Ideal lines of osteosynthesis in mandibular parasymphysis fracture: case report

Linhas ideais de osteossíntese em fratura de parassínfise mandibular: relato de caso

Líneas ideales de osteosíntesis en fractura de parasínfisis mandibular: reporte de caso

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ABSTRACT

Through the case report of a patient who suffered trauma to the face, presenting a complete fracture line in the left mandibular parasymphysis region, as well as an incomplete bilateral condylar fracture line ("green branch" pattern), the study intends to revisit the literature on the ideal lines of rigid fixation for osteosynthesis of the mandible, the influence of tension and compression zones in the choice of plates and screws and, finally, the reason for the essential use of two parallel fixation forces in the anterior region of the mandible. Method: Analysis and monitoring of emergency care procedures in the emergency department of the Ruth Cardoso municipal hospital/Balneário Camboriú-SC, clinical and tomographic examinations, photographic records before and after the surgical procedure (up to the third month after

trauma), outpatient follow-up after hospital discharge and literature review on the proposed topic. Conclusions: By restoring function and aesthetics through osteosynthesis appropriate to the biomechanical standards of the mandibular bone, proposed since Maxime Champy and still endorsed by the AO Foundation (Association for the Study of Internal Fixation), among the treatment possibilities, it was concluded that the good quality of the material needs to be linked to constant scientific knowledge (biomechanical and surgical) to optimize clinical results.

Keywords: trauma, mandibular parasymphysis, rigid internal fixation.

RESUMO

Por meio do relato de caso de um paciente vítima de trauma em face, apresentando traço de fratura completa em região de parassínfise mandibular esquerda, bem como traço incompleto de fratura bilateral de côndilos (padrão "galho-verde"), o estudo intenciona revisitar a literatura acerca das linhas ideais de fixação rígida para osteossíntese da mandíbula, a influência das zonas de tensão e compressão na escolha das placas e parafusos e, finalmente, o porquê da essencialidade do uso de duas forças paralelas de fixação em região anterior mandíbula. Método: Análise e acompanhamento das condutas no atendimento de urgência do setor de pronto-atendimento do hospital municipal Ruth Cardoso/ Balneário Camboriú-SC, exames clínico e tomográfico, registros fotográficos anteriores e posteriores ao procedimento cirúrgico (até o terceiro mês pós trauma), acompanhamento em ambulatório após alta hospitalar e revisão de literatura acerca do tema proposto. Conclusões: Ao devolver função e estética por meio de osteossíntese adequada aos padrões biomecânicos do osso mandibular, propostas desde Maxime Champy e até hoje chancelada pela AO Foundation (Associação para o Estudo da Fixação Interna), dentre as possibilidades de tratamento, concluiu-se que a boa qualidade do material precisa estar atrelada ao constante conhecimento científico (biomecânico e cirúrgico) para a otimização de resultados clínicos.

Palavras-chave: trauma, parassínfise mandibular, fixação interna rígida.

RESUMEN

A través del relato de caso de un paciente que sufrió un traumatismo en la cara, presentando un trazo de fractura completo en la región de la parasínfisis mandibular izquierda, así como un trazo de fractura condilar bilateral incompleto (patrón "rama verde"), el estudio pretende revisar la literatura sobre las líneas ideales de fijación rígida para la osteosíntesis de la mandíbula, la influencia de las zonas de tensión y compresión en la elección de placas y tornillos y, finalmente, el porqué del uso esencial de dos fuerzas de fijación paralelas en la región anterior de la mandíbula. Método: Análisis y seguimiento de los procedimientos de atención de emergencia en el servicio de urgencias del hospital municipal Ruth Cardoso/Balneário Camboriú-SC, exámenes clínicos y tomográficos, registros fotográficos antes y después del procedimiento quirúrgico (hasta el tercer mes después del trauma), seguimiento ambulatorio después del alta hospitalaria y revisión de la literatura sobre el tema propuesto. Conclusiones: Al restaurar la función y la estética a través de la osteosíntesis adecuada a los estándares biomecánicos del hueso mandibular, propuesta desde Maxime Champy y aún avalada por la Fundación AO (Asociación para el Estudio de la Fijación Interna), entre las posibilidades de tratamiento, se concluyó que la buena calidad del material necesita estar vinculada al conocimiento científico constante (biomecánico y quirúrgico) para optimizar los resultados clínicos.

Palabras-clave: trauma, parasínfisis mandibular, fijación interna rígida.

1 INTRODUCTION

Mandibular fractures are epidemiologically relevant in facial trauma due to their high frequency in the area of oral and maxillofacial surgery. Therefore, it is essential to recognize the importance of appropriate treatment, aiming to reestablish aesthetic and functional deformities. Currently, many techniques for mandibular osteosynthesis are reported in the literature, and the surgeon should choose the best form of treatment considering aspects related to the pacient and fracture (Ramos-Reis J.E. *et al.*, 2021).

From this perspective, the mandible is identified as the most frequently fractured bone structure, which may occur in isolation or in conjunction with other facial structures, with a predictability of mandibular, zygomatic and maxillary involvement in the proportion of 9:4:1, statistically representing 15.5% to 59% of all facial fractures (Yazdani, J.*et al* , 2019). Several authors attribute this prevalence to mandibular osteology, including projection and mobility, which contribute to the primary absorption of trauma by this structure. In addition, there are specific mandibular areas that are more predisposed, due to muscle attachments and dentition (Ramos-Reis J.E. *et al.*, 2021 ; Vashishta, A. *et al* , 2017).

Many methods have been used in the treatment of mandibular fractures, and the concept of bone plates (rigid internal fixation) has been increasingly improved as a product of the technological evolution involved in the engineering of these biomaterials. Currently, the use of titanium alloy miniplates has been the most popular method for the fixation of bone fractures in the face due to their biocompatibility properties, relative simplicity in handling during the surgical procedure and good clinical results over the years, as demonstrated by several studies (Yazdani, J.*et al* , 2019; K.-U. Feller *et al*, 2002).

Rigid internal fixation of the mandible, introduced by Michelet (1973) and later improved by Champy (1975), is still the standard for treating these fractures. In the surgical technique, two miniplates are fixed in the portion between the mental foramens. The upper one (in the tension line, on the base of the alveolar ridge) is fixed monocortically, in order to avoid injuries to the dental roots of the anteroinferior segment (K.-U. Feller *et al*, 2002). Due to the thinness of the cortical bones, the probability of injuries to the roots of the lower dental elements is three times greater than in the maxila (Borah G.L; Ashmead, D, 1996).

Champy *et al* , in 1975, demonstrated that for the ideal osteosynthesis of any fracture, the surgical procedure of reduction and fixation should be based on the lines of tension and compression suffered by the bone being treated (in the present study, the mandible). According to the authors, the alveolar ridge (upper mandibular portion) is where the tension forces are

acting, while compression forces can be detected at the lower edge of the mandible, by the action of the depressor muscles (figure 1).

The continuous functions of the stomatognathic system (responsible for these force vectors, according to each muscular action involved), are of fundamental understanding at the time of fixation of the fractured segments. In the region of the mandibular symphysis and parasymphysis, torsion vectors are also added (evaluated and demonstrated in the study by Champy *et al* in a graph by region of dental correspondence in the mandible (figure 2).

The authors demonstrated that, due to these torsional forces, the anterior region of the mandible requires two fixation bands (plates) so that – at a three-dimensional level – it is possible to adequately restore the mechanical functions of the fractured mandibular bone. Thus, the tension forces in the mandible, promoted by the stomatognathic system, are present in the alveolar ridge region, and can cause bone distraction in the fractured segments. The compression forces, potentiated by the torsional vectors in the symphysis and parasymphysis region, require a second fixation band (bicortical), at the mandibular base, so that the mechanical qualities of the mandible can be completely restored (Ramos-Reis J.E. ,*et al* , 2021 ; Saluja, H.Y., 2012). These two lines, called ideal osteosynthesis lines, advocated in this study are still used today as a reference for the fixation of these fractures.

Treatment for these fractures, which should be based on the location, degree of displacement, age and health of the patient, is usually done with open reduction, although closed reduction is an alternative for patients with simple, non-displaced fractures. Due to torsion, fixation with two miniplates, one at the lower edge of the mandibular symphysis (bicortical) and the other 4 to 5 mm above (at the base of the alveolar ridge, monocortical), offers good results ((Ramos-Reis J.E. ,*et al* , 2021).

The present study aims to interrelate the established concept of ideal osteosynthesis lines proposed by Champy *et al*.[6], with the case report of a patient who suffered trauma to the face, presenting a complete fracture line in the left mandibular parasymphysis region, as well as an incomplete bilateral condylar fracture line (“green branch” pattern), duly authorized according to the attached free and informed consent, from the moment of admission to the emergency room of the Ruth Cardoso Hospital and Maternity, Balneário Camboriú-SC, until 90 days postoperatively using SignoOrtho® titanium plates and screws.

2 CASE REPORT

Patient G.R.F., male, 31 years old, admitted to the emergency room of the Ruth Cardoso

Hospital and Maternity in Balneário Camboriú-SC, victim of a scooter accident, presenting with a cut-contusion injury in the chin region (as well as facial abrasions, lip edema and anterior upper alveolar-dental trauma, with the consequent avulsion of elements 12, 21 and 22). The tomographic image examination detected a complete fracture line in the left mandibular parasymphysis region with displacement of the bone stumps (clinically, unevenness of the lower occlusal plane, in a typical step indicative of fracture mandibular), in addition to incomplete fracture traces, bilaterally, in condyles (also within a pattern of force vectors transferred from the impact on the chin and absorbed by the condyles, resulting in fractures of the same), as shown in figure 3.

The surgical approach (open) was chosen for the reduction and fixation of the fracture in the parasymphysis and conservative conduct (closed) with the use of locking screws (placed at the time of surgery) associated with the use of orthodontic elastics for the condyles that presented incomplete fractures, "green branch" pattern and, therefore, favorable to osteosynthesis.

After general anesthesia and nasotracheal intubation, asepsis procedures were performed, sterile surgical fields were placed, and the oropharyngeal tamponade was positioned. Four 2.0 mm self-drilling locking screws were then properly positioned in the interpremolar region (upper and lower, bilaterally) for intermaxillary locking and occlusal reestablishment with sterile steel wire. The occlusal guide allowed the correct repositioning of the fractured bone stumps in the left parasymphysis region, where - according to the ideal osteosynthesis lines proposed by Champy[6] – two straight 2.0 mm SignoOrtho® system plates were positioned.

The plate in the tension line (base of the alveolar region), with four holes, used four 04 mm titanium screws (monocortical), while the plate positioned in the compression line (basilar central region of the mandible), with six holes (three holes proportionally positioned on each side of the fracture line), and six screws of 6 and 7 mm (bicortical). The lower plate was first positioned, approximately 5 mm away from the second plate (upper), as recommended by Champy *et al*.[6,7], as demonstrated in figure 4.

The fixation bands must follow the balanced pattern in terms of the number of drilled points (also using the specific drills and keys for each system), so that the fracture line remains under the extension of the plate (and not at the insertion point of any screws used). Unfortunately, teeth 12, 21 and 22 were lost due to alveolar-dental trauma and, already dislocated, were removed during surgery.

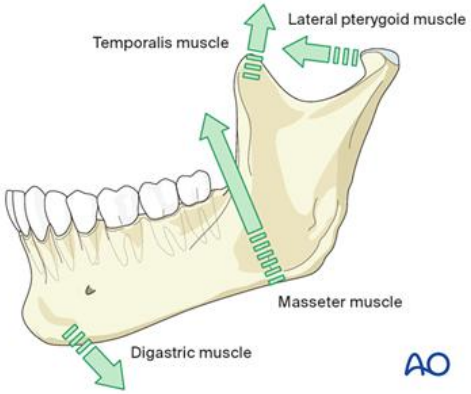
After confirmation of adequate fracture reduction and rigid internal fixation, the

occlusion was rechecked and suturing was performed in layers (deep and mucosal with Vycril® 2-0 absorbable suture) and lacerations of the lip, skin and alveolar with 5-0 nylon suture. The locking screws were kept for monitoring that took place up to 45 days after the trauma with the use of intermaxillary orthodontic elastics due to concomitant incomplete fractures in the condyle region, bilaterally and not due to the parasymphysis fracture. Champy *et al* [6], state that - once the ideal osteosynthesis lines are respected - there is no need for intermaxillary locking when fractures in the mandibular symphysis and parasymphysis are isolated.[9]

The patient underwent radiography of the facial bones in the immediate postoperative period, and was followed up on an outpatient basis 30, 60 and 90 days after the procedure, with new computed tomography scans of the face performed 30 and 90 days after surgery, respectively. The intermaxillary locking screws were removed 45 days after surgery and the use of orthodontic elastics, in an outpatient clinic. Mouth opening was also reassessed, with complete clinical progress until the end of follow-up. Temporary paresthesia was reported and associated therapies were indicated, such as laser and vitamin B complex supplementation for the total reconstruction of the mental nerve affected during the trauma, as well as the subsequent dental treatments necessary (implants) for the total functional and aesthetic recovery of the patient (figures 5, 6, 7 and 8).

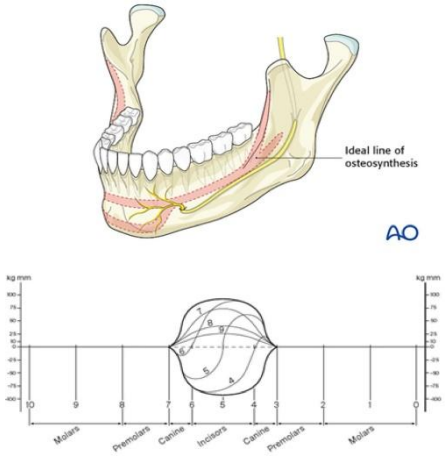
2.1 TITLE OF FIGURES (BOARDS, TABLES, ETC.)

Figure 1: ação muscular na mandíbula



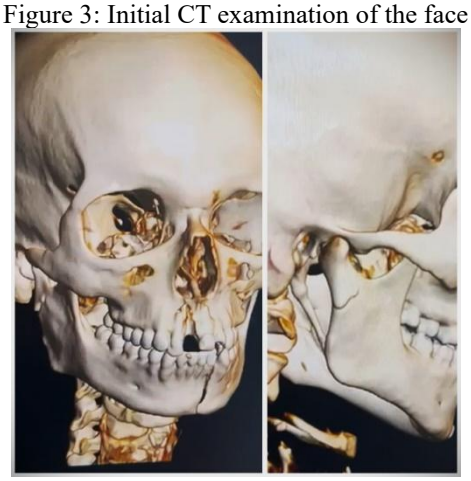
Source :https://surgeryreference.aofoundation.org

Figure 2: Torsion vector in the anterior region of the mandible and ideal osteosynthesis lines by Champy et al[6]



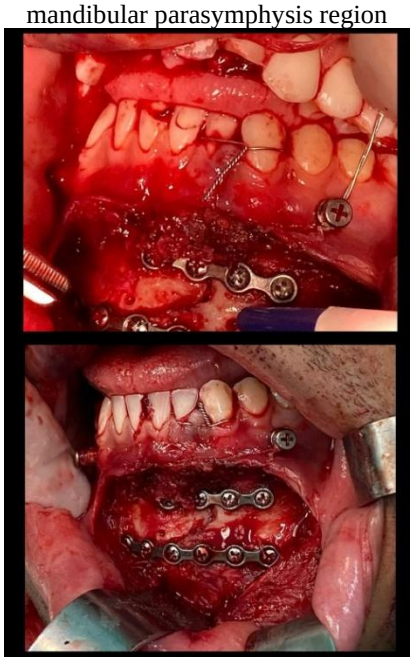
Source :https://surgeryreference.aofoundation.org

Figure 3: Initial CT examination of the face



Source: image produced by the authors themselves

Figure 4: Intermaxillary blockade and final rigid internal fixation following the ideal osteosynthesis lines in the mandibular parasymphysis region

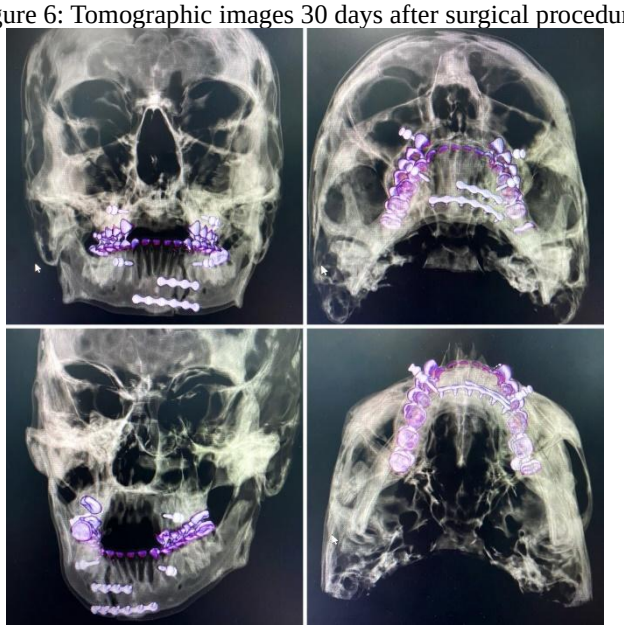


Source: image produced by the authors themselves

Figure 5: Radiograph of facial bones immediately after surgery showing the proper positioning of the plates and locking screws maintained for the use of elastics due to bilateral condylar fracture.

Source: produced by the authors themselves

Figure 6: Tomographic images 30 days after surgical procedure



Source: produced by the authors themselves

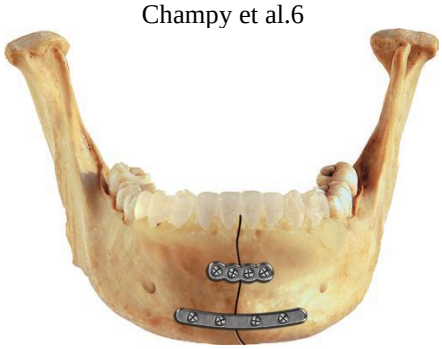
Figure 7: Control tomography 90 days after surgery, showing fixation stability, material efficiency and bone regeneration of the fracture lines

Source: produced by the authors themselves

Photo 8: Clinical control (with dental treatment already completed) 8 months after surgery

Source: photos produced, sent and authorized (as per the attached free and informed consent form) by the patient

Figure 9: Schematic model of fixation in the mandibular symphysis and parasymphysis region, according to Champy et al.6



Source :https://surgeryreference.aofoundation.org

3 DISCUSSION

The biomechanical behavior of the mandible is important in several clinical situations: it interacts with the bone and osteosynthesis materials. Due to this behavior, several studies have been developed to better understand the resulting mechanical action in the different regions of the mandible during its functional demand in order to define these concepts in detail and provide support for the use of stable internal fixation in the surgical treatment of mandibular fractures.[7]

Since the mandible is the only bone in the face that has mobility, and therefore has several forces acting on it, the principles of internal fixation were based on mandibular fixation, since the other bones of the maxillofacial skeleton do not present major problems in relation to their treatment, with a very low percentage of postoperative complications related to bone non-union. For a long time, bone fractures were treated conservatively, with results that were often unsatisfactory.

In the first methods of open reduction, steel wires were used to fix mandibular fractures. Since the steel wires were insufficient to immobilize the fractured stumps, the patient had to be kept in an intermaxillary block until the fracture was consolidated. In the middle of the last century, oral and maxillofacial surgeons rescued from orthopedics and medical traumatology the first devices for internal fixation of the skeleton of the maxillofacial region. It was observed that when the patient was approached through open reduction with rigid internal fixation, the postoperative results were better, and the recovery time was shorter.[7, 11]

The AO-ASIF (Association for the Study of Internal Fixation) was the first institution to investigate and encourage the use of internal fixation using titanium plates, which in the 1960s and 70s were thick (mostly 2.7 mm) for use in the mandible. At that time, it was believed that, in addition to larger plates, it was necessary to use compression between the fractured stumps for optimal bone healing. Thus, the era of compression plates began.

In 1978, Champy [6] described the use of a mini-plate for the treatment of a mandibular angle fracture, which was placed only in the traction band (the area where the fractured stumps tend to separate). Champy[6] observed that the mandible suffered from distinct forces, which characterized traction and compression zones, and advocated the use of skeletal fixation with 3 plates of 2.0 mm profile, placed in the traction band.[6] With this, there was a description of the ideal fixation lines proposed by Champy[6], where the author described that, in the posterior region of the mandible, only one plate was necessary for correct bone repair and in the symphysis and parasymphysis region, two plates were necessary, one in the traction zone and

another in the compression zone, due to the torsional forces suffered in this region.[6]

With these two distinct concepts proposed by Champy[6] and by AO-ASIF, the concepts of rigid internal fixation and functionally stable internal fixation emerged, where, in the first, micromovements between the fractured stumps occurred, however, they did not impede correct bone healing, and in the second, there was absolute stability between the fractured stumps, which also generated adequate healing. Therefore, since the early 1970s, it was already understood that osteosynthesis provided by mini and micro plates had proven successful in treating injuries in the craniofacial region. The advantage of this method over the one used until then is quite large, because - although sutures with metal threads can be used to adapt small bone fragments in the orbito-nasal region - they do not produce three-dimensional stability, requiring several approaches with sutures and potentially damaging the surface of the bone tissue.[10]

In other words, whenever a fracture is treated rigidly, it is as if it did not exist in biomechanical terms, as the two fractured stumps will be juxtaposed in such a way that there will be no movement between them, simulating bone continuity.

Internal fixation with miniplates is described as a system consisting of a plate attached to a screw via the screw-bone interface and is now routinely used for surgical treatment of mandibular fractures. The advantage of using miniplates is that they ensure adequate fracture stability, reducing the risk of postoperative displacement of the fractured fragments. Miniplates can be used for ramus, angle, body, or symphysis fractures.

Fractures with minimal comminution are the most suitable for the application of miniplates, and large intact bone segments provide optimal conditions for a good result.[12]

Considering the scientific evolution of techniques and materials used, the AO (Association for the Study of Internal Fixation) has described the following principles (since 1958) for the reduction and rigid internal fixation of bone fractures:[13]

(1)Anatomical reduction: reduction and fixation of fractures should restore the original anatomy of the affected bone;

(2)Stable fixation: Achieve maximum stability (depending on the type of injury) for adequate osteosynthesis;

(3)Preservation of blood supply: The management of bone stumps must be careful in order to preserve the local vascularization of the bone and soft tissues involved;

(4)Consider not only the fracture, but the patient as a whole (in their functional and aesthetic recovery), as quickly and safely as possible;

The understanding of the ideal lines of osteosynthesis of the mandible when using a

rigid internal fixation system (Michelet in 1973 and Champy, in 1975) provided the foundation for the development of safer, less invasive materials and techniques that are more in line with the objectives proposed by the AO, as described above, aiming at better recovery of the patient suffering from a fracture (in this report, fractures of the mandibular symphysis, one of the most frequent worldwide, due to different etiological factors). Basically, this knowledge has, as its main core, the neutralization of unfavorable tractions acting on the fracture line, while (at the same time) favoring the transmission of compressive forces that maintain the bone stumps in maximum contact, allowing the formation of the bone callus and osteosynthesis.

The advantages are numerous, such as: possibility of smaller incisions (intentionality in choosing the positioning of the plates and screws), less dissection of soft tissues, adequate positioning of the rigid fixation, allowing less postoperative palpability of the permanent material, reduction of the effects of stress on the fixed material (again favoring stability and therefore osteosynthesis), less chance of dental injuries (by respecting the proper positioning of the monocortical and bicortical band), less chance of postoperative infection (which is the main cause of the need for surgical reapproach).[13]

Still according to Champy's ideal lines, the use of two fixation plates is necessary due to the torsional force vectors in the mandibular parasymphysis region, thus eliminating the need for postoperative intermaxillary fixation (figure 9)

4 CONCLUSION

Although the basic foundation regarding the resistance and fragility zones of the mandible, as well as the ideal osteosynthesis lines, have been known and well documented for some decades as theories that guide diagnoses and planning (conservative or surgical) within Oral and Maxillofacial Surgery and Traumatology, we understand that science and technology (since Champy's proposals in the 1970s) have evolved rapidly in terms of fixation materials (from different types of metal alloys, resorbable materials, plate and screw designs) and virtual planning, which increase the precision of professional conduct, in an assertive manner and with more clinical benefits to patients.

Thus, it can be said that science, as a whole, has never been static or crystallized. On the contrary, it revisits previous studies and theories, breaks paradigms or reinforces evidence, as technology walks hand in hand with health (in all its physical, emotional, aesthetic and social well-being aspects). Three-dimensional images and customized materials are realities, today, accessible even within the brazilian Unified Health System (SUS), as is the case of the Ruth

Cardoso Hospital, in Balneário Camboriú-SC, where the clinical case reported was documented and authorized by the patient.

Science, therefore, is made up of constant reflection between theory and practice; investigative and empirical, in order to pave the way for the knowledge that will be passed on to future generations (but also to current ones) of researchers.

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