Escola Superior de Saùde Atlàntica

Diploma in Physiotherapy

Research project

4th year

Academic year 2018/2019

Final project

REHABILITATION AFTER ANTERIOR SHOULDER DISLOCATION WITH THE KINEQUANTUM® TOOL ON YOUNG JUDOKAS

Students:

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Memory tutor:

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Barcarena, 2018-2019

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ABSTRACT

Introduction: Virtual reality allows functional rehabilitation professionals to work in various health fields. This new therapeutic approach transforms conventional exercises into fun and captivating games which also offers the possibility of obtaining measurable positive or negative feedback. In our study, we will combine rehabilitation with virtual reality with conventional rehabilitation on judokas, aged 20 to 29 years old, who have suffered from anterior shoulder dislocation; in order to compare the effectiveness of the different treatments.

Objective: The main objective of our study is to express the positive effects of virtual reality in the rehabilitation of anterior shoulder dislocation. The specific objective of our study is to show the impact of the virtual reality device used on different essential aspects of rehabilitation: muscle recovery and joint amplitude, improvement of shoulder proprioception and stability, reduction of pain and finally reduction of recurrence frequency which consequently lead to the decrease of the surgery recourse concerning this affection.

Methodology: This project is a prospective and evaluative experimental study because it allows the comparison of the protocol on two groups. The control group is subject to a conventional rehabilitation protocol, whereas the experimental group is subject to a protocol combining the principles of conventional rehabilitation and exercises through virtual reality using KinéQuantum®. Tested population sample will be selected according to our inclusion and exclusion criteria and then randomly assigned to both groups. The variables measured are pain, joint amplitude, muscle strength, proprioception, dynamic shoulder stability and recurrence. Using assessments, and statistical analyses, we will be able to compare the effects of the treatment in each group.

Conclusion: The analysis of our study results confirms that VR, here through the KinéQuantum® platform, can become an additional tool in the therapeutic arsenal available for the physiotherapist. However, it is important to remember that this tool is still at the beginning of its medical implementation. As a result, its effectiveness in all aspects of physiotherapy treatment is not yet complete. It is the democratization of this type of technology that will make an improvement possible in order to achieve a more complete rehabilitation.

Keywords: Scapulohumeral anterior dislocation, Virtual Reality, KineQuantum®, Rehabilitation, Unstable shoulder

ABSTRAÇAO

Introdução: A realidade virtual permite que os profissionais de reabilitação funcional trabalhem em diversos campos da saúde. Esta nova abordagem terapêutica transforma os exercícios convencionais em jogos divertidos e cativantes que também oferecem a possibilidade de obter feedback positivo ou negativo mensurável. Em nosso estudo, combinaremos reabilitação com realidade virtual com reabilitação convencional em judocas, com idades entre 20 e 29 anos, que sofreram de luxação anterior do ombro; a fim de comparar a eficácia dos diferentes tratamentos.

Objetivo: O objetivo principal do nosso estudo é expressar os efeitos positivos da realidade virtual na reabilitação da luxação anterior do ombro. O objetivo específico de nosso estudo é mostrar o impacto do dispositivo de realidade virtual utilizado em diferentes aspectos essenciais da reabilitação: recuperação muscular e amplitude articular, melhora da propriocepção e estabilidade do ombro, redução da dor e, finalmente, redução da freqüência de recorrência que consequentemente leva a a diminuição do recurso cirúrgico em relação a esse afeto.

Metodologia: Este projeto é um estudo experimental prospectivo e avaliativo porque permite a comparação do protocolo em dois grupos. O grupo controle está sujeito a um protocolo de reabilitação convencional, enquanto o grupo experimental está sujeito a um protocolo que combina os princípios da reabilitação convencional e exercícios através da realidade virtual usando KinéQuantum®. A amostra da população testada será selecionada de acordo com nossos critérios de inclusão e exclusão e, em seguida, designada aleatoriamente para ambos os grupos. As variáveis medidas são dor, amplitude articular, força muscular, propriocepção, estabilidade dinâmica do ombro e recorrência. Usando avaliações e análises estatísticas, poderemos comparar os efeitos do tratamento em cada grupo.

Conclusão: A análise dos resultados do nosso estudo confirma que a RV, aqui através da plataforma KinéQuantum®, pode se tornar uma ferramenta adicional no arsenal terapêutico disponível para o fisioterapeuta. No entanto, é importante lembrar que esta ferramenta ainda está no início de sua implementação médica. Como resultado, sua eficácia em todos os aspectos do tratamento fisioterapêutico ainda não está completa. É a democratização desse tipo de tecnologia que possibilitará uma melhoria para uma reabilitação mais completa.

Palavras-chave: Luxação anterior escápulo-umeral, Realidade Virtual, KineQuantum®, Reabilitação, Ombro instável

SUMMARY

LIST OF ABBREVIATIONS

ASD : Anterior shoulder dislocation

VR : Virtual reality

PT : Physiotherapy treatment

GHJ : Glenohumeral joint

HH : Humeral head

ER : External rotation

CR: Conventional rehabilitation

GHL : Glenohumeral ligament

CHL : Coracohumeral ligament

IR : Internal rotation

MRI : Magnetic Resonance Imaging

CKC : Closed Kinetic Chain

OKC : Open Kinetic Chain

I. INTRODUCTION

As part of our degree in physiotherapy at ESSATLA, we've been asked to carry out a final study work consisting on research project development. Our project is in trauma's field and relates to the "Rehabilitation after anterior shoulder dislocation [ASD] with a virtual reality [VR] system, the KinéQuantum® tool, on young Judokas".

Within VR, the user is immersed in a virtual and multisensory experience, thanks to different technologies combination (Li, Montaño, Chen, & Gold, 2011). The use and combination of visual, auditory, olfactory and tactile stimuli will lure the user's senses, so this immersion is as complete as possible (Malloy & Milling, 2010). In the 1990s, this technology expanded into other fields and developed medical applications. For a decade now, VR has been growing in the medical field thanks to rapid technological development and increasingly sustained collaboration between universities and industries (Ng Wing Sang, 2015).

However, during our research, we found that the documentation combining physiotherapy rehabilitation and VR, consulted through various books and scientific articles, lists only very few studies concerning trauma. However, it is undeniable that VR is becoming increasingly important in today's medical landscape. As part of our work, we wanted to measure the innovative technology impact in the physiotherapy treatment [PT] of a relatively common condition such as ASD.

Shoulder stability is provided by different passive and active elements. Dislocations of the glenohumeral joint [GHJ] are the most common dislocations in humans. Among these, anterior dislocations are predominant at 95% compared to 4% for posterior dislocations (Cocquempot & Yassin, 2012). The injuries inventory reported to emergency services in hospitals across the country, conducted by the National Electronic Injury Surveillance System in the United States between 2002 and 2006, led to the implementation of a targeted study on shoulder dislocations in the population. Thus, 8940 dislocations were identified, representing an overall incidence rate of 23.9 (95% confidence interval[CI], 20.8 to 27.0) per 100,000 person-years, men are in majority with 71.8% (Zacchilli, M.A. and Owens, B.D., 2010). Generally, ASD are due to a fall: either directly on the shoulder stump, or indirectly on the hand or elbow with the limb in abduction and external rotation [ER] (Rodineau & Besch, 2014).

After a first episode of ASD, medical procedure is set as follow:
- X-rays of the shoulder, in frontal and axial incidences, allowing objectivity of dislocation and exclusion of associated complications described later. If a complication is suspected, arthro-CT and arthro-MRI are performed (Wagner, Lanier, Arditi, & Guerne, 2013);
- Dislocation's reduction, if nothing prevents it, which must be carried out quickly by a doctor in order to limit the risk of complication's risk (Elouakili et al., 2014) (APPENDIX 1);
- Shoulder's immobilization with the arm in an elbow brace to the body (analgesic position) for a 3 weeks period in order to put the injured structures in the best position for a good healing (Dodson & Cordasco, 2008).
- Implementation of PT forfunctional joint amplitudes recovery, muscle strengthening, proprioception work, learning positions of joint stability and reathletisation in order to limit the risk of recurrence (Chanussot & Danowski, 2005; Xhardez & Wardavoir, 2015)
- In the case of frequent recurrences, surgical intervention is considered, most often using Bankart or Latarjet procedures, depending on the ISIS score obtained by the patient (Bessièrea, Gaucia, Balgb, & Boileau, 2015). Bankart's intervention corresponds to the anchoring of the glenoid bead on the glenoid (Shibata et al., 2014) while the Latarjet operation, which is more invasive, consists of creating a bone stop, by osteotomy, of the coracoid process (Walch & Young, 2012). The extensive use of surgical operations mentioned above has drawn our attention to the high recurrence rate that accompanies ASD with lush episodes that still occur regularly 2 years after the first dislocation. Indeed, as shown in the study conducted in the United States by Zacchilli and Owens, conducted over a decade, a maximum incidence rate (47.8[95% confidence interval, 41.0 to 54.5]) is observed in a 20 to 29 year age group with a particular focus

on the 46.8% rate of dislocations affecting men aged 15 to 29 years (Zacchilli, M.A. and Owens, B.D., 2010).

It is therefore on a male population in an age group between 20 and 29 years old that we chose to carry out our study, in order to be able to decide on the different parameters inherent to the overall recovery of the shoulder: pain, joint amplitude, muscle strength, proprioception, dynamic stability and finally recurrence. We decided to evaluate the different parameters mentioned above on two groups of 20 patients each. A conventional rehabilitation [CR] will be carried out with the control group as well as with the experimental group, which will be completed by VR work using the KinéQuantum® tool.

In order to follow a logical pattern in our research, we structured our study around 7 chapters. It therefore begins in the first chapter with the introduction of the thesis responsible for highlighting the different axes that we have chosen to develop throughout our work. The 2nd chapter reviews the existing literature on our topic, which successively deals with: the definition of the ASD, anatomical reminders of the shoulder, the ASD in judo, to finish on the VR and the KinéQuantum® tool. The third chapter describes the methodology used during our study, addressing in turn: our problem, our objectives, our hypothesis, the type of study, the target population and its sample, the variables, the material used, the evaluation instruments, the data processing procedures and finally the experimental protocol providing the framework for our progress. The 4th chapter critically analyses our study and draws the appropriate conclusion and recommendations for future researches on VR in physiotherapy rehabilitation. Chapters 5, 6 and 7 conclude our study with the bibliographical references that enabled us to build our thesis, the appendix and finally the annexes.

II. THEORETICAL CONTEXT

The shoulder is the place of a permanent balance between mobility and stability mechanisms. The knowledge of the anatomy of the shoulder and its stability elements is very important in the understanding of the lesional mechanisms of ASD (Marc, Rifkin, Teissier, & Gaudin, 2017).

1. Anterior dislocation of the shoulder

The Medical Larousse defines dislocation as the displacement of two bone ends of a joint resulting in a loss of the normal contact between the two joint surfaces. Concerning the ASD, it's a permanent loss of the contact between the humeral head [HH] and the glenoidal cavity of the scapula ("Luxation", 2018).

The clinical signs of ASD are multiple, starting with severe pain and a classic total functional impotence. Indeed, the « sign of the Shepherd » is often observed in the patient's shoulder, that is to say an arm in irreducible abduction (Fontaine, 2012). From a front view, the shoulder seems totally deformed. It loses its shape due to the emptiness of the glenoid and reveals a notch that is identified as the "external axe blow". The "epaulette's sign" is also recognizable due to the absence of the usual contact between the TH and the outer end of the collarbone. The latter then appears suspended above the void, protruding like the epaulette of a jacket. Finally, on a sagittal view, an arch is observable in the delto-pectoral sulcus, corresponding to the luxated HH projection (Cocquempot & Yassin, 2012; Cutts, Prempeh, & Drew, 2009).

Different mechanisms can cause ASD, which are referred to as direct and indirect trauma. The indirect mechanism can correspond to several combined movements: a fall on the elbow or a fall on the palm of the hand with the elbow in full extension (when the limb is in abduction and ER, or when the limb is in retropulsion and ER); a forced movement mechanism from arm to the rear when in abduction and ER with bent elbow (arm plurality position); rarelyer, during traction on the member in abduction and RE.

The direct mechanism is characterized by a fall on the shoulder stump. It occurs less often, during an intense trauma such as a bad fall in judo (Barrault, Brondani, & Rousseau, 2000). Falling is therefore spotted as the main cause of this type of injury (58.8%), mostly occurring at home (47.7%) or while participating in sports or leisure activities (34.5%) (Zacchilli, M.A. and Owens, B.D., 2010).

Frequently during an ASD, the joint capsule tears at its insertion on the edge of the glenoid, damaging the glenoidal bead as it passes (Cutts, Prempeh, & Drew, 2009). Its desinsertion corresponds to the Bankart lesion, currently recognized as the most frequent lesion encountered in GHJ dislocations and as one of the factors involved in the recurrence's risk (Gerometta, Rosso, Klouche, & Hardy, 2016). Some other complications, more or less are important, may accompany ASD:

- tendino-muscular: desinsertion of the capsule at the edge of the glenoid (Broca detachment), lesions of the rotator cuff with a possible rupture of the different tendons (lesions of the supraspinatus by rupture or disinsertion carrying away the trochitis);
- vascular nerve: damage of the brachial plexus, particularly the axillary nerve and the circumferential nerve, or more hardly, compression of the axillary artery;
- bone: glenoid fracture, trochitis fracture, HH fracture or fracture by sinking the posterior edge of the HH (Hill-Sachs lesion) (Elouakili and al., 2014; Sirveaux, Molé, & Walch, 2002)

A study on anterior shoulder instability indicates that only 50% of participants were re-educated after undergoing ASD. Therefore, it seems interesting to improve the therapeutic education dispensed regarding this condition (Jamal and al., 2016).

2. Anatomical reminders

1. Topographic anatomy of the shoulder

The shoulder is an articular complex composed of 5 joints (ANNEX 1). GHJ is a spheroid joint that presents three degrees of freedom and allows circumduction movement (Dufour & Pillu, 2007). These joint surfaces are neither congruent nor concordant. Indeed, the HH brings ⅓ of sphere while the relatively flat glenoid only brings ⅙ of it (Dufour, 2016) (ANNEX 2).

2. Functional anatomy of the shoulder

Then, the shoulder is a joint with low bone conformity, which permits a great mobility to arms and hands in the space; however, this same characteristic is also responsible for the high frequency of dislocations affecting it (Dufour, 2016). Thus, to avoid these dislocations, the joint needs powerful stability mechanisms.

a. *Passive stabilizers*

Among these elements is the joint capsule, which, due to its position and construction, allows significant decoaptations and complex movements. As the articular labrum doubles the surface of glenoid fossa to increase the congruence, it acts as a shock absorber and becomes fundamental for antero-posterior stability (Dufour & Pillu, 2007). The upper and middle glenohumeral ligaments [GHL] at the front of the capsule and the coracohumeral ligament [CHL] at the upper anterior part of the capsule allow anterior restraint of HH. These ligaments together limit the shoulder ER, flexion and extension (Chevalier, 2016). The lower part of the capsule is reinforced by the lower GHL, the main brake on abduction and rotations while abducted; because of the involving of those two movements combined in the lesional mechanism of the ASD (ANNEX 3). Turkel in 1981 shows the stabilizing role of GHL below 90° of abduction, through progressive muscle and ligament sections on cadavers. Indeed, during this movement, the subscapular, described below, moves upwards and releases an area of weakness at the lower pole of glenoid fossa, leaving only the lower GHL the role of maintaining

joint integrity (Turkel, Panio, Marshall, & Girgis, 1981; Zizah, Lahrach, Marzouki, & Boutayeb, 2017). Too much resistance against this movement would defeat this ligament, leading to dislocation. It should be noted that the two CHL beams and the three LGH design a double Z that vertically streak vertically the anterior line . This particular criss-cross of ligaments gives a real protection, in the same way as we could barricade a door with "a zigzag rope" (Dufour, 2016). However, there are two areas of weakness on the capsule between these three GHL: the oval foramen (Weitbrecht) and Rouvière's foramen. The first one, reinforced by the tendon of the subscapular muscle, finds its location between the upper and middle GHL while the second one is located between the middle and lower GHL, where the capsule, really thin, tears to let the HH through during the ASD (Chevalier, 2016).
The presence of many proprioceptive receptors within the GHJ allows a good reactivity of different elements protecting joint integrity. These elements contributeby the way to an adapted and a permanent refocusing of the HH (Sirveaux, Molé, & Walch, 2002).

b. Active stabilisers

Considering the limited efficiency of static stabilizers, muscles will be in charge of a paramount importance. Some of them have a more important stabilizing role than the others, but their actions remain complementary. Thus, the constituent muscles of the rotator cuff have an essential role in physiological and dynamic joint stabilization (Wilk, Reinold, & Andrews, 2009). The subscapular muscle, whose fundamental role within the ASD has been described above, will have a stabilizing role against the forward displacement of HH. Therewith, it is involved in strengthening the average GHL. The supraspinatus muscle helps to strengthen the CHL. Finally, the infraspinous and small round muscles will both be external rotators and abduction of the shoulder, a lesionic movement of the ASD (Dufour, 2016; Rouvière & Delmas, 2002). It is important to remember that within the cap, the elements mentioned above are responsible for the balance between the agonist and antagonist muscle groups with internal rotation [IR] and ER movements. Indeed, dynamic stability depends on the principle that the horizontal component of a muscle is cancelled by the horizontal component of its antagonist; bringing then result to a zero value (Codine, Bernard, Pocholle, & Herisson, 2004).

As muscles of the cap, other muscles contribute to the dynamic stability of the shoulder. The brachial biceps and tendon of the long head of the brachial triceps increase stabilization during ER movement (Dufour, 2016). In this same plane, the stabilizing muscles of scapula such as scapula riser, large and small rhomboids, anterior serratus and lower trapezius are equally important. They are responsible of positioning scapula in order to obtain optimal contact between glenoid fossa and the HH (Rochcongar, Monod, Rivière, Amoretti, & Rodineau, 2013) (ANNEX 4).

The static and dynamic stabilizating elements of the GHJ are responsible of the permanent refocusing of HH in the glenoid fossa of the scapula. A failure in this system,is often part of pathophysiological mechanisms leading to articular and periarticular damage of the GHJ, because of increasing induced joint instability (Dodson & Cordasco, 2008).

3. The anterior dislocation of the shoulder in Judo

As our subject makes interest in a young (20 to 29 years old) male judokas population, we have wanted to notice the place of the ASD within this sport.

Judo is a martial art, or fighting sport, without weapons, with Japanese origins, and that consists in unbalancing your opponent in a flexible way in order to neutralize him (Centre National de la Recherche Scientifique, 2004). A study has been established on different injuries that occurred during judo competitions in France between 1993 and 2002. This takes into account high-leveled judokas as well as unprofessionals up to 150,007 competitors. Over the duration of the study, 2,227 injuries were reported, or 1.48% of all subjects. Detailing, 27.8% of these injuries concern the shoulder and ASD represent 14.57% of the total injuries affecting these judokas. It could mean that the shoulder, which is our interest, is the target of more than a quarter of the injuries occurring on the judoka (27.8%). However, it is said that shoulder dislocations represent

14.57% of total judoka injuries. By a simple calculation, we guess that if 27.8% represents all shoulder injuries, then dislocations represent 52.41% of these injuries, of which 32.3% occur around GHJ (more than half of the observed dislocations) (Frey, A., Rousseau, D., Vesselle, B., Hervouet Des Forges, Y. and Egoumenides, M., 2004).

Some authors point out that in judo, the ASD is essentially the result of a technical error, such as a poorly controlled fall (Barrault, Brondani, & Rousseau, 2000) or a bad catch. Indeed, there is a correlation between a certain technique, the "Ippon Soei Nage", and the traumatized joint. It is said to be responsible for 31% of shoulder injuries, including dislocation and the lesions concern the one who initiates the movement. During this move, the judoka's shoulder combines a 90° abduction and an ER in order to knock down the opponent from his back. If the intensity of the resistance given by the opponent in order to avoid falling is too strong in front of different shoulder stabilizers involved, then it causes joint damages (Barsottini, D., Guimaraes, A. and Renato de Morais, P, 2006).

4. Virtual reality and the KinéQuantum® tool

In our study, we've wanted to show the interest of the VR for the PT in the frame of using the KinéQuantum® tool on an ASD. In the 21st century, it's the definition of VR advanced by Giuseppe Riva in 2012 which is predominately. He characterizes it as a set of technological materials which allow a subject to interact effectively with a three-dimensional environment, in real time managed by a computer (Sand lance, Oppenheimer, & Malbos, 2017). This experience is made possible thanks to the combination of different technologies, namely: a video-headset or HMD (Head Mounted Display) allowing the participant to perceive 3D stereoscopic images; noise-reducing headphones or audio headphones, in which sounds or music is passed; and a joystick or controller allowing the interaction with virtual objects and navigation through this three-dimensional environment. The VR also includes a head position tracking system in order to detect the user's spatial position. Thus, the device gives the user the illusion of being immersed in a virtual world (Li, Montaño, Chen, & Gold, 2011). Using VR is similar to the experiencing of an interactive games (electronic and video), therefore, it requires the recruitement of the user's visual, auditory, kinesthetic and tactile senses as well as the recruitment of cognitive, motor and oculomotor skills (Koller & Goldman, 2012). The difference between VR and other forms of "human-computer" interface is based on the fact that here, the user interacts fully with the virtual world rather than simply using it (Slater & Sanchez-Vives, 2016). However, we had to choose our VR software among a great concurrence. The fact that the software proposed by Vestibulus® is sold alone (the VR equipment still to be purchased elsewhere), that the platform used by C2C® offers more evaluations than exercises, and that the Rezzil® platform used by Kinesport is totally focused on the lower limbs, our choice was naturally focus toward KinéQuantum®. The range of playful exercises allowing a quick immersion of the patient both in the virtual world and in his rehabilitation was very interesting for us. In addition, an active participation is encouraged by recurrent feedbacks, made possible by the recording of the subject's sessions and results, which can then, be monitored along with the progression of the treatment.

After an exploration of the literature combining health and VR, we found that very few studies linking trauma and VR had yet been conducted. Although most of these studies focus on pain, we were able to relate our different variables to the use of our VR platform. Thus, the impact of VR on pain has been studied several times since the 2000s. Some authors have already demonstrated the health benefits of VR such as: the reduction of phantom limb pain (Alphonso and al., 2012), the management of acute pain such as migraines (de Tommaso and al., 2013) or that of the chronic pains such as those experienced by severe burn victims (Morris, Louw, & Grimmer-Somers, 2009). In 2004, Hoffman and al. wanted to demonstrate the impact of VR on the pain felt by the burn victims thanks to the analyses of their session through magnetic resonance imaging [MRI]. Examiners then observe on the MRI a frank decrease in the stimulation of the brain areas already identified as active in the pain mechanism (Hoffman and al., 2004) (ANNEX 5). Hoffmann and al. conducted a new study in 2007 in order to compare the effects of opioid analgesics and VR. This study, involving 9 burn patients aged 20 to 38 years monitored by MRI, shows that VR and opioid analgesics have very similar results (Hoffman and al., 2007).

The effects of VR on the articular range of motion is based on both the decreasing of the pain and the diversion of the subject's attention. On the one hand, in 2010, the work of Detaille and al. enlighten the fact that a decrease in pain leads to the preservation of amplitude gains as well as the limitation of joint stiffness until six months after the end of treatment (Detaille and al., 2010). On the other hand, the recruitment of the subject's attention, concentration and emotions, induced by the diversion of the VR, alter the nociceptive signaling pathways that are responsible of the pain transmission. The decrease in pain associated with a decreased apprehension then allows the patient to perform a more natural movements, thus offers a better exploitation of his articular amplitudes (Arane, Behboudi, & Goldman, 2017).

Concerning the muscle strengthening, the recommendation states a work under maximum tension. Thus, the requested exercises can be performed in different ways: at maximum load, at maximum speed or until the total exhaustion of the subject (Chanussot & Danowski, 2005). Therefore, we have to check if this type of work is compatible with the exercises proposed by our platform. The enhancement of the shoulder stability and the proprioception is based on the combination of closed kinetic chain [CKC] and open kinetic chain [OKC] exercises. Indeed, studies indicate that the CKC is involved in stimulating mechanoreceptors and that the OKC allows the work of movements similar to those performed in many physical activities (Sciascia & Cromwell, 2012; Andrew, 2002). Here again, we have to check if these recommandations are compatible with the use of the KinéQuantum® platform. Finally, the recurrence is not a parameter that we can directly modulate with our VR platform. It is the follow-up of our participants over three years that will determine whether the use of VR through the KinéQuantum® tool positively impacts the high recidivism rate inherent of ASD (Robinson, Howes, Murdoch, Will, & Graham, 2006).

III. METHODOLOGY

1. Study question

This section seeks to outline the protocol implemented during our study, which aims to answer the following: would the use of VR, through KinéQuantum®, have an effect on the overall functional improvement of the shoulder after ASD for 20-29 years old judokas?

2. Objectives of the project

The main objective of our study is to identify a link between the use of VR and its effect on the overall functional improvement of the shoulder. To reach/achieve this objective, we have investigated several crucial aspects of rehabilitation including: the muscle and joint amplitude recovery; the improvement of shoulder proprioception and stability; the reduction of pain; and finally the reduction of the frequency of recurrence leading to a decrease in the use of surgery. Therefore, we will conduct an analysis of the results obtained from two groups of patients. The former's management/treatment comprises a combination of CR and VR whereas the latter will be only treated with CR.

3. Hypothesis

The hypothesis of our study is that VR, through KinéQuantum®, should allow an overall functional improvement of the shoulder by relying, more specifically, on certain essential factors of shoulder rehabilitation, namely: joint amplitude, muscle strength, proprioception, static and dynamic stability and finally, the reduction of pain and the frequency of recurrence characteristic of this pathology.

4. Type of study

To provide an answer to our problem, we must perform an experimental study in the form of a clinical trial. Therefore we conducted a prospective study; which is, the population and the parameters studied were predefined before the start of the trial and monitored longitudinally over time. After informing that we would like to test an innovative rehabilitation protocol for ASD, a cohort of voluntary judokas, who have a set of common characteristics (among our inclusion and exclusion criteria), is gathered. Participants are then informed of all the risks associated with their participation in ordered to provide free and enlightened consent. The separation into two groups occurs randomly here. It is then mandatory for us to specify, for the experimental group, the risks associated with the use of VR. The conduct of the trial is said to be "simple blind" because only we, the examiners, know which of the two groups is actually testing the protocol involving VR. Our study is therefore an evaluative and controlled study that compares a control group, whose ASD is treated with CR, and an experimental group, in which ASD treatment combines CR and VR. The study is also described as quantitative because the participants' results, collected in the form of numerical data, are analysed by statistical processing before being interpreted.

5. Population and sample

In order to be able to carry out this study, the careful selection of the target population and the resulting sample is crucial to support and achieve the purpose of the study. According to Fortin, Coté and Filion (2009): "The sample is a representative fraction of the target population on which the study is conducted". The selection of the sample, known as representative, must be carried out under the best conditions in order to be able to draw conclusions about the population. Here, the target population is represented by those who have undergone ASD and meet the following inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
- Have read, understood and signed the submitted informed consent (APPENDIX 2), - Present here his very first ASD, - Be male between the ages of 20 and 29 (Zacchilli & Owens, 2010), - To be a judo player in a club, and at least have a green belt, Training/ Competing in a (sport) facility and being a green belt judoka as a minimum. - Have a pain sensation of less than 8 on the EVA scale (APPENDIX 6), - Do not present contraindications to VR or isokinetic tests (High Authority of Health, 2006).	- Have had a previous ASD or subsequent dislocation in the past, - Be positive in the anterior drawer test or the furrow test: hyperlaxity and multidirectional instability (Lizzio, Meta, Fidai, & Makhni, 2017), - Present an associated complication, to be verified with standard radiography, MRI and arthroscanner (Wagner, Lanier, Arditi, & Guerne, 2013; Cocquempot & Yassin, 2012): - Injury to the associated cap, - Diaphyseal fracture or glenoid fracture with enlarged fragment, - Vascular and nervous complications.

Title: Table representing the inclusion and exclusion criteria of our population.

Based on the inclusion and exclusion criteria of our population, our sampling was done randomly to be as representative as possible. A consensus of 40 participants was previously decided for logistical and financial reasons. The randomization of our sampling will be allowed by the HASARD® software which will automatically perform an equiprobable draw. Thus, the 40 participants will be divided into two groups: the control group treated with CR, and the experimental group for which CR is supplemented by VR, using the KinéQuantum® tool.

6. Variables

The independent variable is an element that is inserted and manipulated in a research situation in order to have an effect on another variable (Fortin, Coté, & Filion, 2009). Our independent variable is the type of dual-mode support, with or without the use of VR, KinéQuantum®. The dependent variable is the one that is affected by the independent variable, it is on this that the predicted result is based (Fortin, Coté, & Filion, 2009). Our dependent variables are pain, joint amplitude, muscle strength, proprioception, dynamic shoulder stability and recurrence.

a. The pain

The International Association for the Study of Pain (IASP) has defined pain as "a sensory and emotional experience associated with or described in terms of actual or potential tissue damage" ("Pain terms", 1979). Dislocation causes excessive nociceptive pain, acute, abrupt and intense at the level of the GHJ, which causes functional impotence (Barrault, Brondani, & Rousseau, 2000). According to Koller and Goldman, 2012, distraction works on the assumption that if we focus the patient on something attractive and enticing (as here through VR), his ability to withstand painful stimuli is altered, which has the effect of reducing pain, distress and anxiety. In order to evaluate this pain, we use the Visual Analog Scale.

b. Joint amplitudes

The GHJ of interest ~~here~~ has three degrees of freedom, allowing it to orient the upper limb in the three planes of space, around three main axes (Kapandji, 2018; Wilk et al., 2009). After an episode of ASD, the most difficult amplitudes to recover are antepulsion, abduction and ER (Xhardez & Wardavoir, 2015). We've performed a goniometry test to assess the patients' joint amplitudes.

c. Muscular strength

The extent of muscle contraction depends on the integrity of passive and active elements, motor nerve roots and trophicity. ~~In order~~ to measure muscle strength, we've performed manual muscle testing of all movements of the GHJ. In addition, an isokinetic test is also described later. These tests allows the evaluation/assessment of the muscular strength in a dynamic mode on the one hand and the agonist/antagonist ratio on the other hand (APPENDIX 3) (Kapandji, 2018; Schünke, Schulte, & Schumacher, 2016).

d. *Proprioception*

Proprioception is defined as the accumulation of information about the central nervous system from specialized nerve endings called mechanoreceptors (Ribeiro & Oliveira, 2007). It should be noted that pain felt in the shoulder would be correlated with a decrease in proprioception due to the stimulation of nociceptors. This stimulation then takes precedence over that of the mechanoreceptors. Shoulder instability is also involved in proprioception deficit. These deficits result in an alteration of motor control that will alter muscle activation as well as a deficit of co-activation of rotator cuff muscles (Myers, Wassinger, & Lephart, 2006). We've used the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) to assess proprioception.

e. *Shoulder stability*

It is allowed by the ability of HH to remain centered in contact with the glenoidal cavity of the scapula, or to quickly regain this position. This capacity is mainly based on three systems: capsulo-ligamentary, muscular and neuro-motor. During an ASD, all three systems are altered (Mellal, 2010). The passive and active stability of the GHJ has been described above within the theoretical framework. Neuromotricity, which is involved in joint stability, is based on proprioception and neuro-muscular control by acting on three levels: muscle reflex, coordinated muscle activation and muscle tone regulation. Thus, within the GHJ, a force applied to the capsule stimulates the reflex arch located between the capsulo-ligamentary structures leading to the activation of the rotator cuff muscles as well as th deltoid, trapezius and pectoralis major, which guarantee joint integrity (Marc, Rifkin, Teissier, & Gaudin, 2017). We've used the Constant score to assess the stability of the shoulder.

f. *Recurrence*

The study conducted by Robinson (2006) found that 55.7% of patients with ASD will have a recurrence episode within two years. This rate is increased to 66.8% if patient observation is increased from two to five years (Robinson, Howes, Murdoch, Will, & Graham, 2006). Thus, these data reflect a lack of performance in the CR.

7. Material

The KinéQuantum® equipment includes a computer with its usual standard components. Through a connection box, it is connected to an VR helmet equipped with a lens at the front and numerous sensors at the front and sides for monitoring head movements. To ensure that the immersion is as complete as possible, the headset is also equipped with a noise-reducing audio device and two controllers, also supplied with tracking sensors (APPENDIX 4). Finally, the sensors located at height send signals to the headphones and controllers to ensure proper movement tracking and software adaptation. For optimal use of the platform, it is necessary to have a clear floor space of at least 2 metres by 1.50 metres so that patients can fully exploit the possibilities offered by this safe VR device. With the Kinéquantum® platform it is possible to work on different axes of a rehabilitation of the cervicals, lumbar vertebrae or upper and lower limbs. It is also possible to intervene operate on balance disorders, vestibular and neurological disorders or to create relaxation sessions (APPENDIX 5). For these various fields of application, KinéQuantum® offers assessments that are adapted, recorded and can be carried out at any time, as well as a range of exercises with modular objectives (APPENDIX 6). Each exercise can be configured in terms of duration, difficulty or position of the body and injured limb (APPENDIX 7). Exercises and assessments are described by auditory and visual instructions, and their progress is visible in the form of a curve (APPENDIX 8). The session is supervised by the physiotherapist, who ensures that the patient's posture is appropriate and safe and that the required movements are performed correctly.

For CR, we have equipment for analgesics (electrotherapy, Game-Ready, etc.); weights, elastics, TRX (Total Resistance eXercice) for muscle strengthening; floor mats, unstable planes (Bosu, Freeman plateau, etc.).), Klein balloons, swiss ball, medicine ball for proprioceptive work and dynamic stability; an isokinetic device for muscle testing; and an elliptical bicycle for warm-up.

8. Evaluation instruments

In order to evaluate our patients, each will have to pass certain specific tests described below: the Visual Analog Pain Scale (VAS), the Goniometry Test, the Muscle Test, the Constant Score, the Isokinetic Test, and the Closed Kinetic Chain Upper Extremity Stability Test CKCUEST. The results of the various tests performed throughout our study are integrate to a table, with the exception of the isokinetic test, for which the results will be printed directly. This allows us to keep an up-to-date record of the evolution of our participants (APPENDIX 9).

a. *Visual Analogue Pain Scale: VAS (ANNEX 6)*

The VAS is a subjective self-assessment scale for pain. It is in the form of a continuous line of 10 cm, graduated from 0 to 10: the score of 0 then corresponds to the estimate "no pain", while the score of 10 corresponds to the estimate "maximum pain imaginable". The subject must position a cursor at the place that best represents the pain felt at the time T (Agence Nationale de l'Accréditation et de l'Évaluation en Santé, 1999).

b. *Goniometry of the gleno humeral joint*

Amplitude measurements are made using a universal standard goniometer. This device enables us to objectify both the observed limitations that hinder the achievement of functional movement and the patient's evolution as he progresses. A distinction is made between passive and active joint amplitude (Piriyaprasarth & Morris, 2007; Schünke, Schulte, & Schumacher, 2016).

c. *Overall muscular testing of the shoulder (ANNEX 7)*

Manual muscle testing is an evaluation method for quantifying the contractile capacity of a muscle or muscle group. It includes 6 grades from 0 in the absence of contraction to 5 for normal contraction (Cuthbert & Goodheart, 2007). The healthy or less affected side should be tested first in order to provide a benchmark for the conclusions drawn on the injured side. However, the rating is subjective, as it depends on the examiner's perception (Naqvi & Sherman, 2019). This interpersonal variability, making the reproducibility of our study more complicated, encouraged us to add a second test for evaluating the muscle strength of our participants: the Isokinetic test.

d. Constant Score (ANNEX 8)

The Constant-Murley score is an instrument to assess the overall function of the shoulder, regardless of the diagnosis. This tool assesses, on 100 points, four aspects related to shoulder pathology: pain and activities of daily living on the one hand (subjective aspects) on 35 points; the amplitude of movement as well as the force deployed on the other hand (objective aspects) on 65 points (Constant and al., 2008).

e. Isokinetic test

The principle of isokinetic exercises is to perform muscle contractions under maximum effort, while maintaining a constant speed over the entire range of joint movement. The machine therefore adapts to the effort developed by the subject, and allows three modes of contraction to be tested: concentric, eccentric and isometric (Edouard & Degache, 2016). At the level of the shoulder muscles, the isokinetic evaluation allows the calculation of the muscular balance of the medial and lateral rotators, and thus determines the functional ratio and stability of the joint. Studies have shown an effect of position on maximum force moments, hence the need to standardize a reference position (Codine, Bernard, Pocholle, & Herisson, 2004). Nowadays, isokinetic tests are commonly used to evaluate the evolution and progress of rehabilitation, including the processing of results on a computer, represented as a graph, and then analyzed for clinical purposes (Fitzgerald, Lephart, Hwang, & Wainner, 2001).

f. Closed Kinetic Chain Upper Extremity Stability Test CKCUEST

The subject is in the pump position, elbows stretched out, with one hand on each of the ground markers, previously installed by the physiotherapist. The shoulders remain in line with the markers and the two feet are tied together. The patient must take one hand off the ground to touch his opposite hand. He then returns to the initial position and performs the same operation with the second hand, and so on. The exercise consists of making as many keys as possible in 15s. It is reproduced 4 times, interspersed with 45s of rest. This test was validated in 2000 by Goldbeck and Davies (Lee & Jongsoon Kim, 2015).

9. Data processing

In order to present the data collected during our study, we will perform a descriptive statistical analysis using the statistical analysis software Statistica version 13.2, which will allow us to calculate the mean, standard deviation and variance for each of our two groups. We will perform a Student T-test on all our variables for the control and experimental groups to see if there are any significant differences. Thus, it will finally be possible for us to accept or reject our hypothesis and therefore to see if the use of VR through the KinéQuantum® platform really constitutes an added value in the functional PT of the shoulder following an ASD.

10.Protocol

Our protocol begins with the selection of the target population for our study, based on our inclusion and exclusion criteria. A representative sample is then drawn from our population and randomly divided into two groups of 20 participants.

Before the treatment, we'd conducted an individual interview with each of our subjects. The purpose of this interview is to explain the ins and outs of our study so that everyone can sign the enlightened consent of the group to which they belong. In this way, patients are aware of the potential risks they face and the rights they have as they continue to participate in our study. After answering our history (APPENDIX 10), we can palpate and inspect the shoulder. It is also during this first session that the patient is evaluated through the tests that we've selected: the visual analog pain scale (VAS), the goniometry test, the muscle test and finally the Constant score.

These same four tests will be repeated once a month by all participants until the third month. From the third month onwards, the isokinetic test and the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) are added.

Sessions are regular for the first four months and then patients are followed for three years with an interview every six months. On this occasion, the subjects once again take all the tests of our study and participate in an oral interview in order to shed light on the six months of non-adherence. One of the purposes of these interviews is to provide us with information about the risk of recidivism.

The frequency of the sessions, which decreases over time, is as follows: five sessions per week during the first rehabilitation phase (S0 to S3); four sessions per week during the second (S4 to S6) and third (S7 to S12) phases; and finally, two sessions per week during the fourth and last phase (S13 to S16). It should be noted that the sessions take place over forty minutes.

The Vade-mecum of Physiotherapy and Functional Rehabilitation is the guide to the CR exercises that are imposed on all participants. During the first phase, the immobilization phase, the experimental and control groups receive the same treatment. Indeed, VR is not of great interest during this phase because it is based on the execution of movements. After obtaining infra-painful joint amplitudes, with the exception of abduction and ER movements, which should not be performed before the third phase, the group undergoing VR can then begin its treatment protocol. The duration and difficulty of the proposed exercises is gradually increased, depending on the patients' capacity, throughout our study, regardless of the group in which they are enrolled.

Following management, the experimental group session is divided into two parts: 25 minutes of CR for 15 minutes of exercise on the VR platform. Rehabilitation protocols, whether conventional or experimental, all have the same objectives per treatment phase. The description of the techniques and manipulations to be carried out to achieve these objectives are described in a table (APPENDIX 11), as well as specific exercises through the KinéQuantum ® platform (APPENDIX 12).

Phase 1: Immobilization of the shoulder elbow to the body and analgesic phase (S-0 → S-3).

Phase 2: After immobilization of the shoulder, recovery phase of joint amplitudes and muscle strength (S-4 → S-6). Before this phase, the patient must go to specialists to have a control ultrasound and pass the manoeuvres and tests that check the capacity of the shoulder muscles (APPENDIX 13).

The transition to phase 3 is made possible by the passive recovery of bending, abduction and rotation amplitudes, with some painful limitation in the last degrees.

Phase 3: Muscle strengthening in all amplitudes and beginning of proprioceptive work (S-7 → S-12)

Phase 4: Re-training for effort and resuming the sporting gesture (S-13 → S-16):

IV. CRITICAL THINKING AND CONCLUSION

This chapter allows us to enlighten the results of our study and provide a critical reflection. The objective of our work is to show that the integration of the VR platform, KinéQuantum®, in the physiotherapy rehabilitation after ASD, would improve the overall functional recovery of the shoulder. Therefore, we will discuss the results obtained, in regard to the various parameters involved in the shoulder’s integrity: muscle recovery and recovery of joint amplitudes, improvement of the proprioception and dynamic stability of the shoulder, reduction of pain and finally reduction of the frequency of recurrence.

The state of the art described in the "theoretical framework" provides us the information about the effects of VR on our different variables particularly the VR-pain relationship. Indeed, many authors agree on the positive consequences of the use of VR on the hyperalgesia in different areas such as: phantom limb pain (Alphonso and al., 2012), acute migraine pain (Tommaso and al., 2013) or chronic and intense pain experienced by severe burn victims making care difficult (Morris, Louw, & Grimmer-Sommers, 2009). In their work in 2004, Hoffman and al. demonstrated the correlation between pain reduction and VR, verified by MRI. Thus, the MRI results show a significantly lower stimulation of brain areas, identified as active in the triggering of the pain mechanisms (Hoffman and al., 2004) (APPENDIX 4).
It has also been shown that the decrease in painful stimuli can be correlated with a gain in joint amplitude. In fact, the work of Detaille and al. in 2010 supports this hypothesis, through their study on the effects of a continuous intrascalenic block of the brachial plexus on the hyperalgesia of the regional pain syndrome in the shoulder complex. Their results show that, in parallel with the reduction in pain, a real improvement in joint amplitude, lasting over time, is observed up to six months after the end of rehabilitation (Detaille and al., 2010). An other work, conducted in 2017, seems to confirm this conclusion by focusing on reducing the anxiety in order to reduce pain apprehension. Here, it's the calming effect of VR that is underlined, by the diversion of

the attention it generates. The response to emerging pain signals is slower under VR, which allows the patient to go further in his functional scheme, and thus increasing his joint amplitudes without necessarily being aware of it. The study concludes that VR alters, directly and indirectly (through attention recruitment), the nociceptive signaling pathways responsible of the transmission of painful signals. The KinéQuantum® platform includes many exercises, allowing the configuration of all the different range of motion, combining analytical and more functional gestures. This VR platform therefore offers a progressive support, for the revival of joint mobility that goes hand in hand with the reduction of hyperalgesia.

Concerning the shoulder stability, studies underline the importance of working in an OKC, as is the case in the various exercises offered by the KinéQuantum® platform. This work seems to be inseparable from working in a CKC, when it is gradually introduced. While the CKC leads to a strengthening of the overall stabilisation of the shoulder, the OKC, in complementarity, leads to a strengthening of the rhythmic stabilisations of the shoulder (Sciascia & Cromwell, 2012). This particularity is principally exploited in our experimental group which combines CR and VR. Rhythmic stabilization is necessary for arm plurality position, as observed in the "Ippon Soei Nage" technique; hence its importance in the rehabilitation of judoka. Many physical activities use the upper limb in an OKC, which is why it's important to work on this chain at the end of rehabilitation, just before a more sustained sporting activity reprise. At this level of rehabilitation, the various simulations of KineQuantum® exercises allow the patient to perform sports gestures in extreme positions, with minimal stabilization and at real speed. VR plays here a crucial role in restarting an optimal sporting activity (Andrew, 2002).

At this stage of our work, we have identified more than one interest in the use of VR, indicating a good overall functional recovery of the shoulder. However, these effects are not as conclusive for all of our variables in comparison to a CR.
The basis of muscle strengthening is based on the notion of working with maximum

tension. To achieve this, the subject can perform the requested exercises with or without maximum load. Thus, maximum load exercises require maximum effort resulting in muscle strengthening, while to obtain the same effect with non-maximum load, the exercises must be performed either at maximum speed or until the subject is exhausted. However, in the approach proposed by KinéQuantum®, it's not possible to work against resistance and therefore to develop exercises in maximum tension. We imagined getting around this issue by equipping patients with weights or elastics at the wrists. However, this solution has not been implemented because it introduces a bias in the VR management, which could distort our hypothesis. Indeed, the addition of weight to the wrists leads to an increase of the stress in the shoulder joints, which is not supported by the algorithms of the VR software; the retranscribed progression then becoming much less significant. On the other hand, our care, which intended to be progressive, is not compatible with exercising at maximum speed or until the patient is completely exhausted. All these observations leads here to the technical inadequacy of our VR platform in terms of shoulder muscle strengthening (Chanussot & Danowski, 2005). Concerning the proprioception, several studies agree on the positive effects of working in a CKC. In this mode, the rehabilitation of the unstable shoulder is based on exercises with facial, lateral or unstable supports. Support here stimulates proprioceptive receptors such as Pacini's corpuscles (mechanoreceptors sensitive to compression), thus improving their sensitivity and consequently, improving the kinesthetic activity (Andrew, 2002). However, as mentioned above for the shoulder stability, KineQuantum® exercises are performed only in an OKC. This chain also stimulates proprioceptive affections, but in a more discreet way and mainly when it is worked in parallel with CKC exercises. Here again, we face an other limit in the use of the KinéQuantum® platform in comparison with our initial expectations (Sciascia & Cromwell, 2012).

The analysis of the results of our study confirms that VR, here through the KinéQuantum® platform, can become an additional tool in the therapeutic arsenal available for the physiotherapist. However, this tool is not yet fully developed, as we have noticed on some of our variables. Indeed, the lack of effectiveness of the VR identified on certain points can't allow us to give a favorable opinion on recidivism, which is so characteristic of ASD. In order to have a real impact on the risk of recurrence, it is necessary to have a complete and effective care on all aspects of rehabilitation. Nowadays, rehabilitation assisted by KinéQuantum® is still stammering regarding muscle strength and proprioception, which are key factors in this risk. However, it is important to remember that we are still at the dawn of the integration of this type of technology into the therapeutic landscape of physiotherapy. For such a recent approach, the positive results obtained are very encouraging. Moreover, in the analyzing of our results, it is still important to question the relevance of the material we have used as well as the protocol we have developed. Indeed, it is not impossible that the negative results of our study may be due to our procedure rather than being inherent to the use of the VR itself. We must therefore also question ourselves on some crucial points of our study, such as the number of phases of our protocol and their sequences, the number of our participants, the duration of their follow-up or the time spent on the use of VR.

Therefore, it seems obvious to us that the future development and democratization of the various VR systems on the market is an interesting approach for the modernization of physiotherapy care. We can then imagine that in a more or less near future, virtual reality platforms will be able to meet all the criteria required for an overall functional recovery of the shoulder after ASD and thus constitute in an approach capable of limiting the risk of recurrence.

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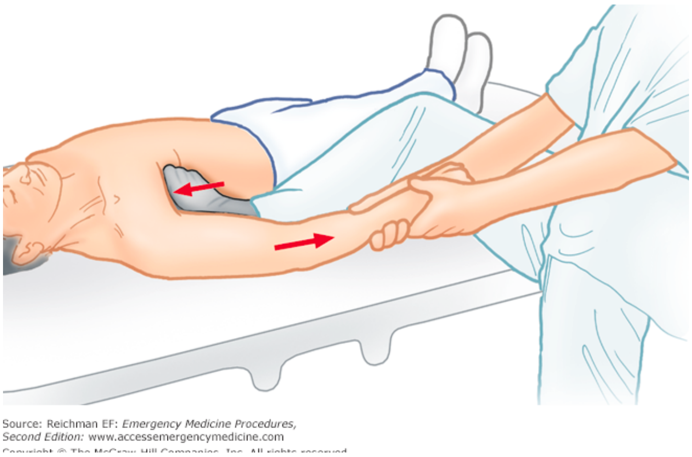
APPENDIX

Appendix 1: Reduction methods for anterior shoulder dislocation

MANUVERY	DESCRIPTION
Before reduction : analgesic treatment adapted to the level of pain, which can be based on: - a morphine titration, - inhalation of an equimolar mixture of nitrous oxide and oxygen (Société française d'anesthésie et de réanimation (SFAR) and al., 2010), - an intra-articular injection of 20 ml of 1% lidocaine subacromially (Orlinsky, Shon, Chiang, Chan, & Carter, 2002).	
Majority traction: **Hippocratic technique with the heel (Fontaine, 2012)**	Patient in supine position, upper limb in abduction of 30°, in the axis of the scapula: - Gentle traction on the upper limb causing a displacement of the HH towards the glenoid; - The counter-pressure makes it possible to leverage by pressing on the upper part of the diaphysis and to maintain the scapula in balance.
Majority lateral rotation: **Kocher's technique (Uglow, 1998)**	Patient sitting in slight shoulder abduction: - 90° elbow flexion, gentle traction of the humerus in the axis of the scapula, these movements will be maintained throughout the manipulation; - ER up to 90° which allows the HH to roll towards the glenoid; - Adduction; - IR.
Combination: **Spaso technique (Yuen, Yap, Chan, & Tung, 2001)**	Patient in supine position, shoulder at 90° of antepulsion: - Gentle vertical traction on the humerus; - ER.



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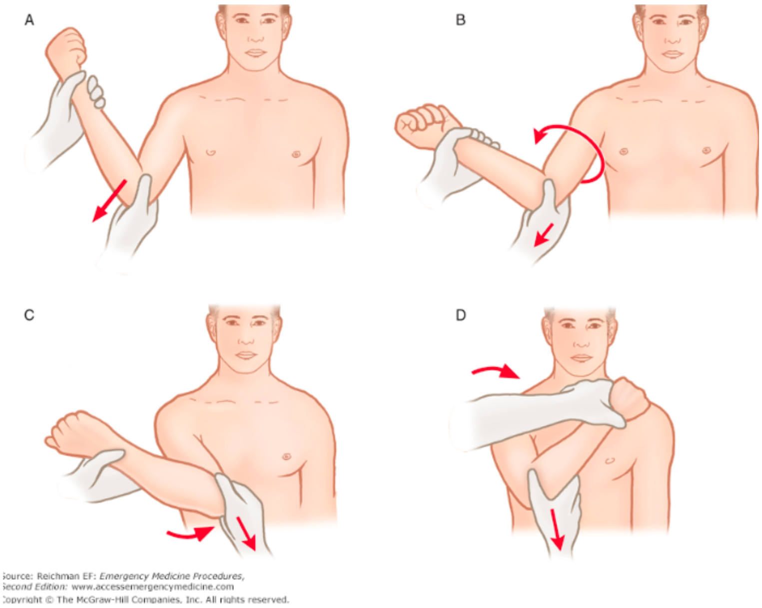
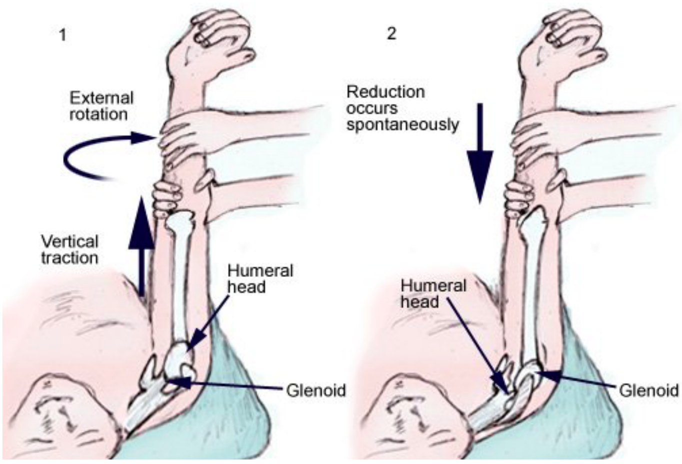
Title: Hippocratic Technique (Reichman, 2013)



Title: Kosher Technique (Reichman, 2013)



Title: Spaso Technique (Reichman, 2013)

Appendix 2: Informed Consent

Protocole « Rééducation après luxation antérieure de l'épaule avec l'outil KinéQuantum® chez des jeunes judokas »

I. Etat civil

Nom:
Prénom:
Numéro de téléphone:
Sexe:
Âge:
Taille:
Poids:

Pathologie/Symptômes:

Traitement/Réduction:

II. Consentement éclairé

En signant ce formulaire, je déclare que je consens à participer à l'étude sur la « **Rééducation après luxation antérieure de l'épaule avec l'outil KinéQuantum® chez des jeunes judokas** » menée par **Mirlocca Stella, Siegmund Alexandre et Chabot Julien** dans le cadre de leurs études en Physiothérapie.

J'ai par ailleurs pris conscience de toutes les informations données aux participants de l'étude et portant sur :

- son objectif, sa méthode et sa durée ;
- Les contraintes et risques éventuellement encourus ;
- les effets secondaires de la réalité virtuelle ;
- Le bénéfice que je peux en attendre ;
- l'usage qui sera fait des résultats.

M'informant notamment du fait que :

- mon identité et mes coordonnées seront traités de manière confidentielle ;
- Je peux demander à tout moment un complément d'information sur l'étude;
- Je peux quitter l'étude à tout moment.

Après avoir discuté librement et obtenu réponse à toutes mes questions, j'accepte de participer à cette étude. Mon consentement ne décharge pas les organisateurs de l'étude de leurs responsabilités. Je conserve tous mes droits garantis par la loi.

Signature du **Patient** :
(Suivie de la mention « lu et approuvé »)

Signatures des **Expérimentateurs** :

Appendix 3: Table representing the muscles, and their motor root, that are involved in shoulder movements.

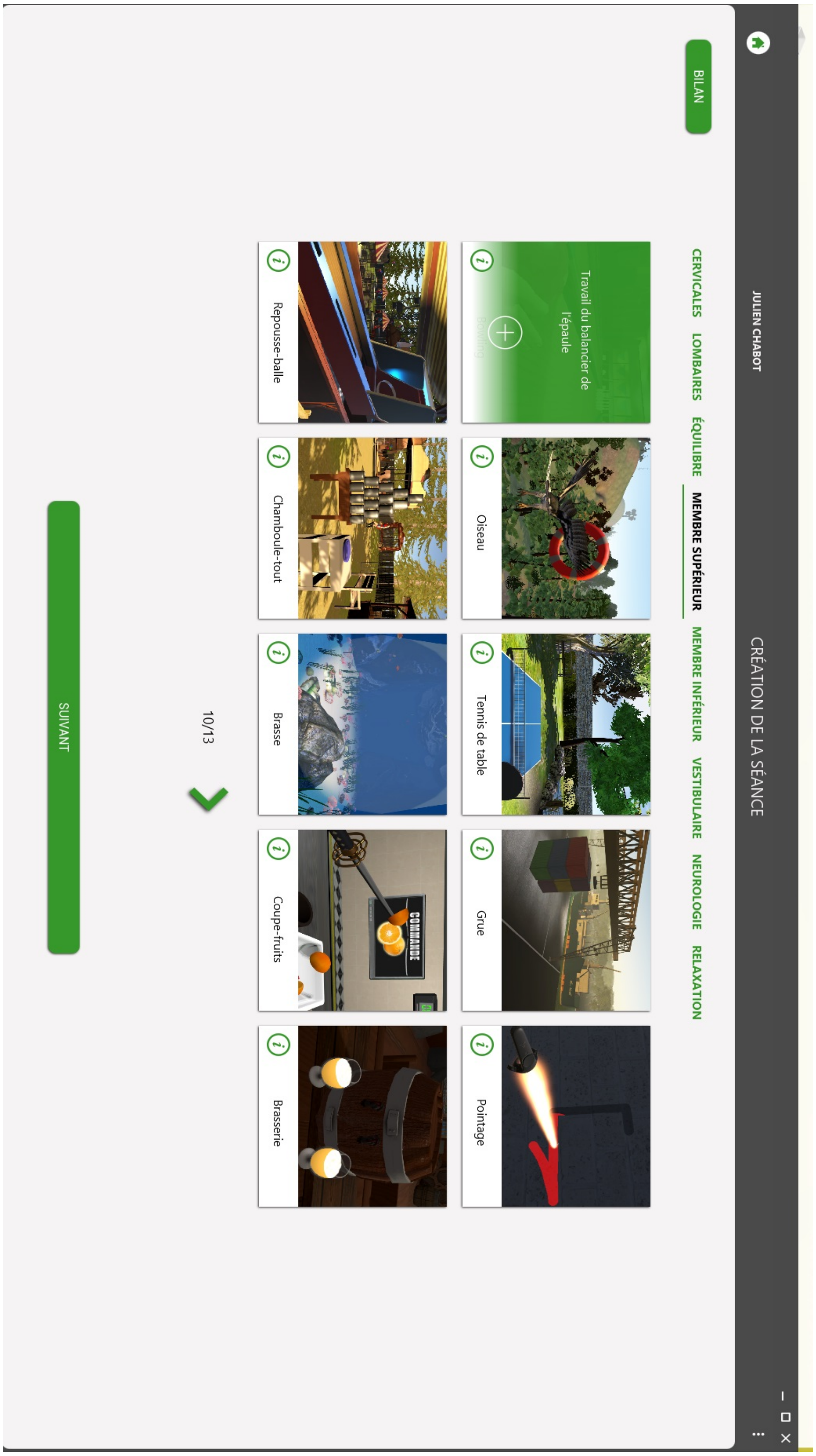
MOUVEMENT	MUSCLES	RACINES
ANTEPULSION	Deltoïde antérieur et moyen	C5-C6
	Biceps brachial	C5-C7
	Grand pectoral (si le bras est en extension)	C5-T1
	Coraco-brachial	C6-C7
	Grand dentelé et Trapèze supérieur en fin de mouvement, dans la sonnette externe de la scapula	C5-C7 et C2-C3
RETROPULSION	Grand rond	C5-C8
	Grand dorsal	C6-C8
	Chef long du triceps brachial	C6-C8
	Deltoïde postérieur	C5-C6
	Rhomboïde et Élévateur de la scapula dans la sonnette externe de la scapula	C4-C5
ABDUCTION **0°-90°:** scapulo-huméral only	Deltoïde	C5-C6
	Supra-épineux	C4-C6
90°-160°: external bell **160°-180°:** spine inclination	Dentelé antérieur	C5-C7
	Trapèze supérieur	C2-C3
ADDUCTION	Grand pectoral	C5-T1
	Chef long du triceps brachial	C6-C8
	Grand rond	C5-C8
	Grand dorsal	C6-C8

	Chef court du biceps brachial	C5-C7
	Petit pectoral et Rhomboïde pour la sonnette interne	C6-T1 et C4-C5
IR	Sub-scapulaire	C5-C8
	Grand pectoral	C5-T1
	Chef long du biceps brachial	C5-C7
	Deltoïde antérieur	C5-C6
	Grand rond et grand dorsal	C5-C8 et C6-C8
ER	Infra-épineux	C4-C6
	Petit rond	C5-C6
	Deltoïde postérieur	C5-C6

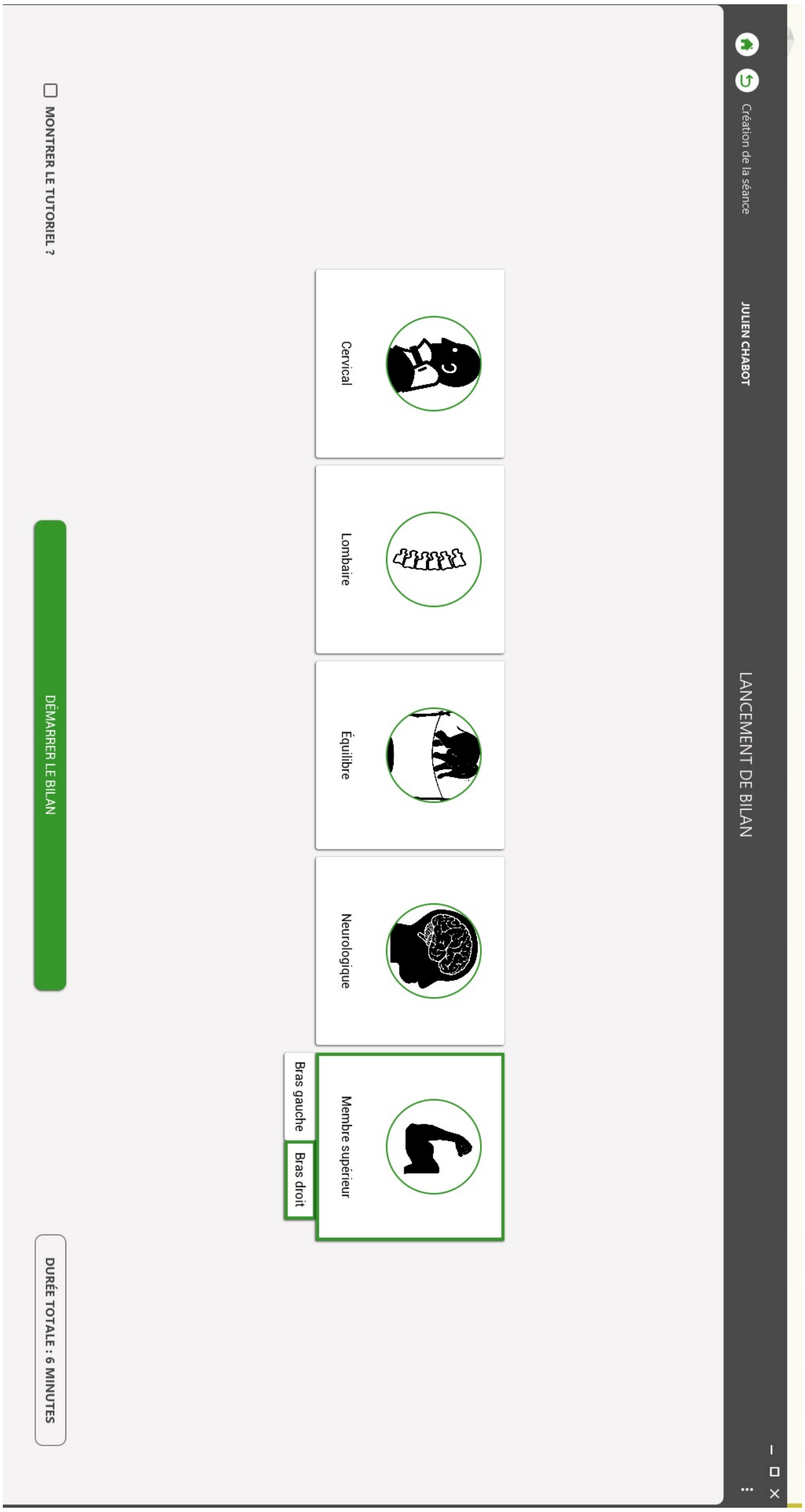
Table 1: Muscles, and their motor root, that are involved in shoulder movements (Kapandji, 2018; Schünke, Schulte, & Schumacher, 2016).

Appendix 4: KineQuantum® equipment

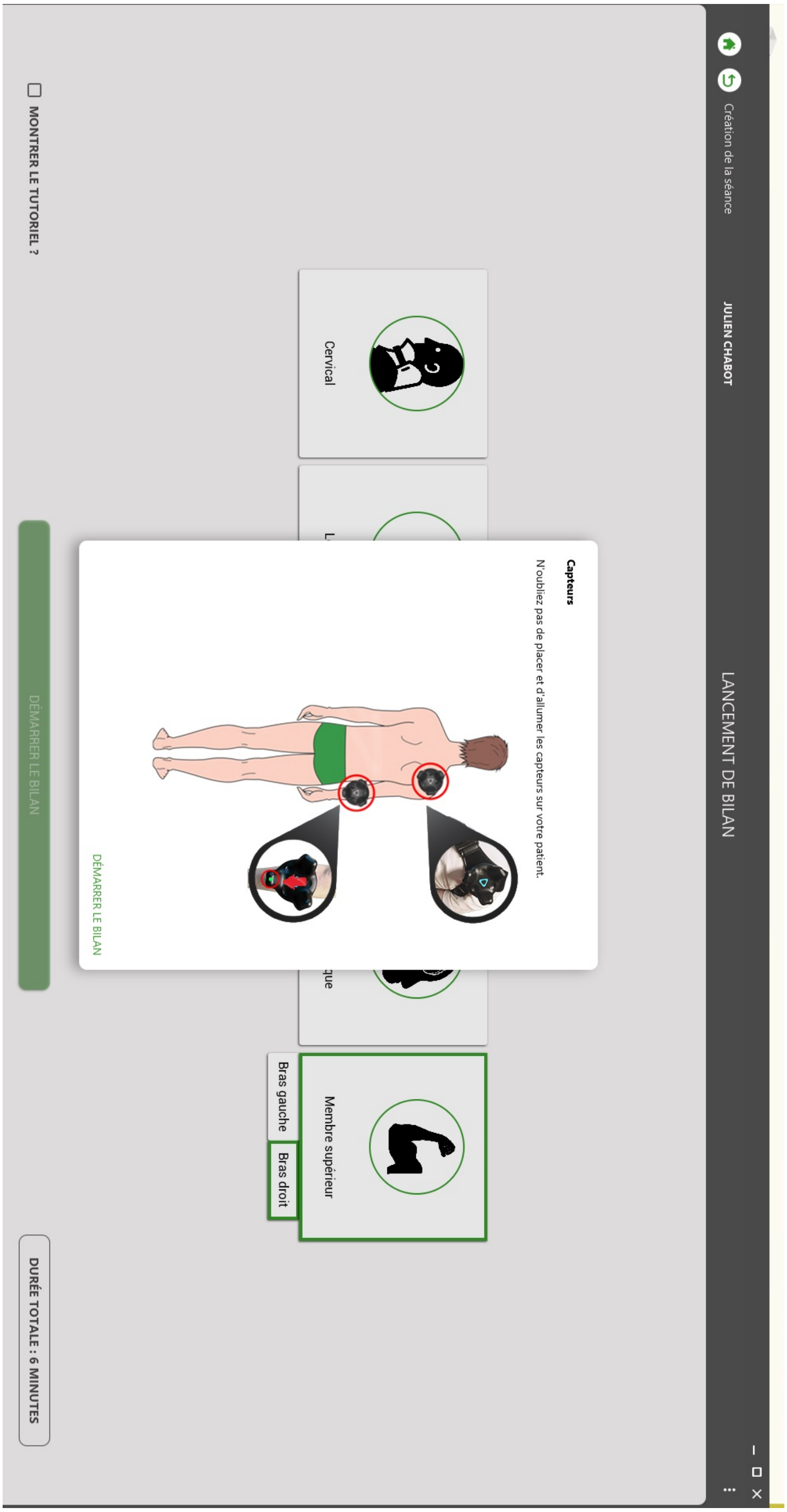
Appendix 5: The various fields of application of KineQuantum®



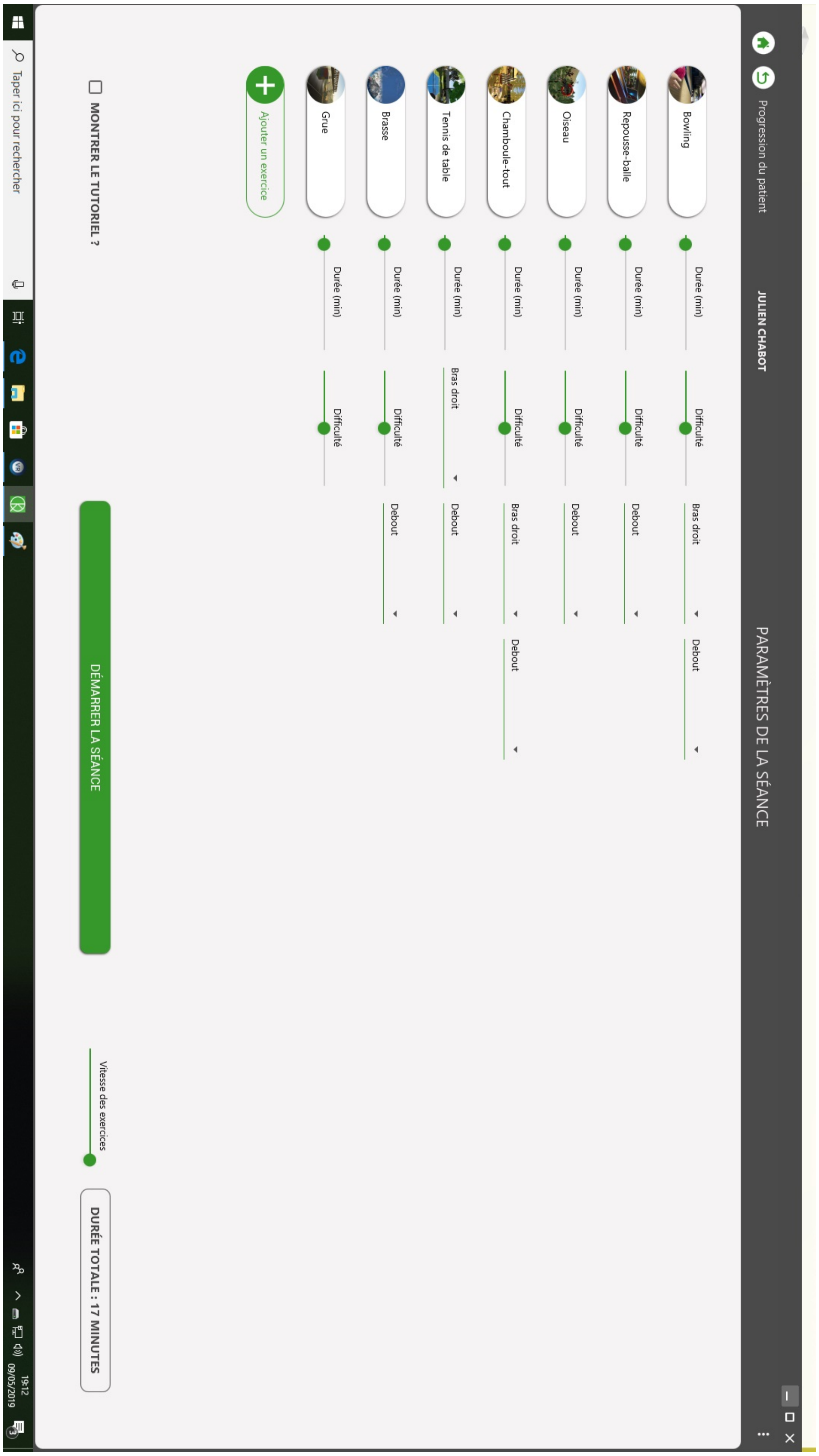
Appendix 6: KinéQuantum® assessments

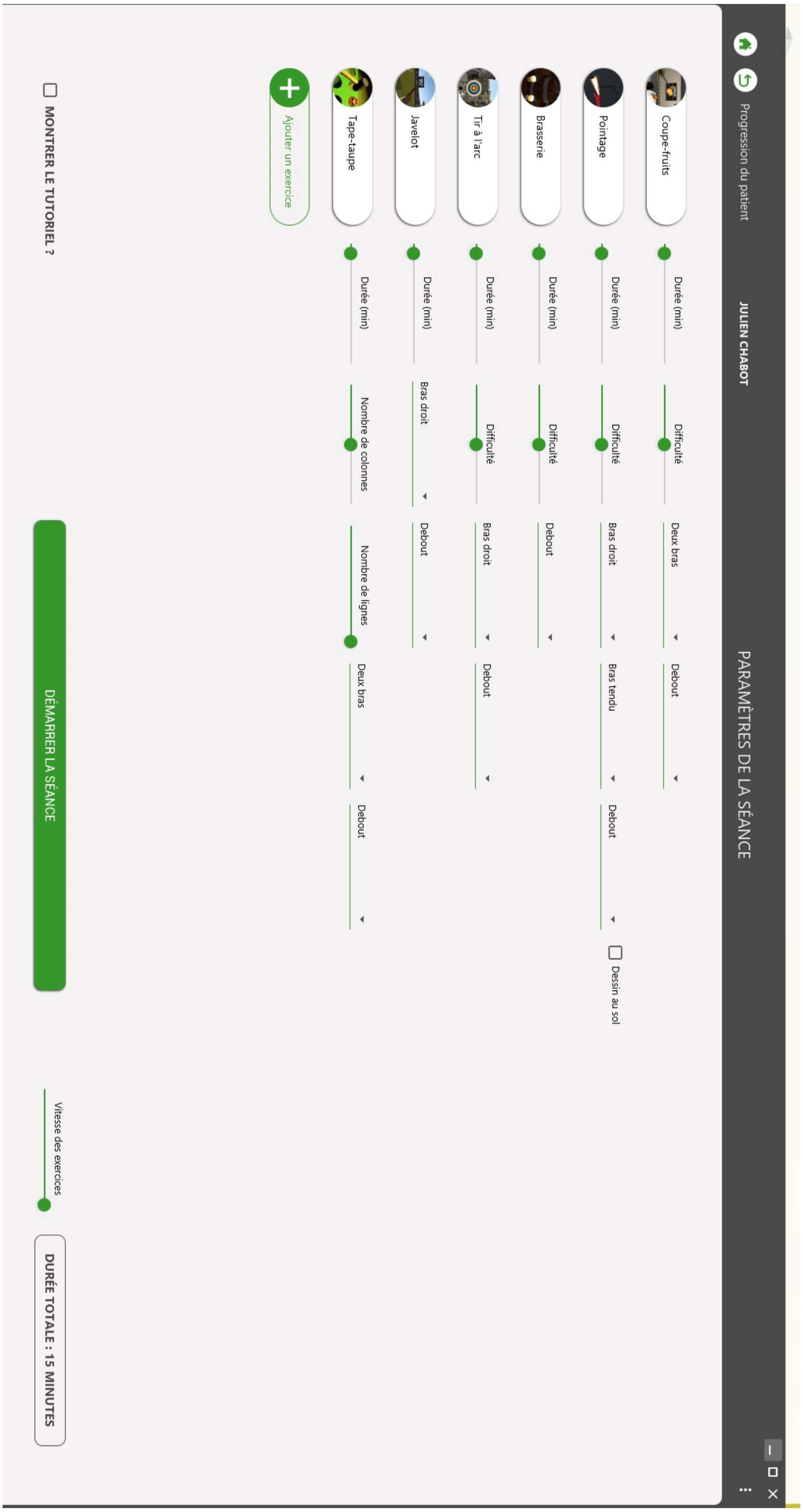



SÉANCE EN COURS
JULIEN CHABOT
GRAPHIQUE LIVE
Le graphique n'est pas disponible.
SÉANCE
Bilan de l'épaule
Bilan du coude
Proprioception de l'épaule
VUE DU PATIENT
HOME
Veuillez saisir les manettes et vous asseoir au fond
VIDEO 1
Avec manette(s)
VIDEO 2
Contre le dossier
VIDEO 3
AVANCEMENT
Bilan de l'épaule
Bilan du coude
Proprioception de l'épaule

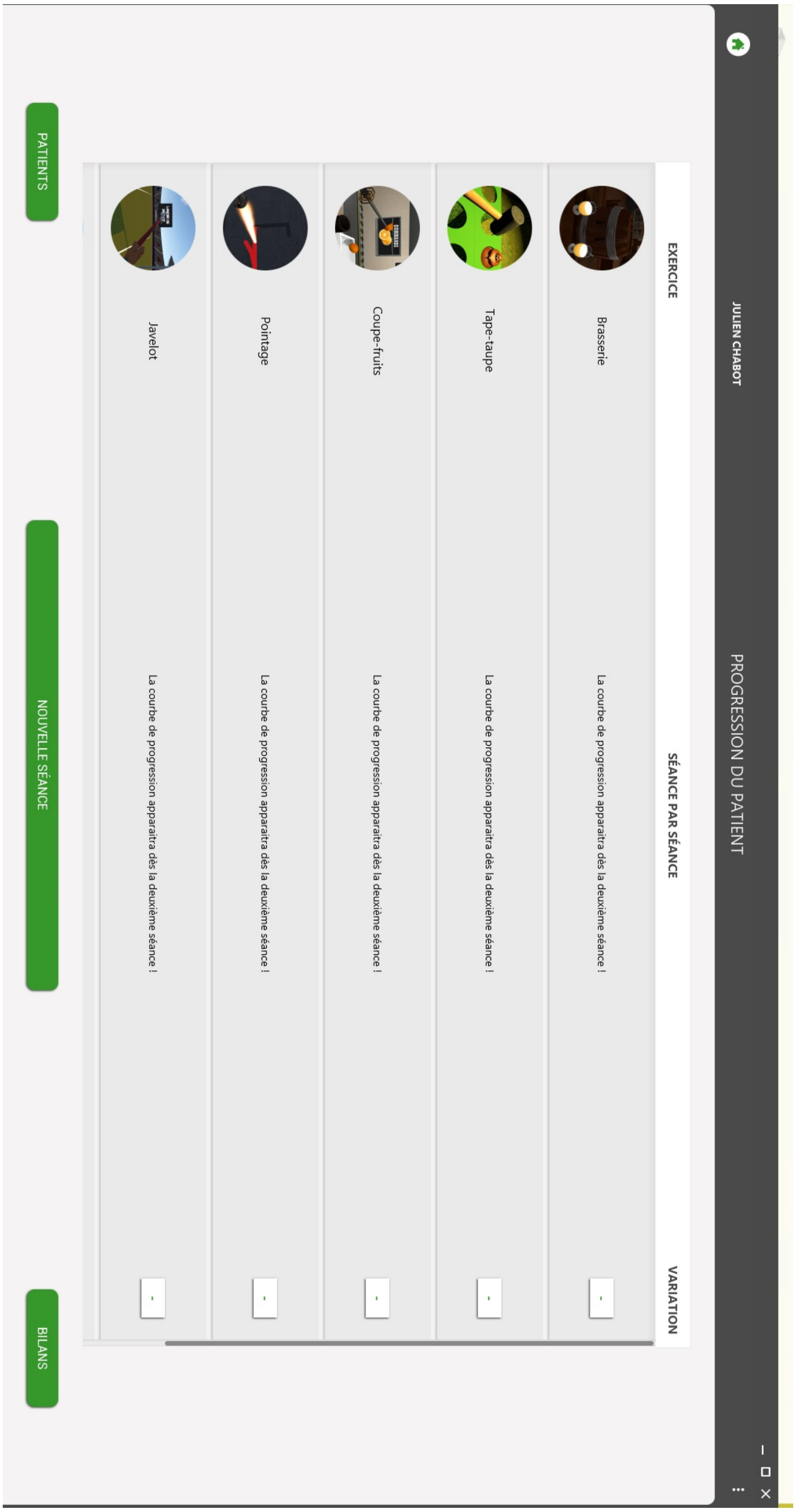

Création de la séance
JULIEN CHABOT
LANCEMENT DE BILAN
Cervical
Membre supérieur
Bras gauche
Bras droit
Capteurs
N'oubliez pas de placer et d'allumer les capteurs sur votre patient.
DÉMARRER LE BILAN
MONTRER LE TUTORIEL ?
DÉMARRER LE BILAN
DURÉE TOTALE : 6 MINUTES

Appendix 7: KineQuantum® Exercise Settings




Progression du patient
JULIEN CHABOT
PARAMÈTRES DE LA SÉANCE
Coupe-fruits
Durée (min)
Difficulté
Deux bras
Debout
Pointage
Durée (min)
Difficulté
Bras droit
Bras tendu
Debout
Dessin au sol
Brasserie
Durée (min)
Difficulté
Debout
Tir à l'arc
Durée (min)
Difficulté
Bras droit
Debout
Javelot
Durée (min)
Bras droit
Debout
Tape-taupe
Durée (min)
Nombre de colonnes
Nombre de lignes
Deux bras
Debout
Ajouter un exercice
MONTRER LE TUTORIEL ?
DÉMARRER LA SÉANCE
Vitesse des exercices
DURÉE TOTALE : 15 MINUTES

Appendix 8: Progress of KineQuantum® exercises



Appendix 9: Tables of Assessment Test Results

Goniometry

Nombre de mois	0	1	2	3	4	10	16	22	28	34	40
Antepulsion											
Retropulsion											
abduction											
adduction											
ER R1											
ER R2											
ER R3											
IR R1											
IR R2											
IR R3											

Title: Table representing the articular amplitudes of the shoulder during the study.

Test CKCUEST

Nombre de mois	0	1	2	3	4	10	16	22	28	34	40
Répétitions											
Répétitions											
Répétitions											
Répétitions											

Title: Table representing the patient's results in the CKCUEST test during the study.

Muscle testing

Number of months	0	1	2	3	4	10	16	22	28	34	40
Antepulsion											
Retropulsion											
abduction											
Adduction											
ER R1											
ER R2											
ER R3											
IR R1											
IR R2											
IR R3											

Title: Table representing the patient's results in functional muscle testing during the study.

Constant Score

Number of months	0	1	2	3	4	10	16	22	28	34	40
Results											

Title: Table representing the patient's Constant score results during the study.

Visual Anatomical Scale (VAS)

Number of months	0	1	2	3	4	10	16	22	28	34	40
Score											

Title: Table representing the patient's VAS score results during the study.

Appendix 10: History

Anamnèse

Nom, Prénom :

Renseignements socio-administratifs :

- Date de naissance :
- Situation administrative :
- Environnement/hygiène de vie (tabac, alcool, etc.) :
- Autres activités/sports :
- Situation familiale :

Douleur :

- Localisation :
- Intensité :
- Type :
- Survenue/Sédation :

Pratique du Judo :

- Ceinture :
- Loisir ou compétition :
- Nombre d'année de pratique :

Renseignements médicaux :

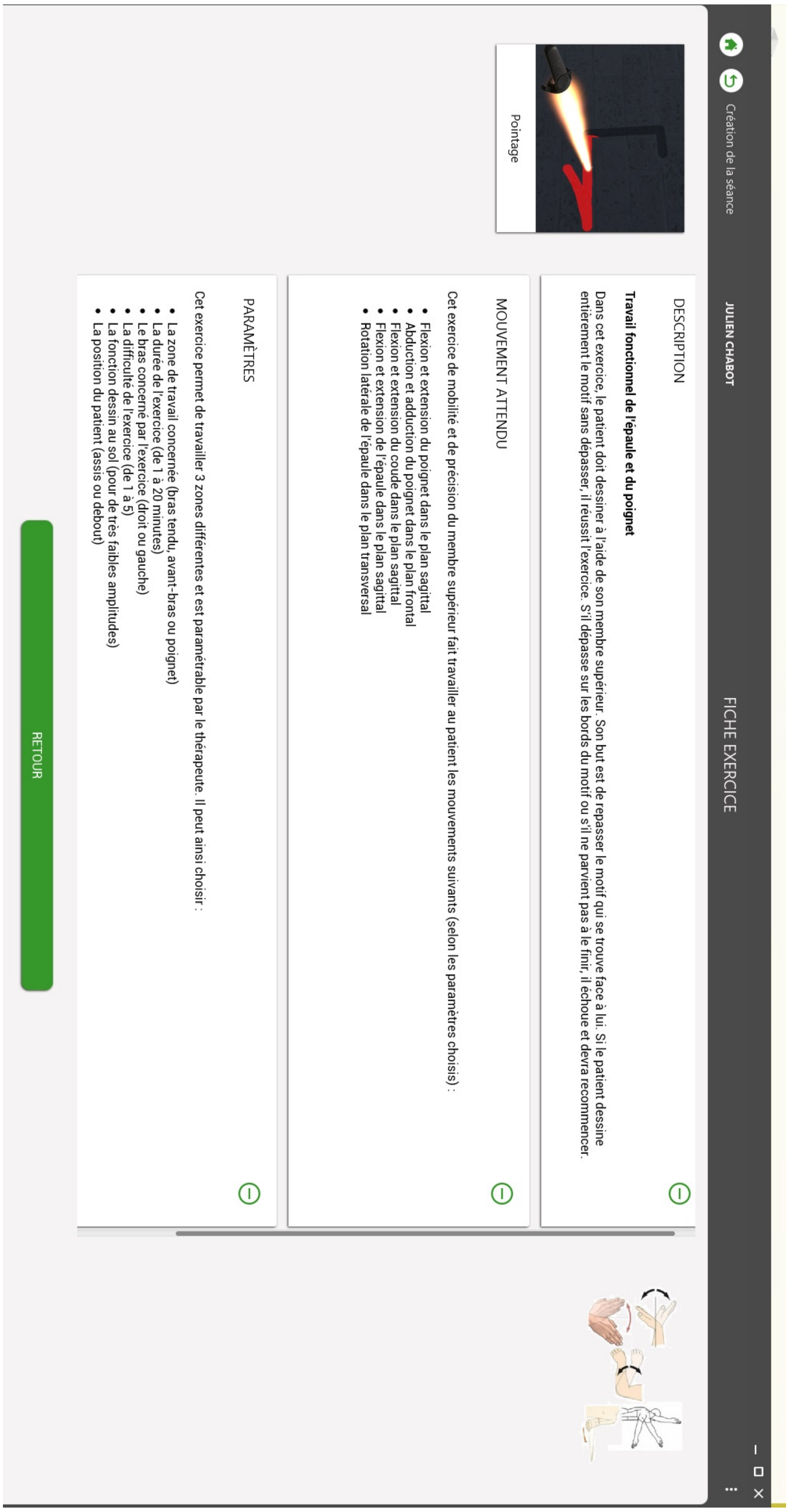
- Diagnostic médical :
- Mécanisme lésionnel :
- Antécédents médicaux (autres traumatismes, chirurgie, etc.) :
- Type de réduction :
- Traitement médical :

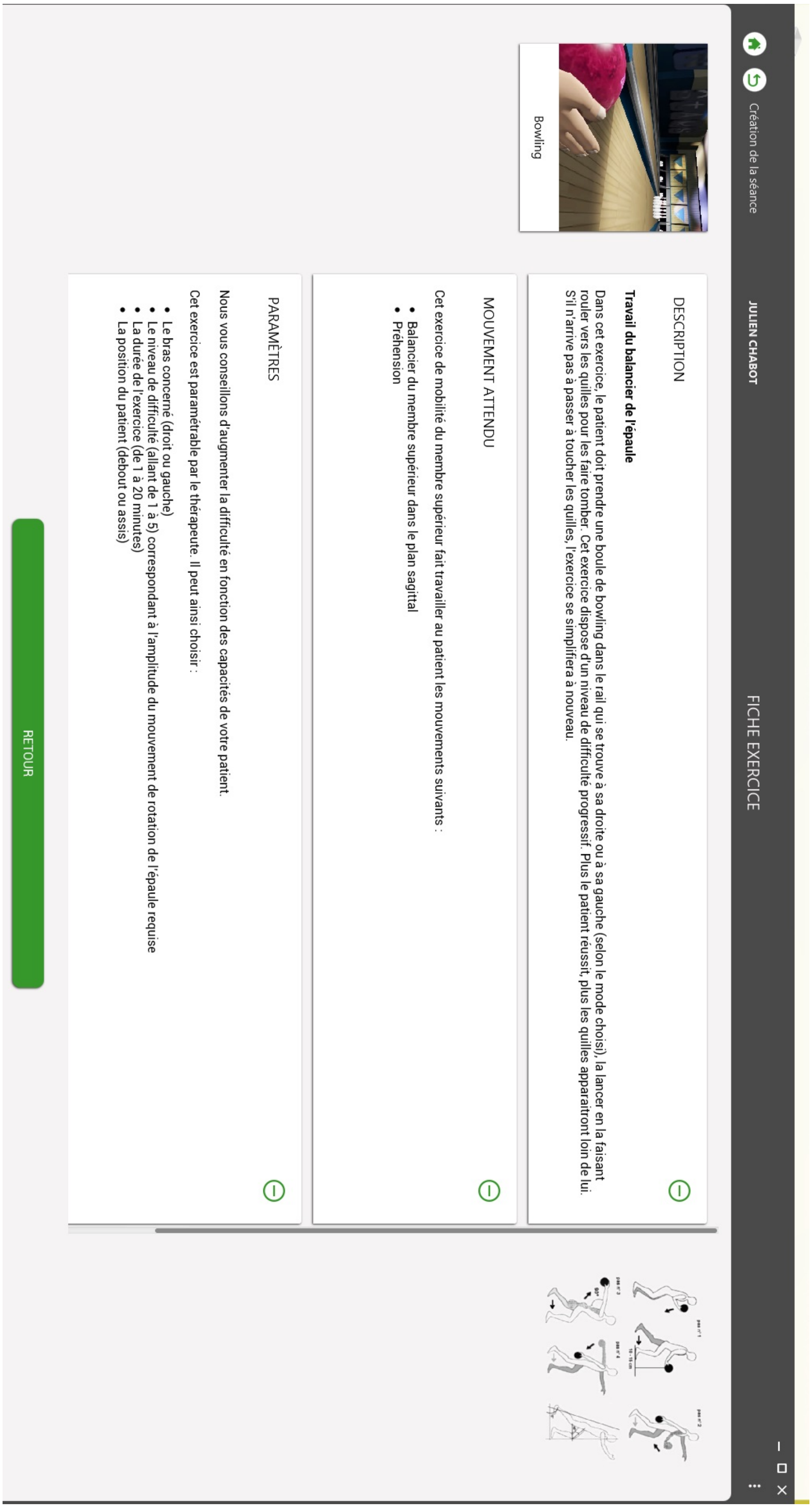
Appendix 11: Conventional and experimental treatment protocol

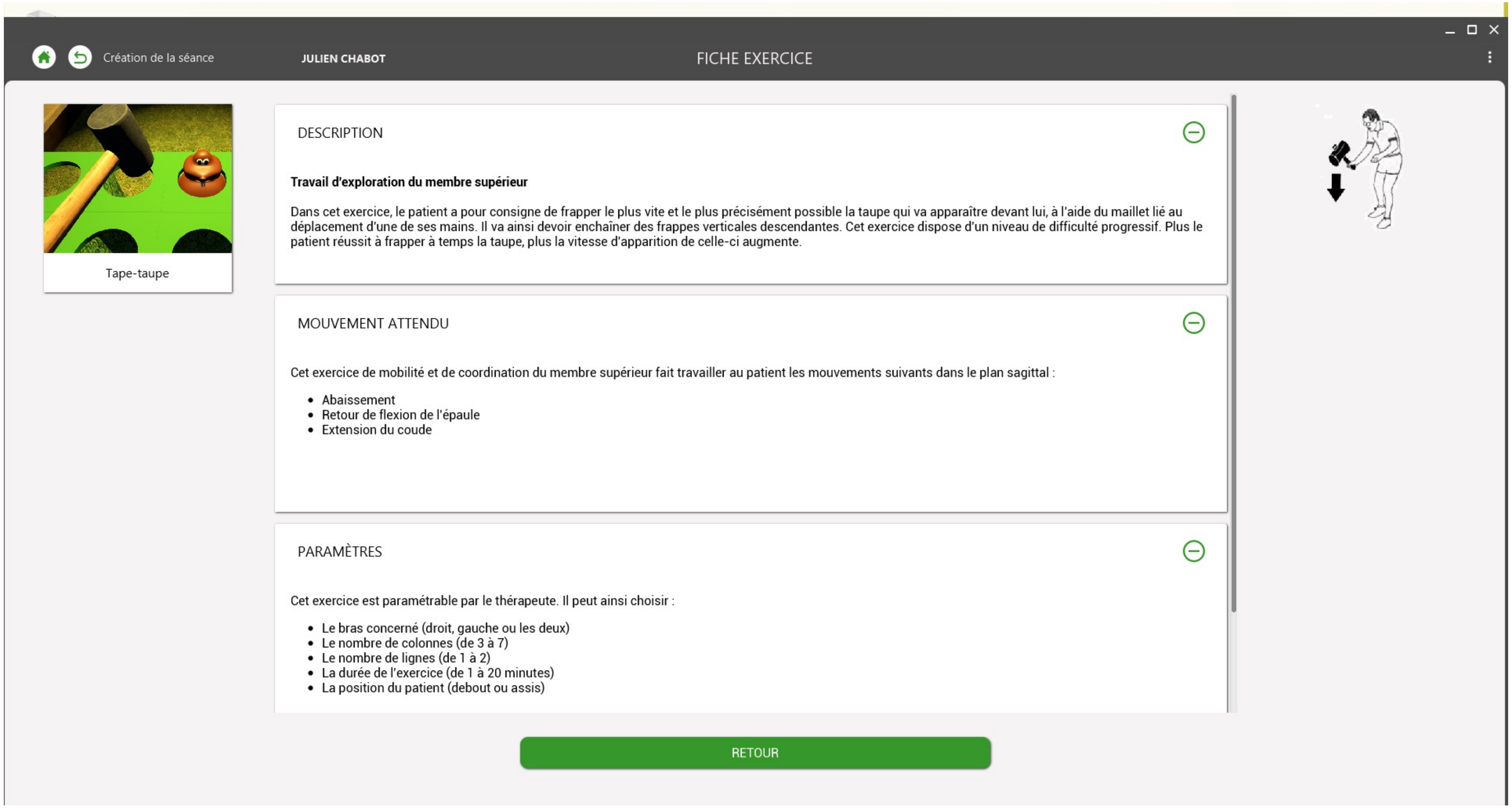
	PROTOCOLE DE RC	PROTOCOLE DE RV
Phase 1	- Analgesic electrotherapy on the shoulder complex. - Cryotherapy thanks to Game Ready, which allows to encompass the entire shoulder complex and thus to fight against inflammatory phenomena. - Relaxing and circulatory massages of the entire shoulder. - Various relaxation and analgesic techniques. - Postural correction of the shoulder, cervical spine and maintenance of the flexibility of the cervical-dorsal spine. - Active mobilization of the underlying joints: elbow, wrist and hand. - Beginning of the pendulum work of the shoulder without load to bring about a relaxation by voluntary release. This exercise limits the defensive contractures that maintain pain. - Passive mobilization of the shoulder joints by limiting abduction, antepulsion and ER movements in infrapain, in order to avoid an uncontrolled proliferation of collagen fibers and thus to recover functional joint amplitudes.	
Phase 2	- Same as the previous phase, with physiotherapy, massages, and methods that allow a gain in flexibility. - Pendulum work with load from the third week onwards. - Passive and active recovery of all joint amplitudes by limiting abduction, antepulsion and ER movements up to 6 weeks after the ASD episode. - Recovery of muscle strength through isometric exercises on the scapula fixing muscles (adduction, elevation and lowering), humerus coaptor muscles (internal and external rotators) and long muscles (pectoralis major, great dorsal and deltoid). - Progressive dynamic muscle strengthening of the rotator cuff muscles, deltoid and scapula fixators.	- KinéQuantum® exercices (APPENDIX 12): - Score, - Bowling, - Tap-taupe, - Push back ball..

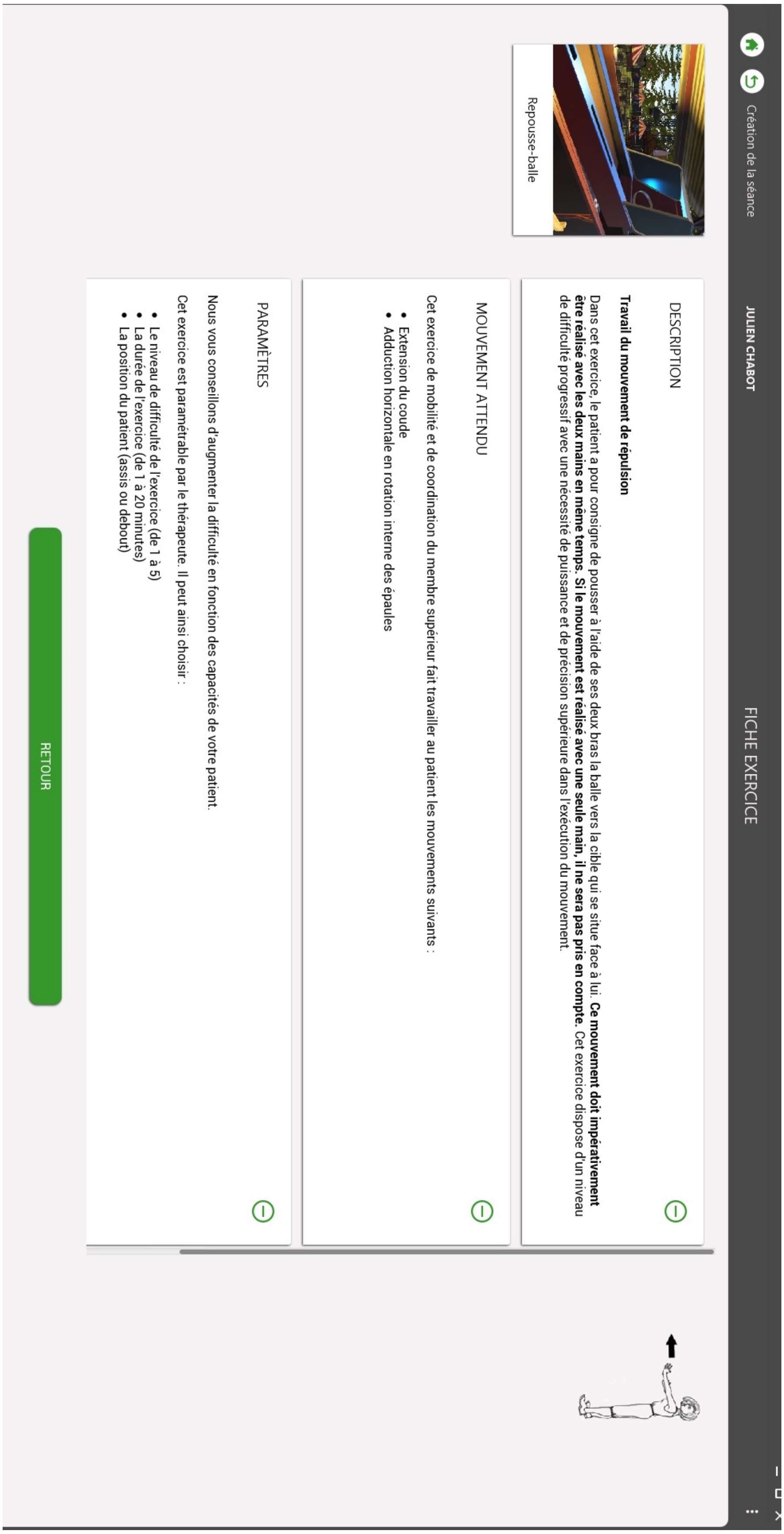
<table>
<tr><th></th><th>PROTOCOLE DE RC</th><th>PROTOCOLE DE RV</th></tr>
<tr><td rowspan="2">Phase 3</td><td colspan="2">- Active mobilization work and intensification of muscle strengthening in isometric, eccentric and concentric.
- Proprioceptive work on the shoulder in a CKC (Andrew, 2002) thanks to a frank distal contact (in direct support on a vertical plane or on the ground), then in a semi-closed position (using a stick or an elastic band) and finally in an OKC (Sciascia & Cromwell, 2012). Positions will be more and more challenging, thus increasing instability.
-</td></tr>
<tr><td></td><td>- The difficulty of the previous exercises will be maximum, and we add the following exercises:
- The bird,
- Archery,
- Breaststroke,
- Brewery,
- You know, the whole thing,
- Fruit bowl,
- Table tennis,
- Javelin.</td></tr>
<tr><td rowspan="2">Phase 4</td><td colspan="2">- Muscle strengthening with the isokinetic test, evaluating the maximum force developed by the internal and external rotators, in order to calculate the bilateral difference in % and the ratios IR/ER ;
- Muscular endurance exercises (ergocycle);
- Speed exercises and reflexes;
- Coordination exercises;
- Progressive re-training of the specific sporting gesture;
- Progressive resumption of judo training.</td></tr>
<tr><td></td><td>- The difficulty of the exercises mentioned above will be increased to a maximum.</td></tr>
</table>

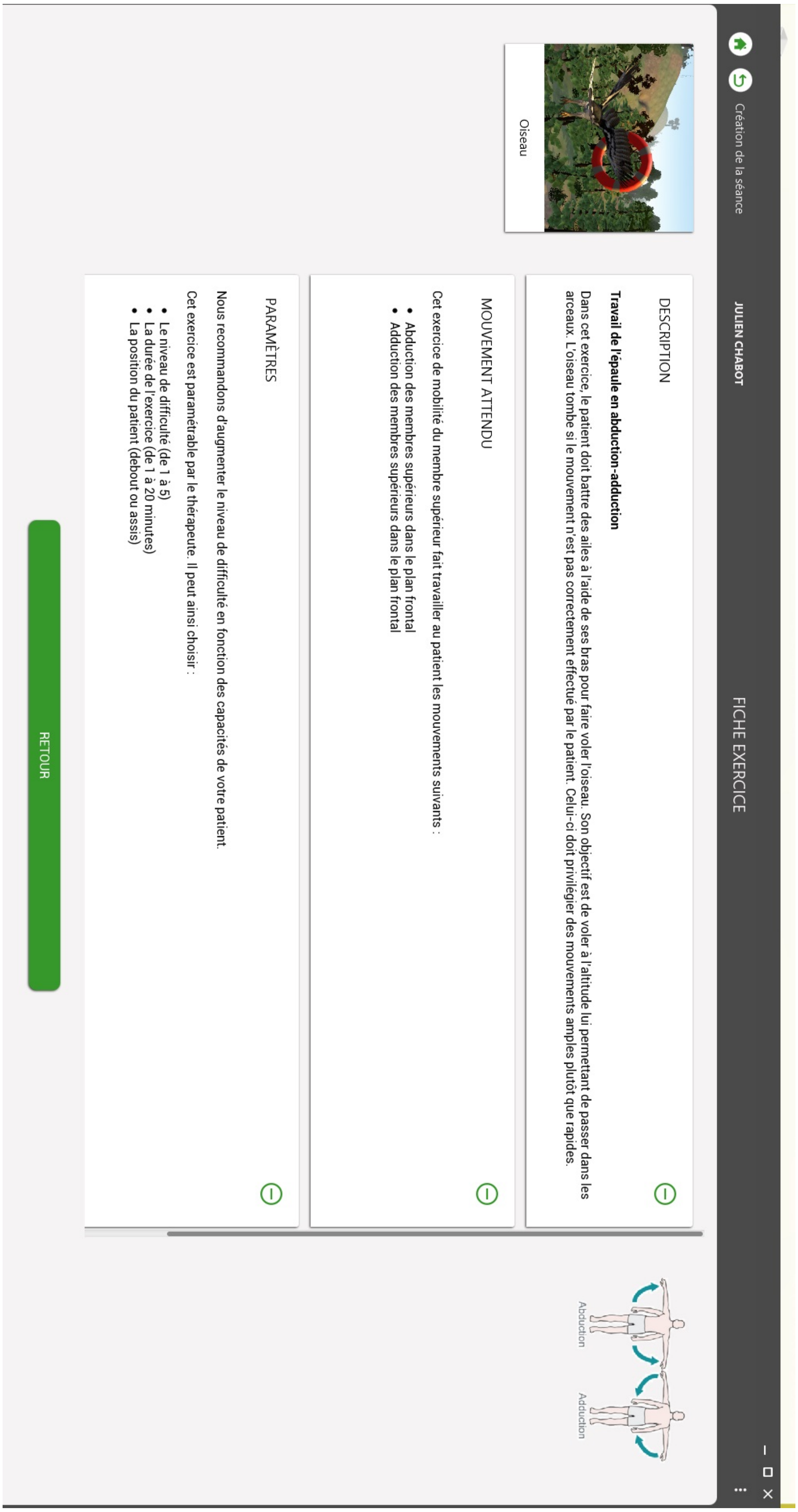
Appendix 12: Descriptions of KineQuantum ® exercises

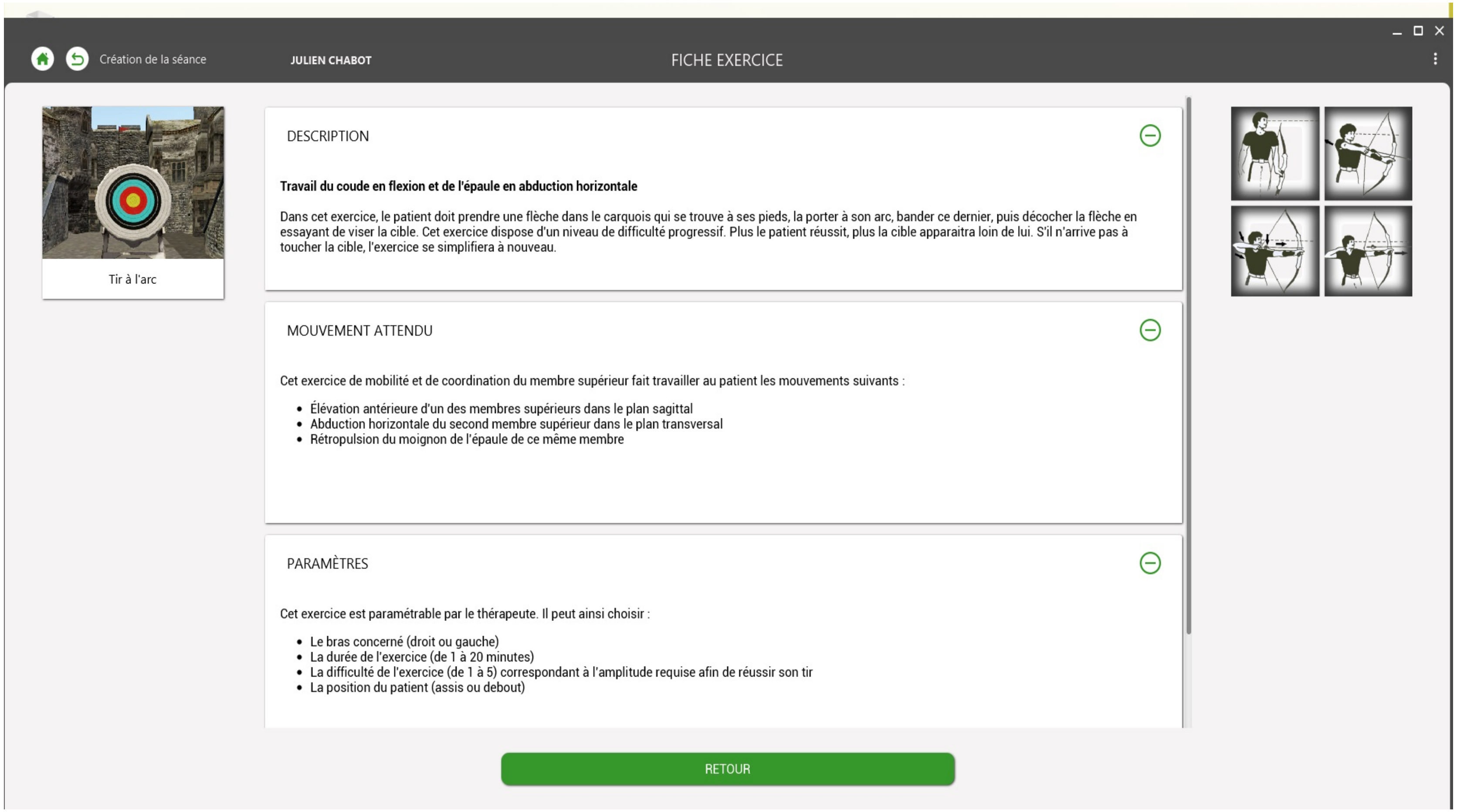


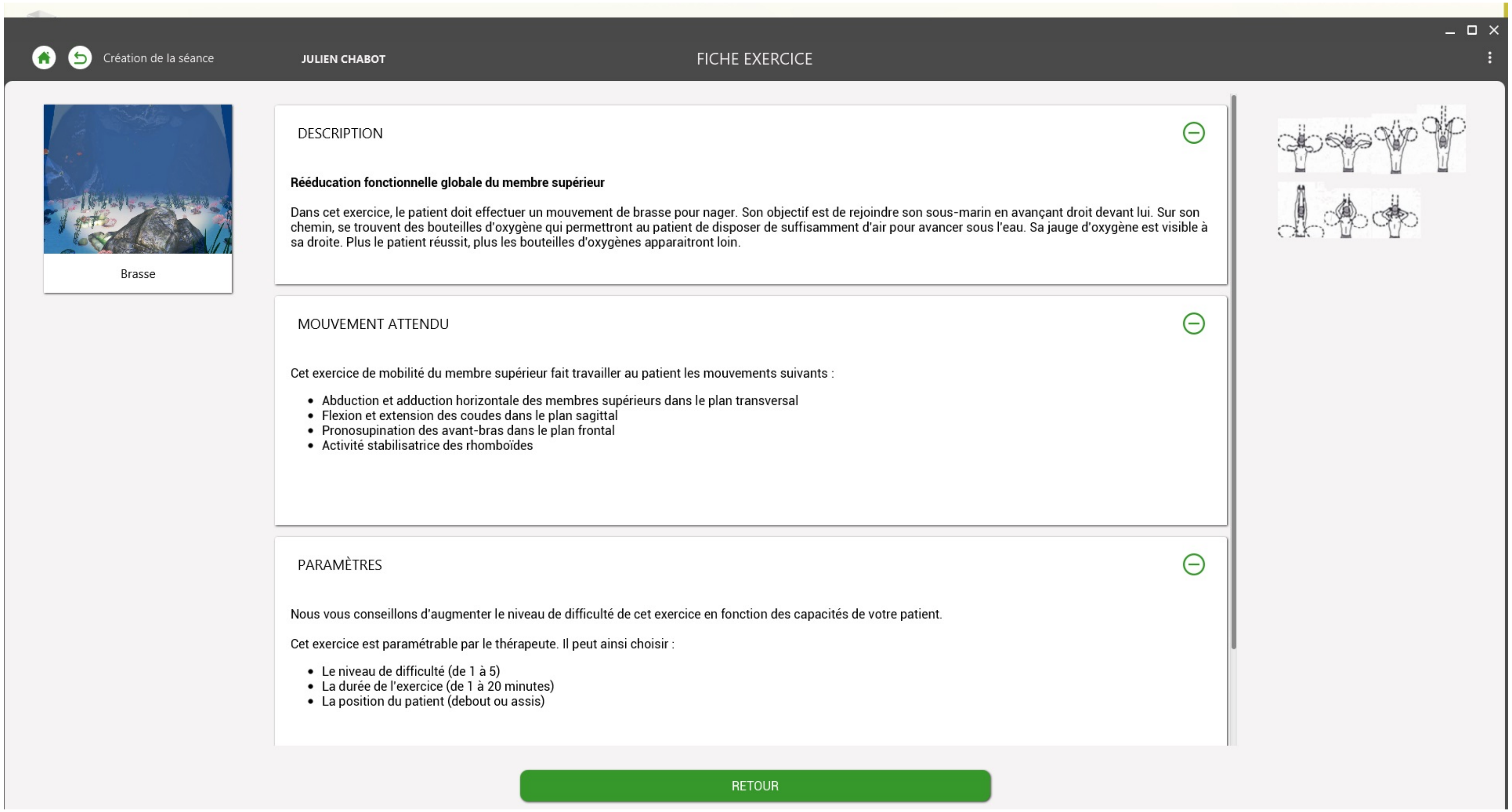

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Bowling
DESCRIPTION
Travail du balancier de l'épaule
Dans cet exercice, le patient doit prendre une boule de bowling dans le rail qui se trouve à sa droite ou à sa gauche (selon le mode choisi), la lancer en la faisant rouler vers les quilles pour les faire tomber. Cet exercice dispose d'un niveau de difficulté progressif. Plus le patient réussit, plus les quilles apparaitront loin de lui. S'il n'arrive pas à passer à toucher les quilles, l'exercice se simplifiera à nouveau.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
• Balancier du membre supérieur dans le plan sagittal
• Préhension
PARAMÈTRES
Nous vous conseillons d'augmenter la difficulté en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• Le bras concerné (droit ou gauche)
• Le niveau de difficulté (allant de 1 à 5) correspondant à l'amplitude du mouvement de rotation de l'épaule requise
• La durée de l'exercice (de 1 à 20 minutes)
• La position du patient (debout ou assis)
RETOUR

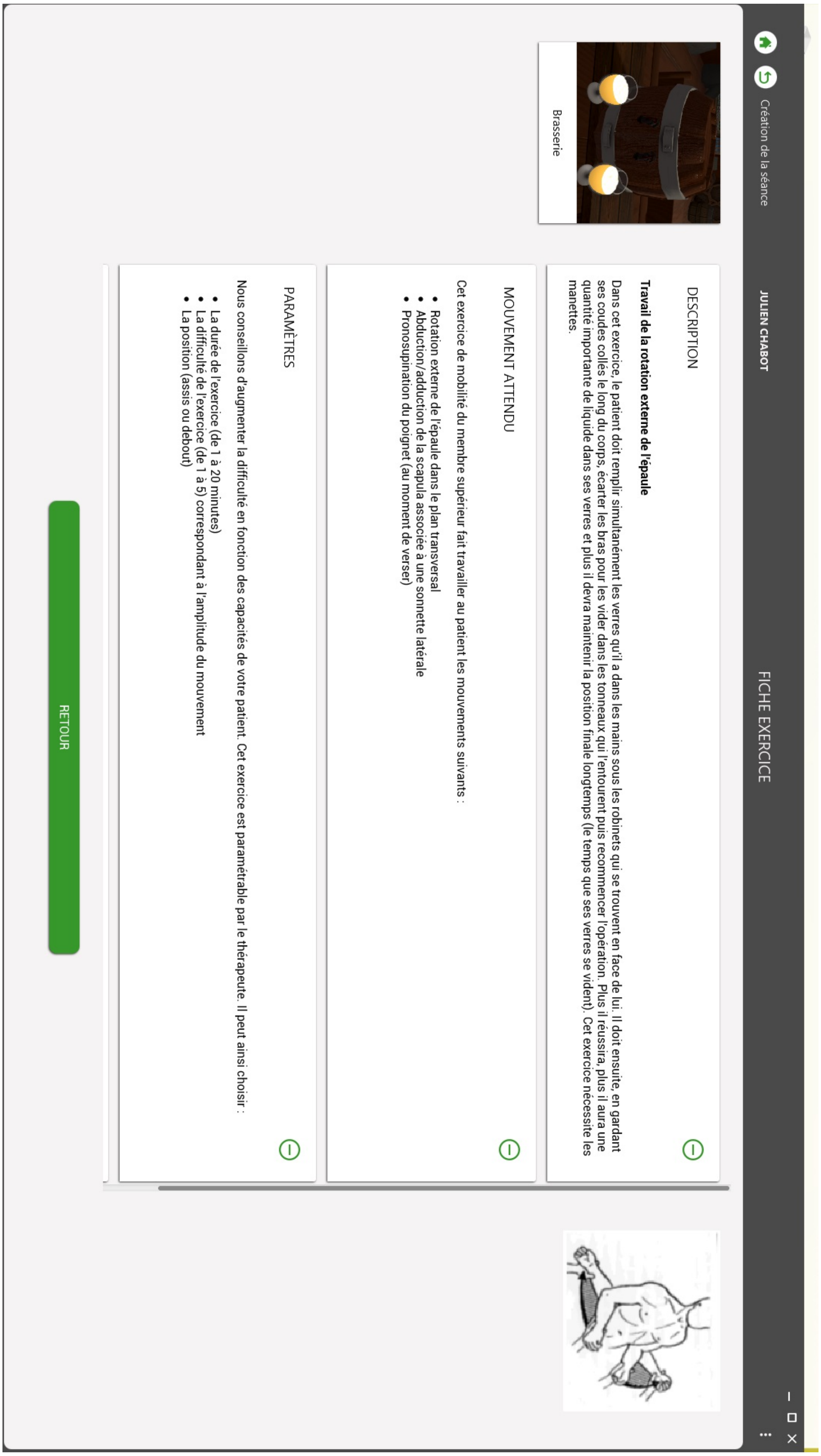

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Tape-taupe
DESCRIPTION
Travail d'exploration du membre supérieur
Dans cet exercice, le patient a pour consigne de frapper le plus vite et le plus précisément possible la taupe qui va apparaître devant lui, à l'aide du maillet lié au déplacement d'une de ses mains. Il va ainsi devoir enchaîner des frappes verticales descendantes. Cet exercice dispose d'un niveau de difficulté progressif. Plus le patient réussit à frapper à temps la taupe, plus la vitesse d'apparition de celle-ci augmente.
MOUVEMENT ATTENDU
Cet exercice de mobilité et de coordination du membre supérieur fait travailler au patient les mouvements suivants dans le plan sagittal :
• Abaissement
• Retour de flexion de l'épaule
• Extension du coude
PARAMÈTRES
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• Le bras concerné (droit, gauche ou les deux)
• Le nombre de colonnes (de 3 à 7)
• Le nombre de lignes (de 1 à 2)
• La durée de l'exercice (de 1 à 20 minutes)
• La position du patient (debout ou assis)
RETOUR

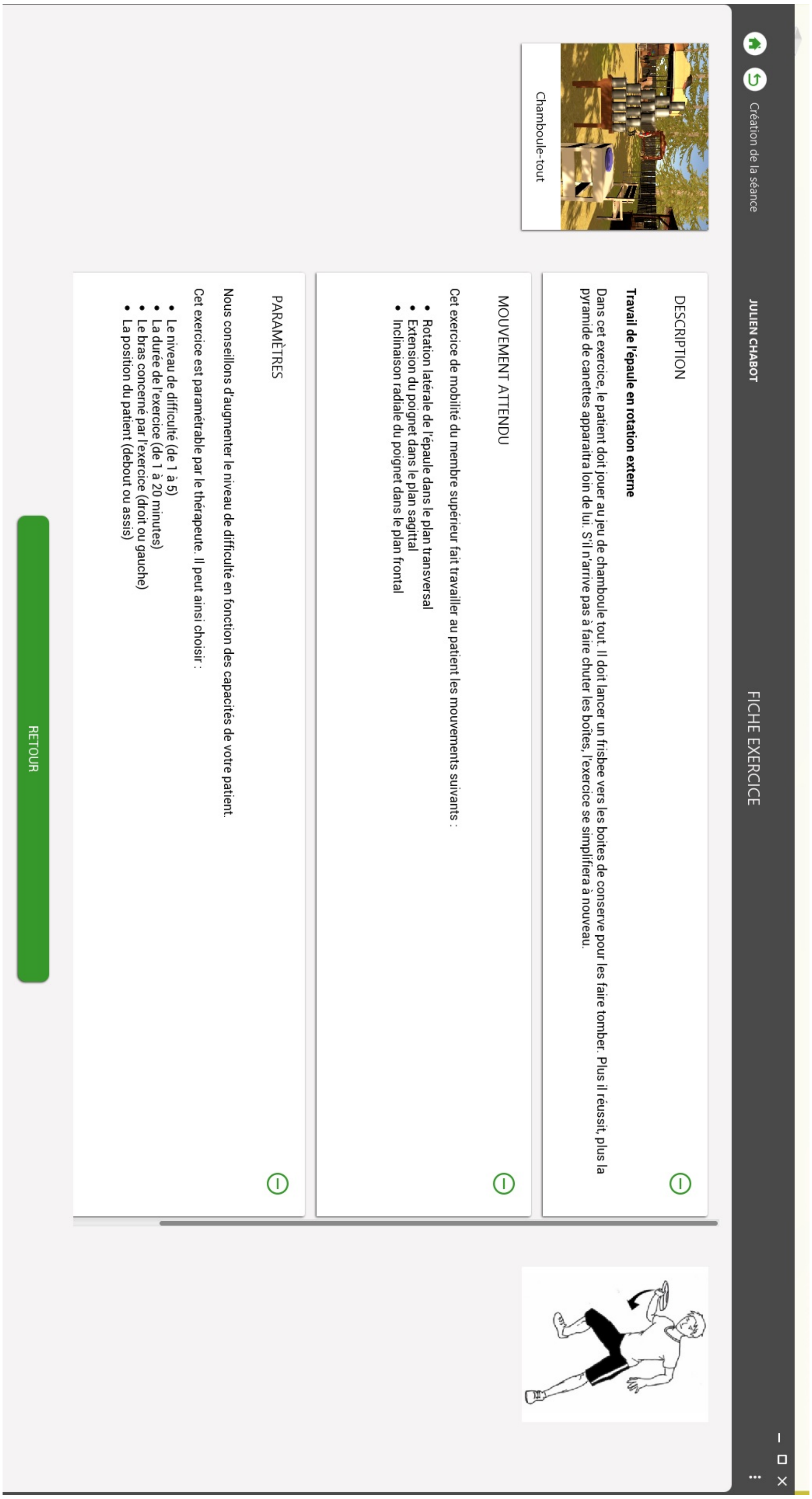

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Repousse-balle
DESCRIPTION
Travail du mouvement de répulsion
Dans cet exercice, le patient a pour consigne de pousser à l'aide de ses deux bras la balle vers la cible qui se situe face à lui. Ce mouvement doit impérativement être réalisé avec les deux mains en même temps. Si le mouvement est réalisé avec une seule main, il ne sera pas pris en compte. Cet exercice dispose d'un niveau de difficulté progressif avec une nécessité de puissance et de précision supérieure dans l'exécution du mouvement.
MOUVEMENT ATTENDU
Cet exercice de mobilité et de coordination du membre supérieur fait travailler au patient les mouvements suivants :
• Extension du coude
• Adduction horizontale en rotation interne des épaules
PARAMÈTRES
Nous vous conseillons d'augmenter la difficulté en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• Le niveau de difficulté de l'exercice (de 1 à 5)
• La durée de l'exercice (de 1 à 20 minutes)
• La position du patient (assis ou debout)
RETOUR

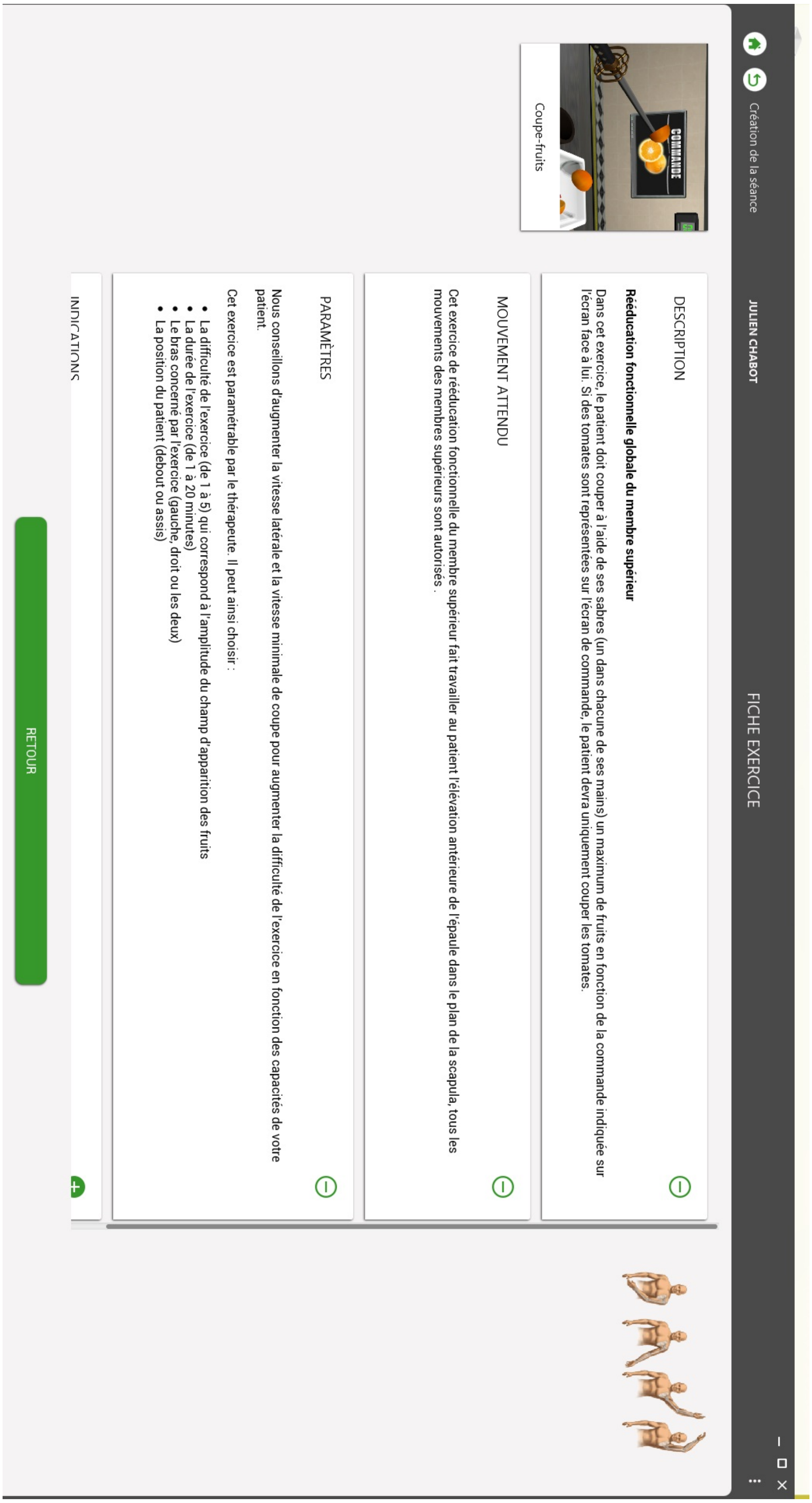

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Oiseau
DESCRIPTION
Travail de l'épaule en abduction-adduction
Dans cet exercice, le patient doit battre des ailes à l'aide de ses bras pour faire voler l'oiseau. Son objectif est de voler à l'altitude lui permettant de passer dans les arceaux. L'oiseau tombe si le mouvement n'est pas correctement effectué par le patient. Celui-ci doit privilégier des mouvements amples plutôt que rapides.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
• Abduction des membres supérieurs dans le plan frontal
• Adduction des membres supérieurs dans le plan frontal
PARAMÈTRES
Nous recommandons d'augmenter le niveau de difficulté en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• Le niveau de difficulté (de 1 à 5)
• La durée de l'exercice (de 1 à 20 minutes)
• La position du patient (debout ou assis)
Abduction
Adduction
RETOUR

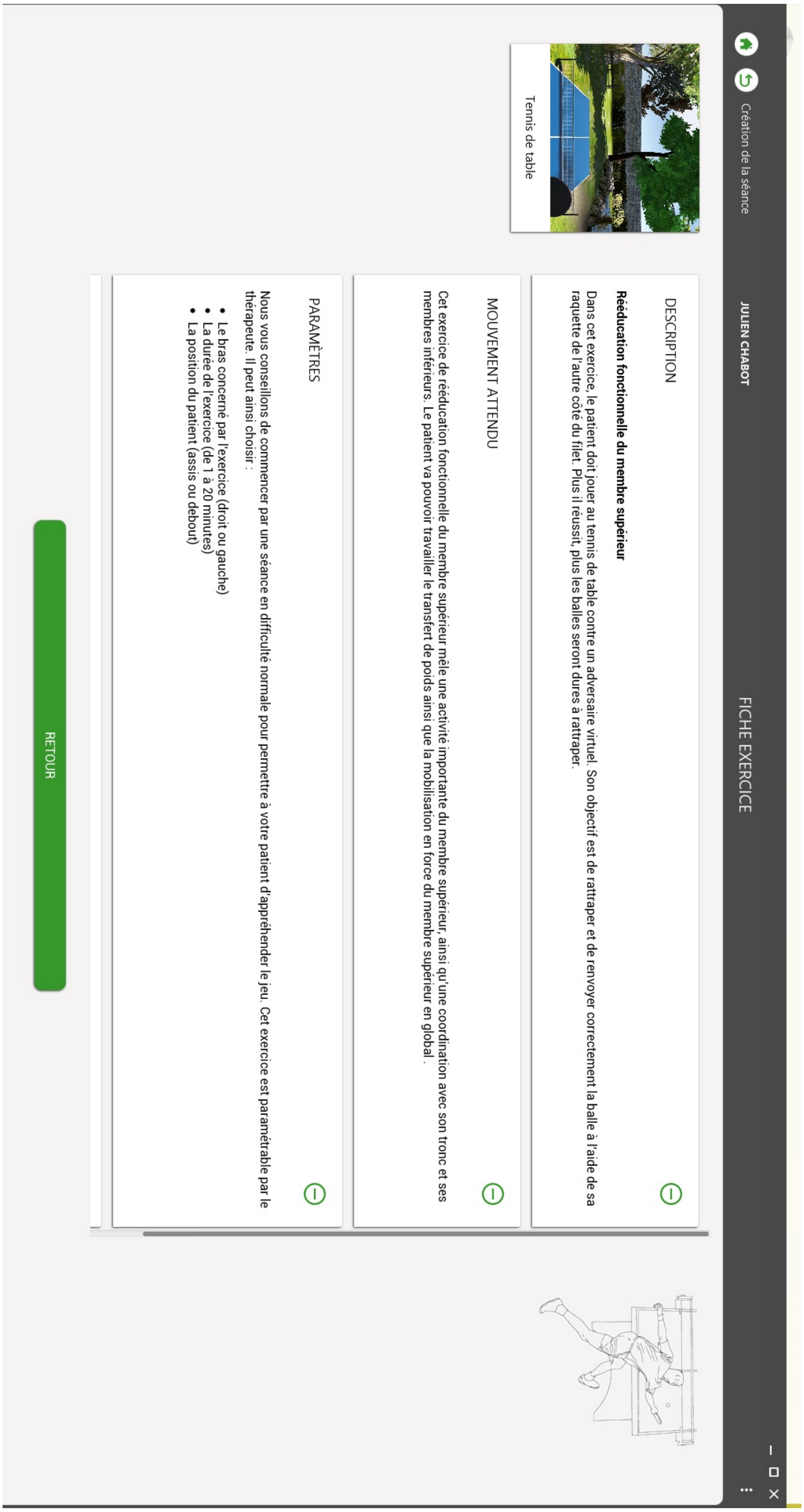

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Tir à l'arc
DESCRIPTION
Travail du coude en flexion et de l'épaule en abduction horizontale
Dans cet exercice, le patient doit prendre une flèche dans le carquois qui se trouve à ses pieds, la porter à son arc, bander ce dernier, puis décocher la flèche en essayant de viser la cible. Cet exercice dispose d'un niveau de difficulté progressif. Plus le patient réussit, plus la cible apparaitra loin de lui. S'il n'arrive pas à toucher la cible, l'exercice se simplifiera à nouveau.
MOUVEMENT ATTENDU
Cet exercice de mobilité et de coordination du membre supérieur fait travailler au patient les mouvements suivants :
• Élévation antérieure d'un des membres supérieurs dans le plan sagittal
• Abduction horizontale du second membre supérieur dans le plan transversal
• Rétropulsion du moignon de l'épaule de ce même membre
PARAMÈTRES
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• Le bras concerné (droit ou gauche)
• La durée de l'exercice (de 1 à 20 minutes)
• La difficulté de l'exercice (de 1 à 5) correspondant à l'amplitude requise afin de réussir son tir
• La position du patient (assis ou debout)
RETOUR

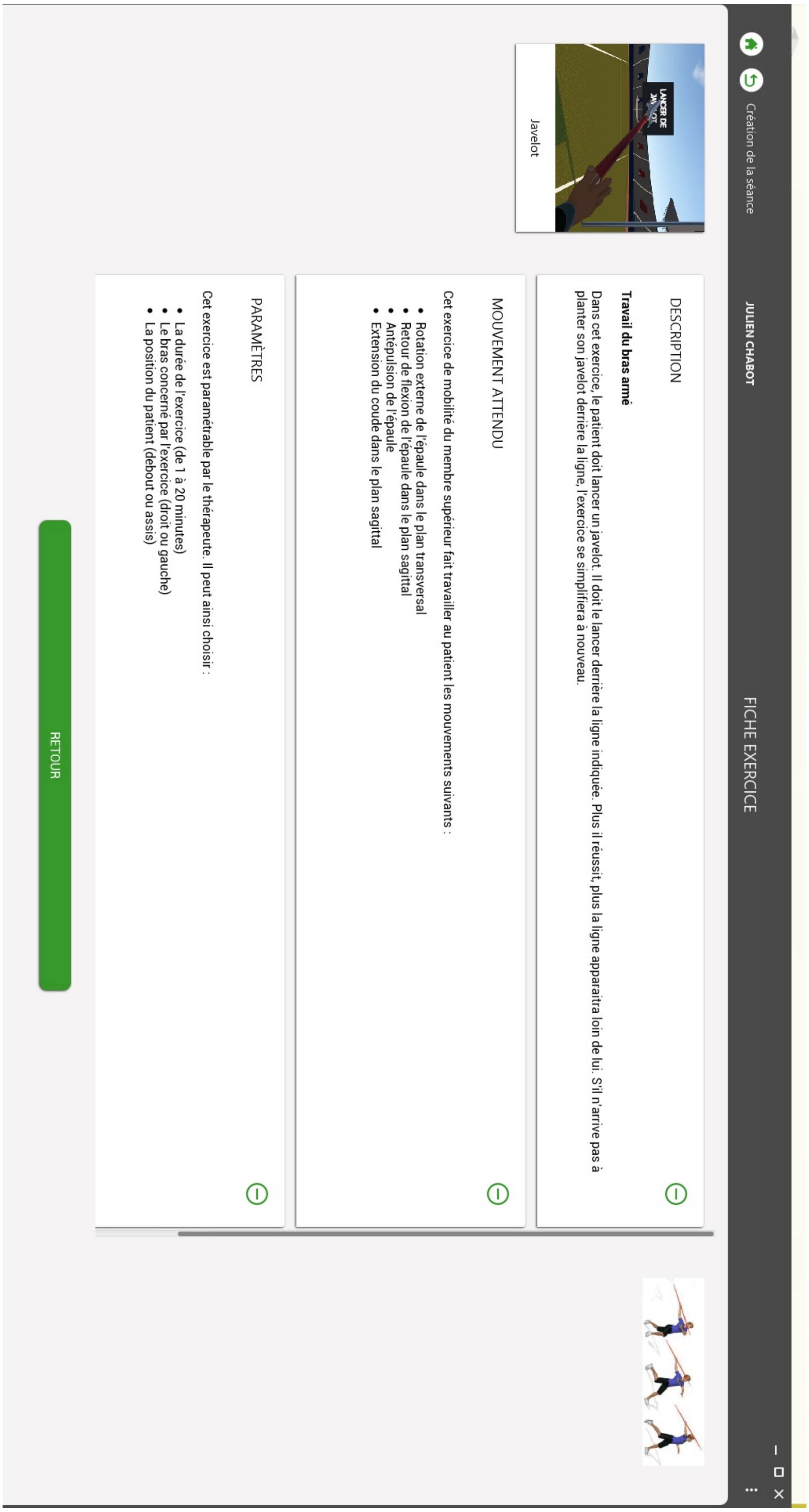

Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Brasse
DESCRIPTION
Rééducation fonctionnelle globale du membre supérieur
Dans cet exercice, le patient doit effectuer un mouvement de brasse pour nager. Son objectif est de rejoindre son sous-marin en avançant droit devant lui. Sur son chemin, se trouvent des bouteilles d'oxygène qui permettront au patient de disposer de suffisamment d'air pour avancer sous l'eau. Sa jauge d'oxygène est visible à sa droite. Plus le patient réussit, plus les bouteilles d'oxygènes apparaitront loin.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
Abduction et adduction horizontale des membres supérieurs dans le plan transversal
Flexion et extension des coudes dans le plan sagittal
Pronosupination des avant-bras dans le plan frontal
Activité stabilisatrice des rhomboïdes
PARAMÈTRES
Nous vous conseillons d'augmenter le niveau de difficulté de cet exercice en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
Le niveau de difficulté (de 1 à 5)
La durée de l'exercice (de 1 à 20 minutes)
La position du patient (debout ou assis)
RETOUR


Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Brasserie
DESCRIPTION
Travail de la rotation externe de l'épaule
Dans cet exercice, le patient doit remplir simultanément les verres qu'il a dans les mains sous les robinets qui se trouvent en face de lui. Il doit ensuite, en gardant ses coudes collés le long du corps, écarter les bras pour les vider dans les tonneaux qui l'entourent puis recommencer l'opération. Plus il réussira, plus il aura une quantité importante de liquide dans ses verres et plus il devra maintenir la position finale longtemps (le temps que ses verres se vident). Cet exercice nécessite les manettes.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
• Rotation externe de l'épaule dans le plan transversal
• Abduction/adduction de la scapula associée à une sonnette latérale
• Pronosupination du poignet (au moment de verser)
PARAMÈTRES
Nous conseillons d'augmenter la difficulté en fonction des capacités de votre patient. Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• La durée de l'exercice (de 1 à 20 minutes)
• La difficulté de l'exercice (de 1 à 5) correspondant à l'amplitude du mouvement
• La position (assis ou debout)
RETOUR


Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Chamboule-tout
DESCRIPTION
Travail de l'épaule en rotation externe
Dans cet exercice, le patient doit jouer au jeu de chamboule tout. Il doit lancer un frisbee vers les boites de conserve pour les faire tomber. Plus il réussit, plus la pyramide de canettes apparaitra loin de lui. S'il n'arrive pas à faire chuter les boites, l'exercice se simplifiera à nouveau.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
Rotation latérale de l'épaule dans le plan transversal
Extension du poignet dans le plan sagittal
Inclinaison radiale du poignet dans le plan frontal
PARAMÈTRES
Nous conseillons d'augmenter le niveau de difficulté en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
Le niveau de difficulté (de 1 à 5)
La durée de l'exercice (de 1 à 20 minutes)
Le bras concerné par l'exercice (droit ou gauche)
La position du patient (debout ou assis)
RETOUR


Création de la séance
JULIEN CHABOT
FICHE EXERCICE
COMMANDE
Coupe-fruits
DESCRIPTION
Rééducation fonctionnelle globale du membre supérieur
Dans cet exercice, le patient doit couper à l'aide de ses sabres (un dans chacune de ses mains) un maximum de fruits en fonction de la commande indiquée sur l'écran face à lui. Si des tomates sont représentées sur l'écran de commande, le patient devra uniquement couper les tomates.
MOUVEMENT ATTENDU
Cet exercice de rééducation fonctionnelle du membre supérieur fait travailler au patient l'élévation antérieure de l'épaule dans le plan de la scapula, tous les mouvements des membres supérieurs sont autorisés.
PARAMÈTRES
Nous conseillons d'augmenter la vitesse latérale et la vitesse minimale de coupe pour augmenter la difficulté de l'exercice en fonction des capacités de votre patient.
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
La difficulté de l'exercice (de 1 à 5) qui correspond à l'amplitude du champ d'apparition des fruits
La durée de l'exercice (de 1 à 20 minutes)
Le bras concerné par l'exercice (gauche, droit ou les deux)
La position du patient (debout ou assis)
RETOUR


Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Tennis de table
DESCRIPTION
Rééducation fonctionnelle du membre supérieur
Dans cet exercice, le patient doit jouer au tennis de table contre un adversaire virtuel. Son objectif est de rattraper et de renvoyer correctement la balle à l'aide de sa raquette de l'autre côté du filet. Plus il réussit, plus les balles seront dures à rattraper.
MOUVEMENT ATTENDU
Cet exercice de rééducation fonctionnelle du membre supérieur mêle une activité importante du membre supérieur, ainsi qu'une coordination avec son tronc et ses membres inférieurs. Le patient va pouvoir travailler le transfert de poids ainsi que la mobilisation en force du membre supérieur en global .
PARAMÈTRES
Nous vous conseillons de commencer par une séance en difficulté normale pour permettre à votre patient d'appréhender le jeu. Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
Le bras concerné par l'exercice (droit ou gauche)
La durée de l'exercice (de 1 à 20 minutes)
La position du patient (assis ou debout)
RETOUR


Création de la séance
JULIEN CHABOT
FICHE EXERCICE
Javelot
DESCRIPTION
Travail du bras armé
Dans cet exercice, le patient doit lancer un javelot. Il doit le lancer derrière la ligne indiquée. Plus il réussit, plus la ligne apparaitra loin de lui. S'il n'arrive pas à planter son javelot derrière la ligne, l'exercice se simplifiera à nouveau.
MOUVEMENT ATTENDU
Cet exercice de mobilité du membre supérieur fait travailler au patient les mouvements suivants :
• Rotation externe de l'épaule dans le plan transversal
• Retour de flexion de l'épaule dans le plan sagittal
• Antépulsion de l'épaule
• Extension du coude dans le plan sagittal
PARAMÈTRES
Cet exercice est paramétrable par le thérapeute. Il peut ainsi choisir :
• La durée de l'exercice (de 1 à 20 minutes)
• Le bras concerné par l'exercice (droit ou gauche)
• La position du patient (debout ou assis)
RETOUR

Appendix 13: Tests and manoeuvres performed by a specialist before phase 3 of rehabilitation

Jobe Manoeuvre Supraspinatus	Both arms at 90° elevation in the plane of the scapula, thumbs facing down. The patient resists the examiner's attempt to lower the arms, so he or she performs an abduction that is counterproductive. The pain caused is a sign of damage to this muscle.
Leg Maneuvering Infraspinous Small round	There are two tests: For the first, the elbow glued to the body and bent at 90°, the patient resists pressure from outside in, at the wrist. Any decrease in force at the ER that is thwarted indicates its rupture. For the second, the patient is positioned in ER, at 90° of abduction in the direction of the scapula. It resists downward pressure with resistance at the wrist, any decrease in muscle strength indicates that it has been affected.
Bugler's Sign Infraspinous Small round	When the patient tries to put his hand to his mouth, if he performs the gesture by raising his elbow, he is positive on the test showing a defect in the ER.
Press Belly Test Sub-scapulaire	Elbow bent at 90°, lifted off the chest, hand against the abdomen, the patient resists the examiner's attempt to lift the hand off the stomach. This test should be comparative and measures muscle weakness, which results in a progressive retreat from the elbow to the abdomen. Any decrease in force at the upset IR indicates its rupture.
Palm up test Long biceps	The examiner opposes the anterior elevation, in slight abduction at 30°, of the patient's arm in extension and supination. This non-specific test signs tendinous involvement if it causes pain and suggests a rupture of the long head of the biceps if it shows a ball-shaped deformation of the biceps.
Neer maneuver	The scapulo-thoracic joint is held by a hand that presses firmly against the spine of the scapula and the coracoid. At the same time, the examiner performs a passive elevation of the upper limb, previously pronated, in the plane of the scapula that causes the large tuberosity to conflict with the acromion. Test is positive if the pain appears between 60 and 120° of anterior elevation. She disappears hand in supination.
Hawkins maneuver	It consists of carrying the arm in anterior elevation at 90°, elbow bent at 90°, and the examiner performs an IR of the shoulder that brings the large tuberosity against the coracoacromial ligament. The sign is positive if the patient feels pain that he or she recognizes (Abitteboul, Y., Leroux, G., Laterre, D., Riviere, D., & Oustric, S., 2011; Duparc, 2007).
Apprehension maneuver	The back to front pressure of the hand placed under the shoulder creates an apprehension that disappears when pressure is applied from front to back (Jobe Refocus Test) (Sirveaux, Molé, & Walch, 2002).

ANNEXS

Annex 1: The different joints of the shoulder (Dufour & Pillu, 2007)

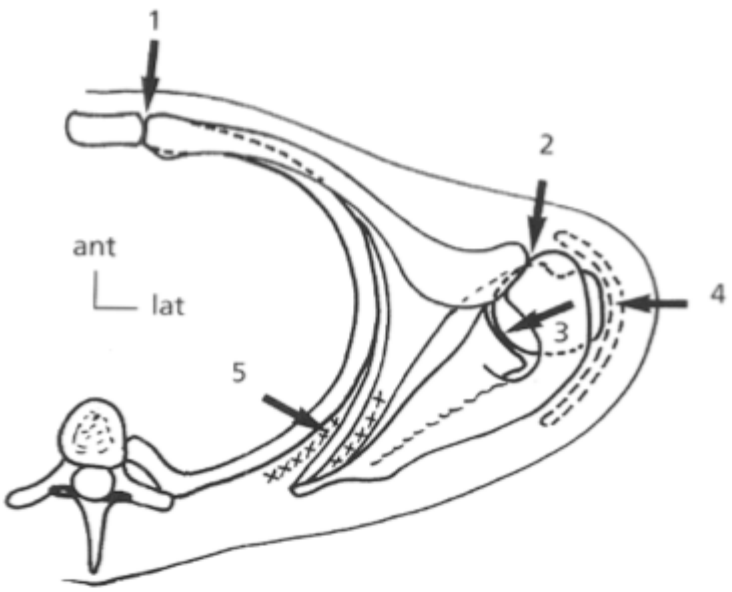
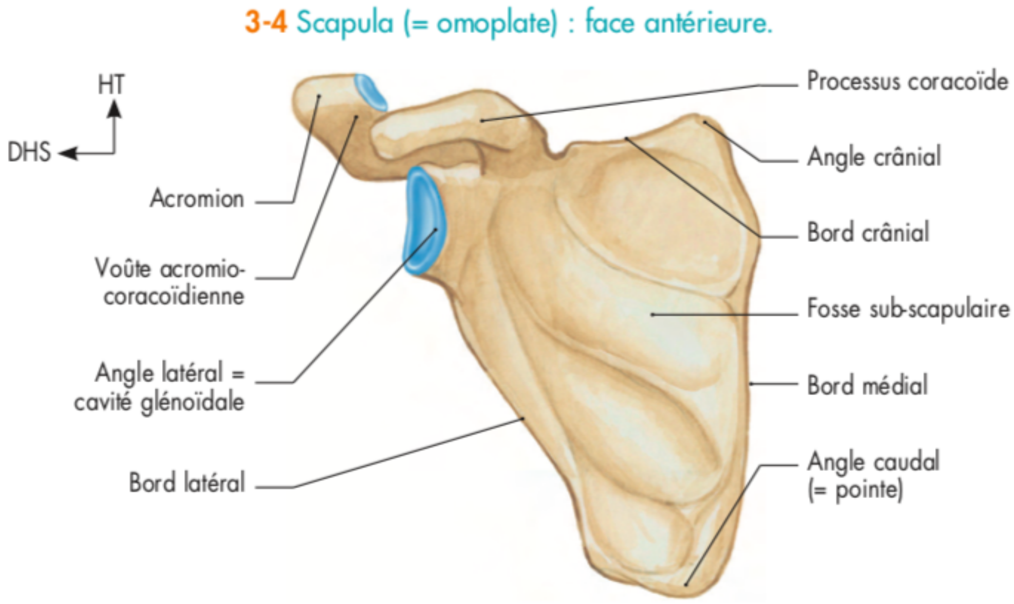


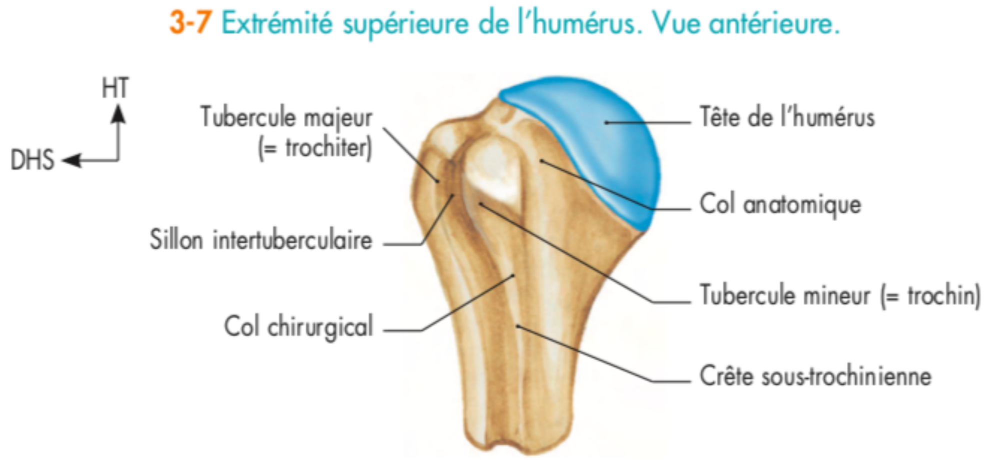
Figure 2. Les 5 articulations du complexe de l'épaule.
(1) sterno-claviculaire, (2) acromio-claviculaire,
(3) scapulo-humérale, (4) subdeltoïdienne,
(5) scapulo-serrato-thoracique.

Title: The 5 joints of the shoulder (Dufour & Pillu, 2007)

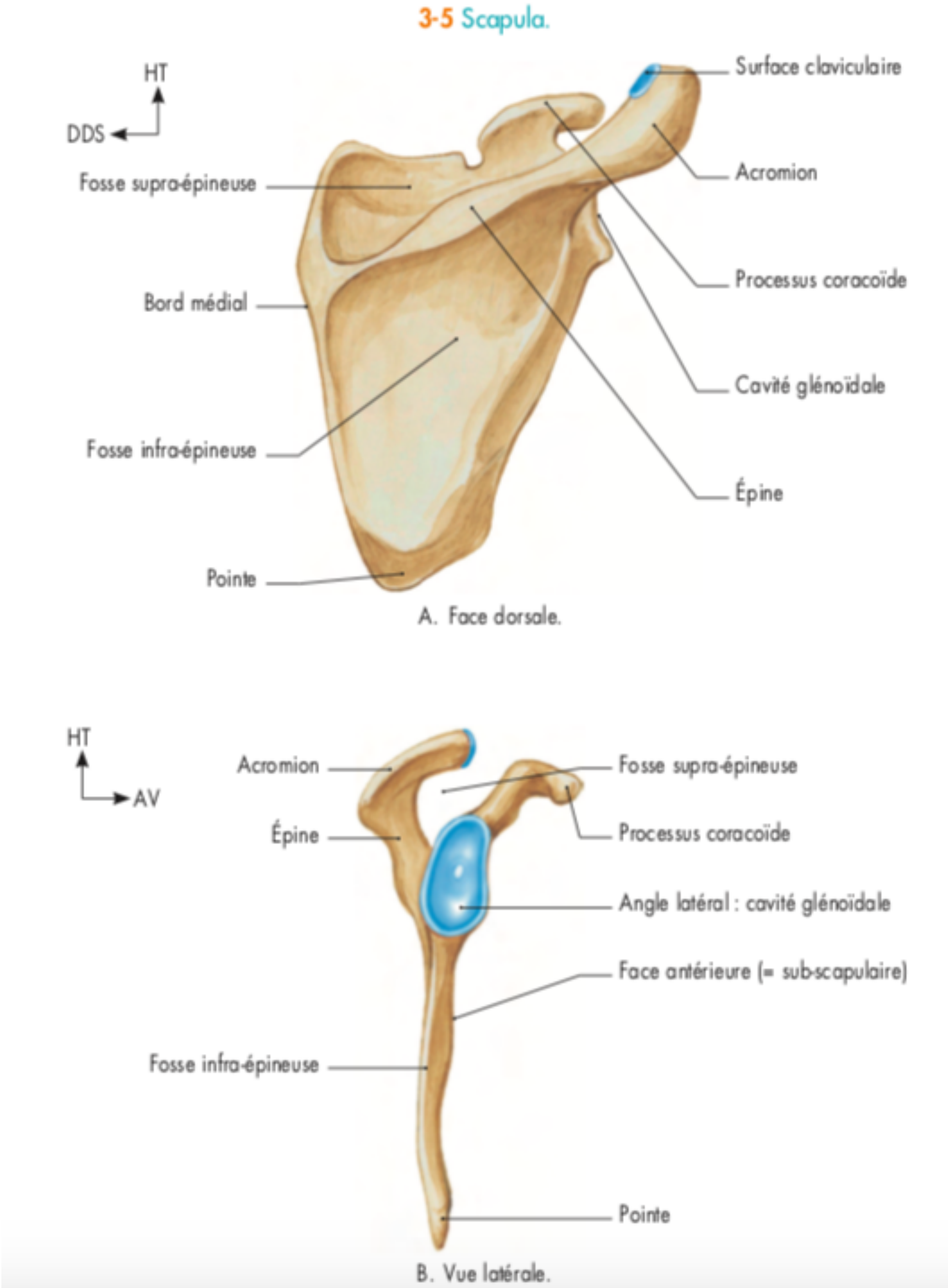
Annex 2: Bones of the glenohumeral joint



Title: Anterior face of the scapula (Chevalier, 2016)

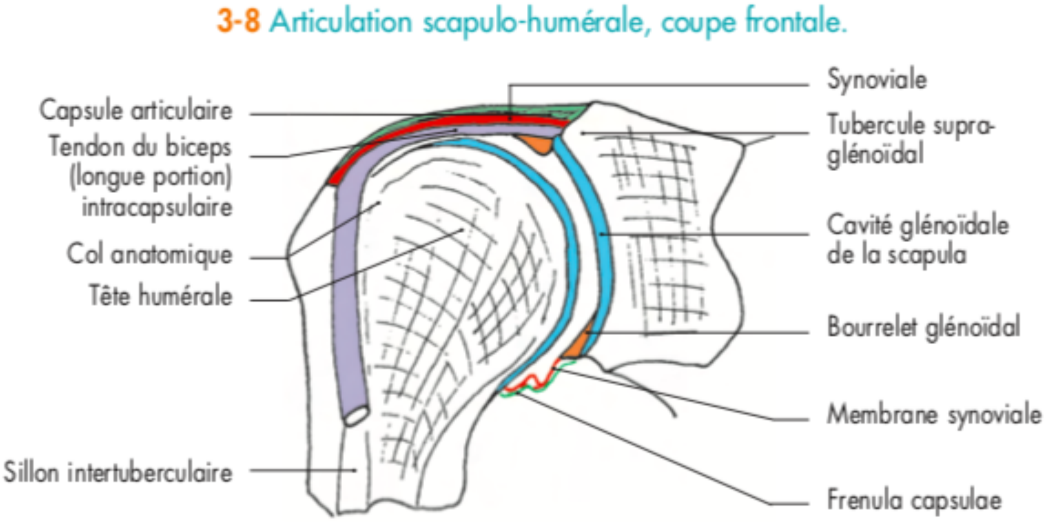


Title: Anterior view of the upper end of the humerus (Chevalier, 2016)

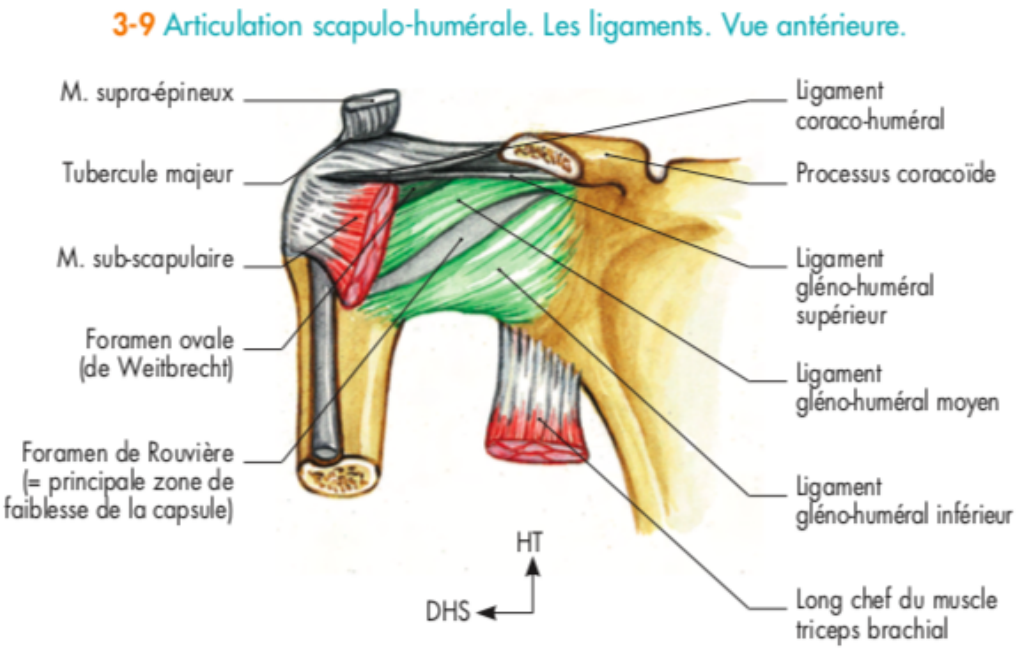


<u>Title:</u> Dorsal face and lateral view of the scapula (Chevalier, 2016)

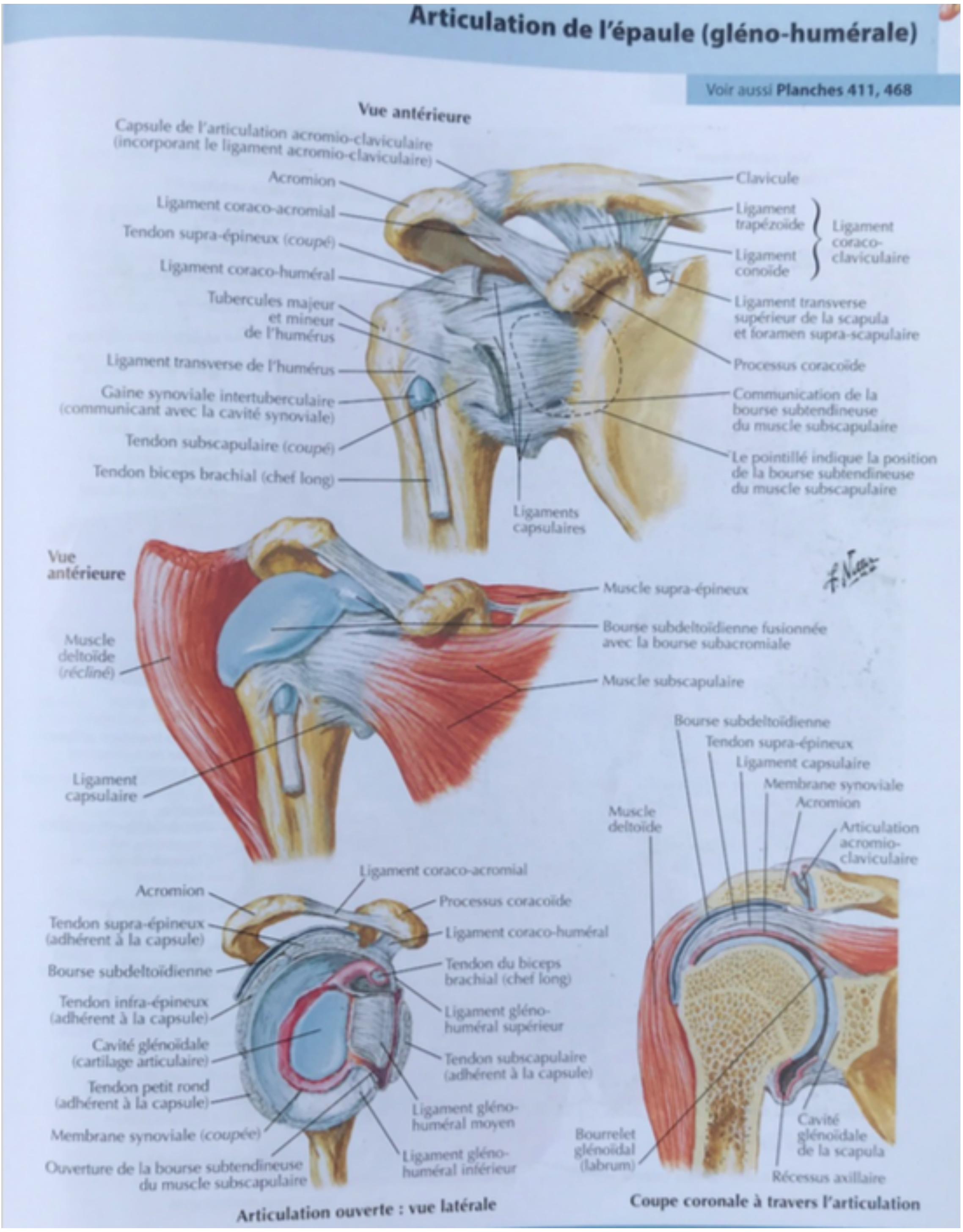
Annex 3: Passive stabilizers of the glenohumeral joint



Title: Front section of the GHA and its passive stabilizers (Chevalier, 2016).

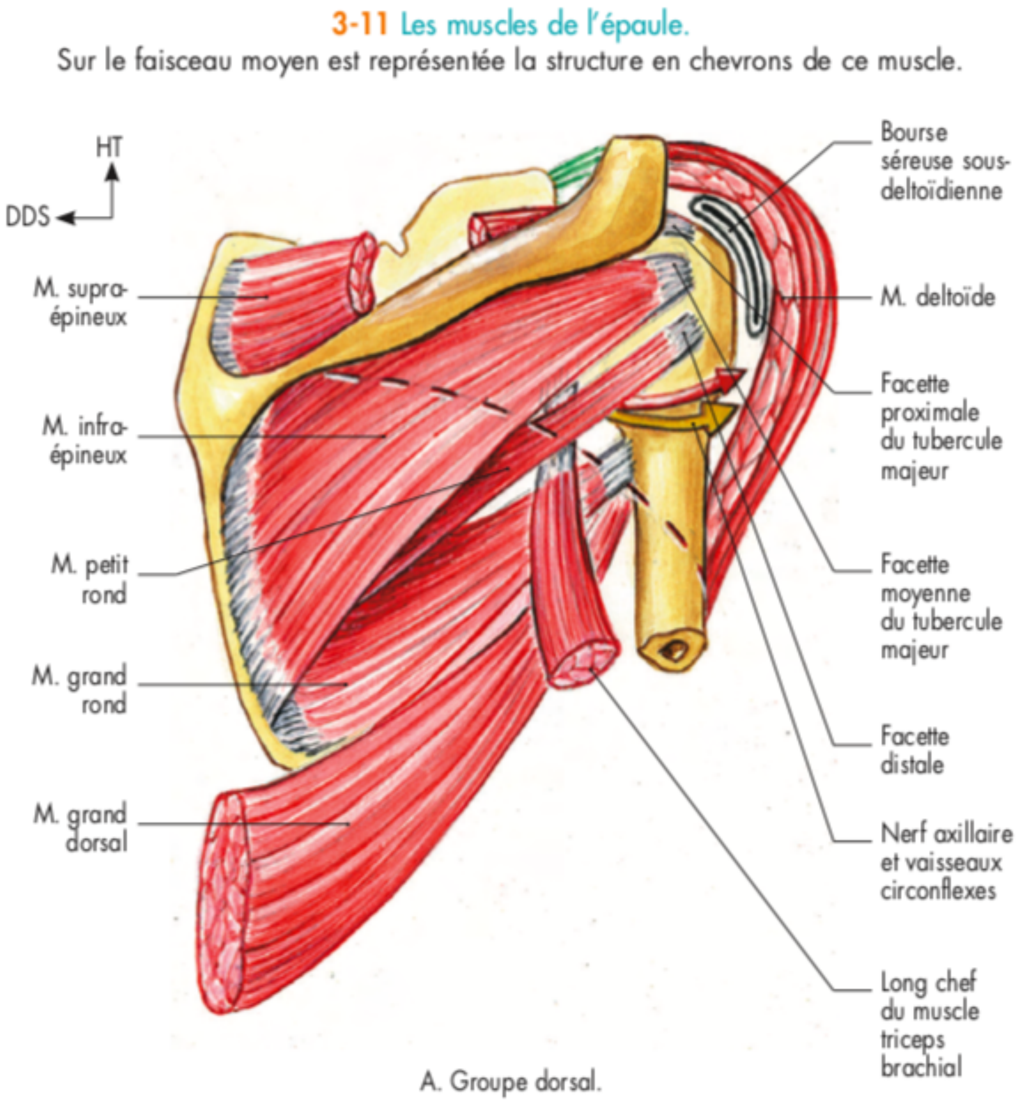


Title: Ligaments of GHA (Chevalier, 2016).

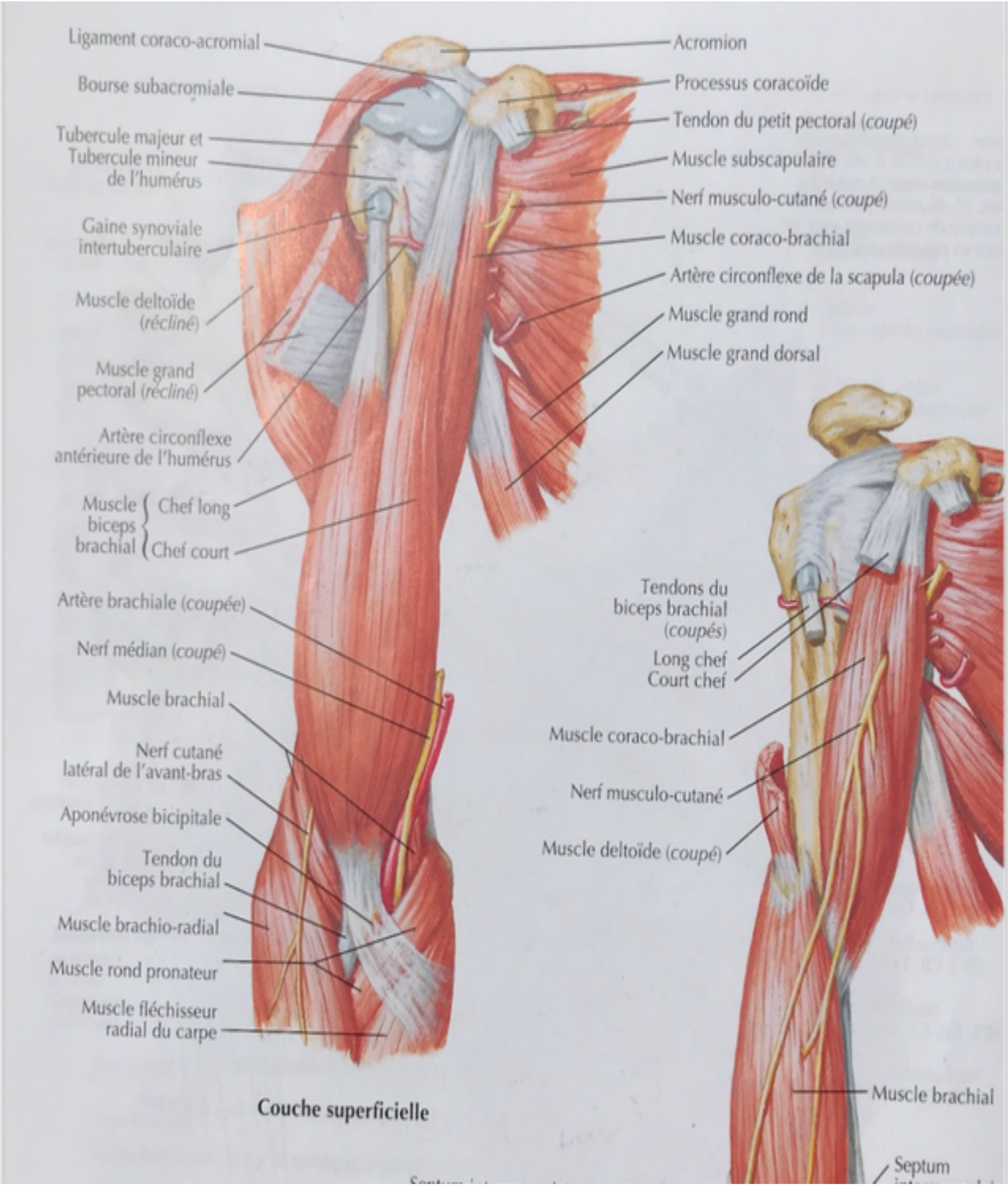


<u>Title</u>: The GHA and its active and passive stabilising elements (Chevalier, 2016).

Annex 4: The muscles of the glenohumeral joint (Knight, 2016)

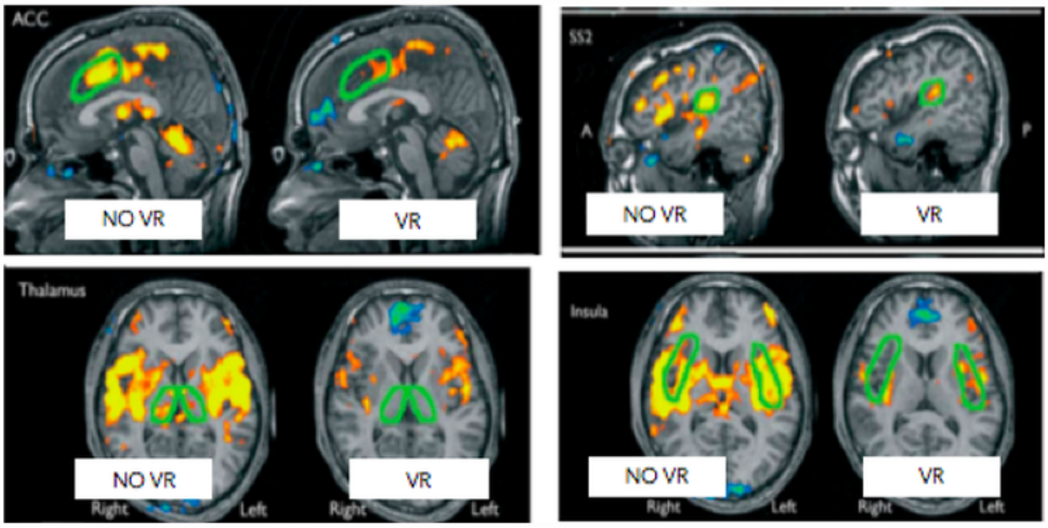


Title: Muscle board rear side of the scapula (Chevalier, 2016).



Title: Muscle board anterior face of the arm, surface layer (Dufour, 2016)

Annex 5: Magnetic resonance imaging results from the study conducted by Hoffman and al (Hoffman and al., 2004)



Annex 6: Analog Visual Pain Assessment Scale (Antalvite, n.d.)

L'ÉCHELLE VISUELLE ANALOGIQUE (EVA)

Définition

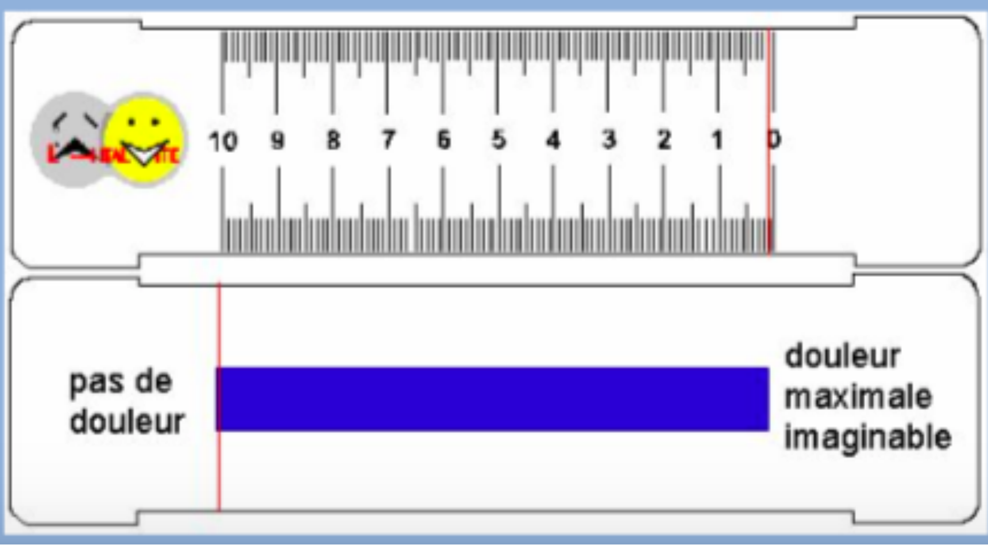
C'est une échelle d'auto-évaluation. Elle est sensible, reproductible, fiable et validée aussi bien dans les situations de douleur aiguë que de douleur chronique, que celles-ci soient en rapport ou non avec un cancer. Elle doit être utilisée en priorité, lorsque c'est possible.

Description

L'EVA se présente sous la forme d'une réglette en plastique de 10 cm graduée en mm, qui peut être présentée au patient horizontalement ou verticalement.

Sur la face présentée au patient, se trouve un curseur qu'il mobilise le long d'une ligne droite dont l'une des extrémités correspond à "*Absence de douleur*", et l'autre à "*Douleur maximale imaginable*".
Le patient doit, le long de cette ligne, positionner le curseur à l'endroit qui situe le mieux sa douleur

Sur l'autre face, se trouvent des graduations millimétrées vues seulement par le soignant. La position du curseur mobilisé par le patient permet de lire l'intensité de la douleur, qui est mesurée en mm.



Annex 7: Examples of muscle testing (Pillu, Viel, Hislop, Avers, & Borw, 2015)

FLEXION DE L'ÉPAULE
Deltoïde antérieur, Supra-épineux et Coracobrachial

Tableau 4-6 Flexion de l'épaule

Muscle	Origine	Terminaison
133. Deltoïde (chefs antérieur et moyen)	Clavicule (antérieure) Scapula (acromion)	Humérus (tubérosité deltoïdienne)
135. Supra-épineux (*sus-épineux*)	Scapula (fosse supra-épineuse)	Humérus (tubercule majeur)
Autres		
131. Grand Pectoral (chef claviculaire)		
139. Coracobrachial		
140. Biceps brachial		

Amplitude du mouvement
0° à 180°

Le muscle Coracobrachial ne peut pas être isolé, et il n'est pas aisément palpable. Il n'a pas de fonction spécifique. Il est inclus ici parce qu'il est classiquement considéré comme fléchisseur et adducteur.

Valeur 5 (Normal) et valeur 4 (Bon)

Position du patient : assis en bord de table avec les bras le long du corps, coudes modérément fléchis, avant-bras en pronation (pour éviter une compensation par la longue portion du Biceps).

Position du thérapeute : debout du côté à tester. La main appliquant la résistance est placée à la partie distale de l'humérus, juste au-dessus du coude. L'autre main peut stabiliser l'épaule (fig. 4-44).

Test : le patient fléchit l'épaule à 90° sans rotation ni déplacement horizontal (fig. 4-44). La scapula doit pouvoir se porter en abduction et tourner vers le haut. Le rapport normal de mouvement huméral par rapport au mouvement scapulaire est de 2:1 — c'est-à-dire qu'il y a 2° de déplacement dans la scapulo-humérale pour 1° de déplacement de la scapula sur le thorax.

Consignes pour le patient : « Soulevez votre bras en avant jusqu'à hauteur de l'épaule. Tenez. Ne me laissez pas pousser en bas ».

Cotation

Valeur 5 (Normal) : le patient tient la position finale (90°) contre résistance maximale.

Valeur 4 (Bon) : tient contre résistance forte à modérée.

Figure 4-44

FLEXION DE L'ÉPAULE

Deltoïde antérieur, Supra-épineux et Coracobrachial

Cotation 3 (Passable)

Position du patient : assis en bord de table avec les bras le long du corps et coudes modérément fléchis.

Position du thérapeute : debout du côté à tester.

Test : le patient fléchit l'épaule à 90° (fig. 4-45).

Consignes pour le patient : « Levez votre bras en avant jusqu'au niveau de l'épaule ».

Cotation

Valeur 3 (Passable) : le patient réalise l'amplitude complète du test (90°) mais ne tolère pas de résistance.

Valeur 2 (Faible), valeur 1 (Trace), et valeur 0 (Zéro)

Position du patient : assis en bord de table avec les bras le long du corps, coudes modérément fléchis.

Position du thérapeute : debout du côté à tester. Les doigts utilisés pour la palpation sont placés à la face antérieure du Deltoïde sur l'articulation (fig. 4-46).

Test : le patient tente de fléchir l'épaule jusqu'à 90°

Consignes pour le patient : « Essayez de lever le bras ».

Cotation

Valeur 2 (Faible) : seulement une partie de l'amplitude.

Valeur 1 (Trace) : l'examinateur perçoit ou observe une contraction du Deltoïde, mais il n'y a pas de mouvement.

Valeur 0 (Zéro) : pas de contraction.

Autre test pour les valeurs 2, 1 et 0.

Si pour quelque raison le patient est incapable de s'asseoir, le test peut être administré en position couchée sur le côté. Dans cette attitude, l'examinateur tient le bras à tester en berceau au coude avant de demander au patient de fléchir l'épaule.

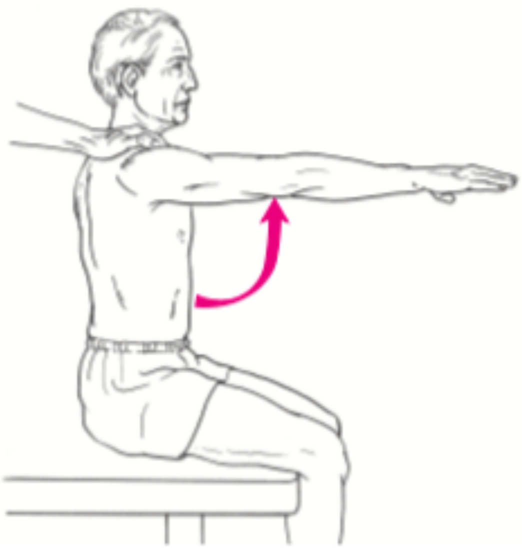


Figure 4-45

ABDUCTION FONCTIONNELLE DE L'ÉPAULE (ou *scaption*)

Deltoïde et Supra-épineux

Ce mouvement consiste en une élévation du bras dans le plan de la scapula, c'est-à-dire entre 30° et 45° antérieurs au plan frontal, soit à peu près à mi-chemin entre la flexion et l'abduction de l'épaule [2]. Cette position, nommée *scaption* par les Anglo-saxons, est plus fréquemment utilisée dans un but fonctionnel que la flexion ou l'abduction.

Valeur 5 (Normal), à valeur 0 (Zéro)

Position du patient : assis en bord de table.

Position du thérapeute : debout devant le patient et un peu décalé vers le côté à tester. La main utilisée pour la résistance recouvre le bras au-dessus du coude (valeurs 5 et 4 seulement).

Test : le patient soulève le bras à mi-chemin entre la flexion et l'abduction (de 30° à 45° antérieurs au plan coronaire) (fig. 4-57).

Consignes pour le patient : « Levez le bras jusqu'à la hauteur de l'épaule, à mi-chemin entre devant vous et sur le côté. Tenez. Ne me laissez pas le repousser » (montrer le mouvement au patient).

Cotation

Valeur 5 (Normal) : le patient réalise l'amplitude du mouvement complète et tient contre résistance maximale.

Valeur 4 (Bon) : amplitude complète et capacité à tenir contre une forte résistance, mais le bras cède en fin de course.

Valeur 3 (Passable) : amplitude complète, mais sans tolérer d'autre résistance que le poids du bras.

Valeur 2 (Faible) : seulement une partie de l'amplitude. Les doigts du thérapeute sont placés pour la palpation sur les parties antérieure et médiane de l'épaule (valeurs 2 et en dessous).

Valeur 1 (Trace), et valeur 0 (Zéro) : activité contractile visible ou palpable pour la valeur 1 ; pas d'activité décelée pour la valeur 0.

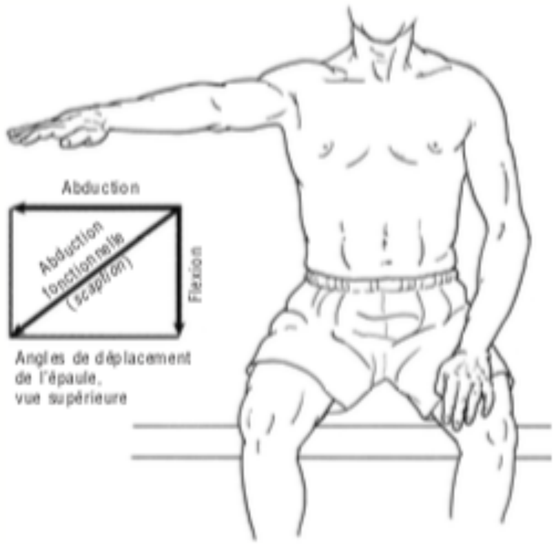


Figure 4-57

ROTATION LATÉRALE DE L'ÉPAULE

Infra-épineux et Petit Rond

Tableau 4–12 Rotation externe de l'épaule

Muscle	Origine	Terminaison
136. Infra-épineux (*sous-épineux*)	Scapula (fosse infra-épineuse)	Humérus (tubercule majeur —*trochiter*)
137. Petit Rond	Scapula (bord axillaire)	Humérus (tubercule majeur — *trochiter*)
Autres		
133. Deltoïde (chef postérieur)		

Amplitude du mouvement

De 0° à 60°
(Dans la littérature, l'amplitude varie entre 0° et 90°. L'amplitude varie également selon l'élévation du bras)

Valeur 5 (Normal), valeur 4 (Bon) et valeur 3 (Passable)

Position du patient : à plat ventre avec la tête tournée du côté à tester. L'épaule en abduction à 90°, le bras sur la table et l'avant-bras pendant verticalement du bord de la table. Placer une serviette pliée sous le bras au bord de la table si celle-ci a un bord tranchant.

Variante de position : assis en bord de table avec l'épaule en abduction à 90°. La résistance tolérée dans cette position peut être plus grande pour les valeurs 5 et 4.

Position du thérapeute : debout du côté à tester au niveau de la ceinture du patient (fig. 4-86). Deux doigts d'une main sont utilisés pour offrir une résistance au niveau du poignet dans les valeurs 5 et 4. L'autre main soutient le coude afin de fournir une contre-pression en fin de course.

Test : le patient déplace l'avant-bras vers le haut dans l'amplitude de rotation latérale.

Consignes pour le patient : « Levez votre bras jusqu'au niveau de la table. Tenez. Ne me laissez pas vous repousser en bas ». Il se peut que le thérapeute doive montrer le mouvement.

Cotation

Valeur 5 (Normal) : le patient réalise l'amplitude complète et tient fermement contre la résistance à deux doigts.

Valeur 4 (Bon) : amplitude complète, mais les muscles cèdent en fin de course.

Valeur 3 (Passable) : amplitude complète, mais ne tolère pas de résistance manuelle (fig. 4-87).

Figure 4-86

Figure 4-87

ROTATION LATÉRALE DE L'ÉPAULE

Infra-épineux et Petit Rond

Valeur 2 (Faible), valeur 1 (Trace) et valeur 0 (Zéro)

Position du patient : plat ventre avec la tête tournée du côté à tester, le tronc au bord de la table. Le membre supérieur entier pend en rotation neutre, la paume de la main face à la table (fig. 4-88).

Position du thérapeute : debout ou assis sur un tabouret bas au niveau de l'épaule du patient. Palper l'Infra-épineux (*sous-épineux*) sur la scapula en dessous de l'épine dans la fosse infra-épineuse (*cf.* fig. 4-87). Palper le Petit Rond à la marge inférieure de l'aisselle et le long du bord axillaire de la scapula (*cf.* fig. 4-88).

Test : le patient tente d'exécuter une rotation latérale de l'épaule. Autre possibilité, placer le bras du patient en rotation latérale et demander au patient de tenir la position finale (fig. 4-89).

Consignes pour le patient : « Tourner la paume de la main vers le dehors ».

Cotation

Valeur 2 (Faible) : le patient réalise l'amplitude complète (la paume vient se placer vers l'avant) dans cette position qui élimine la pesanteur.

Valeur 1 (Trace) : la palpation des muscles révèle une activité contractile mais il n'y a pas de mouvement.

Valeur 0 (Zéro) : pas de contraction palpable ni visible.

CONSEILS

1. Dans les tests de rotation de l'épaule, la résistance doit être appliquée graduellement et lentement, en prenant soin d'éviter une blessure toujours possible car l'épaule manque de stabilité inhérente. C'est encore plus important avec le patient âgé.
2. Le thérapeute doit prendre soin de détecter si une supination prend la place de la rotation latérale dans les tests de valeur 2 et 1 car ce mouvement peut être confondu avec une rotation latérale.

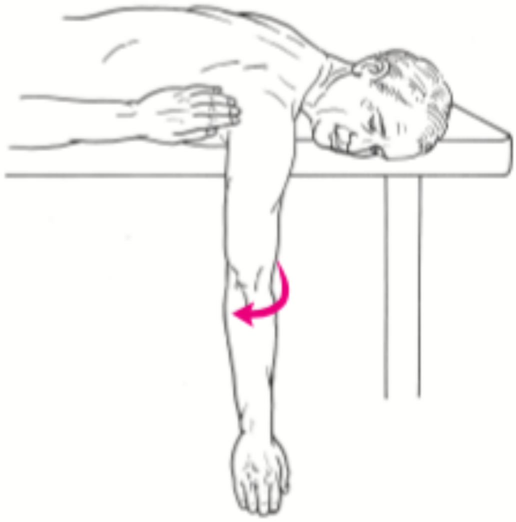


Figure 4-88

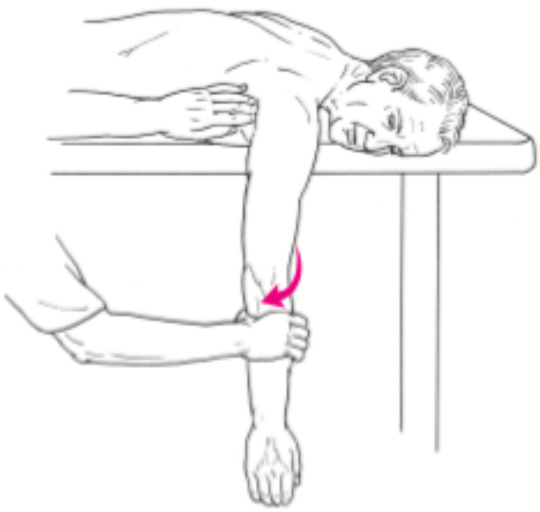


Figure 4-89

Annex 8: Constant Score (High Authority of Health: HAS, n. d.)

HAS
HAUTE AUTORITÉ DE SANTÉ

Score de Constant

D'après Constant CR, Murley AHG. *A clinical method of functional assessment of the shoulder.* Clin Orthop Relat Res 1987;(214):160-4. Traduction de M. Dougados, avec son aimable autorisation.

► Fiche de recueil des résultats

Nom : Prénom : Date de naissance :	Date : Médecin traitant : Médecin prescripteur :

	Date		Début	Milieu	Fin
Douleur (total sur 15 points)	A. Échelle verbale 0 = intolérable 5 = moyenne 10 = modérée 15 = aucune				
	B. Échelle algométrique Soustraire le chiffre obtenu du nombre 15 0________________________________15 Absence de douleur douleur sévère				
	Total	**A + B / 2 (/15)**			
Niveau d'activités quotidiennes (total sur 10 points)	Activités professionnelles/ occupationnelles	travail impossible ou non repris 0 point gêne importante 1 point gêne moyenne 2 points gêne modérée 3 points aucune gêne 4 points			
	Activités de loisirs	impossible 0 point ; gêne modérée 3 points gêne importante 1 point ; aucune gêne 4 points gêne moyenne 2 points			
	Gêne dans le sommeil exemple : aux changements de position	douleurs insomniantes 0 point gêne modérée 1 point aucune gêne 2 points			
Niveau de travail avec la main (total sur 10 points)	À quelle hauteur le patient peut-il utiliser sa main sans douleur et avec une force suffisante ?	taille 2 points ; cou 6 points xiphoïde 4 points ; tête 8 points au dessus de la tête 10 points			
Mobilité (total sur 40 points)	Antépulsion (total / 10)	0-30° 0 point 91-120° 6 points 31-60° 2 points 121-150° 8 points 61-90° 4 points >150° 10 points			
	Abduction (total / 10)	0-30° 0 point 91-120° 6 points 31-60° 2 points 121-150° 8 points 61-90° 4 points < 150° 10 points			
	Rotation latérale (total / 10)	main derrière la tête, coude en avant 2 points main derrière la tête, coude en arrière 4 points main sur la tête, coude en avant 6 points main sur la tête, coude en arrière 8 points élévation complète depuis le sommet de la tête 10 points			
	Rotation médiale (total / 10)	dos de la main niveau fesse 2 points dos de la main niveau sacrum 4 points dos de la main niveau L3 6 points dos de la main niveau T12 8 points dos de la main niveau T7-T8 10 points			
Force musculaire (total sur 25 points)	Abduction isométrique (élévation antéro-latérale de 90° dans le plan de l'omoplate)	si 90° n'est pas atteint en actif 0 point si maintien de 5 s, par 500g 1 point			
Total (total sur 100 points)	Valeur absolue (en points/100)				
	Valeur pondérée (%)				

Tableau 1 : Valeur fonctionnelle normale de l'épaule selon l'indice de Constant en fonction de l'âge et du sexe.

Âge	Hommes			Femmes		
	Droit	Gauche	Moyenne	Droit	Gauche	Moyenne
21/30	97	99	98	98	96	97
31/40	97	90	93	90	91	90
41/50	86	96	92	85	78	80
51/60	94	87	90	75	71	73
61/70	83	83	83	70	61	70
71/80	76	73	75	71	64	69
81/90	70	61	66	65	64	64
91/100	60	54	56	58	50	52