experience was rewarding and inspiring, and that the prototype has the educational potential for the achievement of basic TMJ arthroscopy skills.

Key words: temporomandibular joint surgery; temporomandibular joint disorders; arthroscopy simulator; surgical simulator; surgical education; simulation.

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The use of simulators for skills training is a common practice in our daily life, although we are probably unaware of this. Video games, virtual simulators in aeronautical engineering, and fire drills to evacuate a building are examples of simulations used in our daily routine. A training simulator can be defined as any system that provides the most realistic possible imitation of the steps necessary to follow in a specific procedure.[1] Simulators are usually intended to recreate a real scenario in which events do not occur in an arbitrary way, but rather are previously planned. In this way, training with simulation allows the same procedure to be repeated as many times as needed until the basic skills are acquired, which will later be used in real life.

Generally, simulators are categorized into two types, realistic and virtual. However, it is becoming increasingly more common to find hybrid simulators that combine a device or real scenario with virtual reality software. The use of such simulators in the various fields of Medicine is widespread, such as the use of mannequins to learn to find a blood vessel and to perform the manoeuvres for cardiopulmonary resuscitation or orotracheal intubation.

In surgery, the use of simulators has been common practice for years. There is a multitude of designs – physical, virtual, and hybrid – with hybrid designs being the most recent and undergoing constant development. Another model is the use of animals in experiments, for which anatomical dissimilarities need to be taken into account. Despite the efforts made to find the perfect simulator, the cadaver continues to be the gold standard due to its close resemblance to the real patient. However, the cadaver has certain drawbacks, such as the high cost, the legal requirements, lack of availability in all hospitals, lack of reusability, failure to reproduce different pathologies, and numerous political, cultural, and religious considerations.

For surgical training, most learning programmes in recent decades have followed the Halstedian model, which consists of 'observing, practicing, and teaching'. Surgeons without experience acquire autonomy in a progressive way as they follow surgical procedures under the supervision of an expert surgeon.[2] Nevertheless, there are many limitations to the traditional training method including high costs, the pressure to be present, limited training time, difficulties in monitoring, ethical and legal restrictions, and the lack of standardization; furthermore, it depends on the number of patients, the opportunities for learning, and the advent of new minimally invasive techniques. As a consequence of all these drawbacks, numerous training modalities for surgical techniques have been developed outside the operating room so that the surgeon can negotiate the learning curve before moving on to real patients.[3,4]

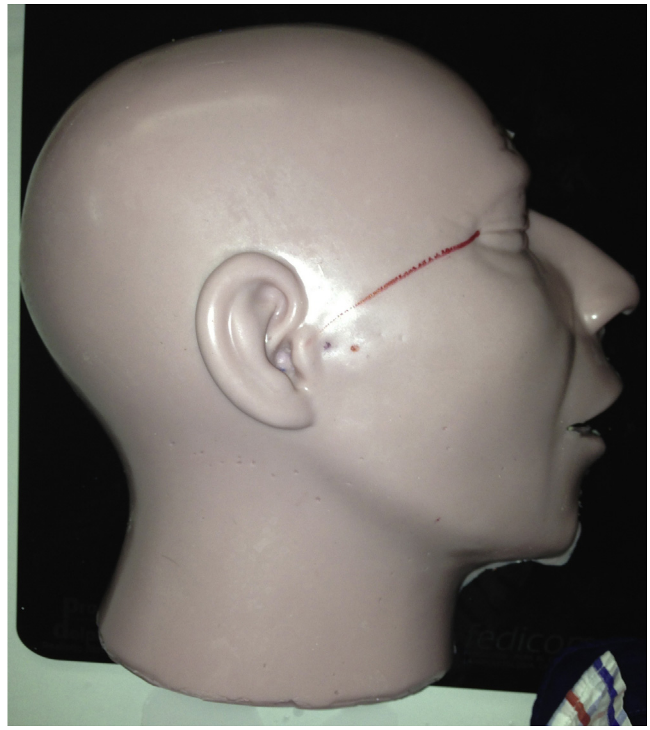

Fig. 1. Design of the prototype.

Within the field of maxillofacial surgery, arthroscopy of the temporomandibular joint (TMJ) is a common technique that has proven effective in the diagnosis and treatment of TMJ disorders. However, the difficulties of the technique make learning complex and sometimes frustrating.[5] Given the extensive experience of the present study team in performing TMJ arthroscopy procedures, there is an apparent obligation for us to offer our surgeons, visitors, and residents a method that will enable them to learn the technique. This method should be reproducible, accessible to any specialist, and allow them to keep updated.

A realistic physical simulator that has been developed for training in arthroscopy of the TMJ is presented herein. The prototype has been constructed according to anthropometric standards using a material that reproduces the different textures and colours of all anatomical parts in the design (Neoderma, Brasil) (Fig. 1). Thus, the skin, subcutaneous tissue, parotid gland, facial nerve, temporal vessels, ligaments, and articular capsule can be distinguished (Fig. 2). In addition, a virtual teaching unit has been designed that consists of an electronic device connected to the simulator, which contains a library of contents grouped into different categories, including theoretical information such as explanatory videos.

The aim of this study was to obtain and report preliminary results for the validation of the simulator. This validation study involved a group of recognized

Fig. 2. (A) The anatomical components of the prototype, including vessels, nerves, and parotid gland. (B) The masseter muscle is found in a deeper layer. (C) The joint capsule and ligaments involving the TMJ are designed using the same material.