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The Use of Botulinum Toxin in Pre-Pubic Aponeurotic Complex Injuries: A Case Report

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Learning Point of the Article:

The pre-pubic aponeurotic complex (PPAC) repair process may be favored by botulinum toxin (BTX) infiltration coupled with platelet-rich plasma therapy (PRPt).

Abstract

Introduction: The pre-pubic aponeurotic complex (PPAC) is a fibrous capsule which lines the anterior of the pubic symphysis. The PPAC may be injured during pelvic torsional movements and single-stance maneuvers.

Case Report: This case report describes a PPAC lesion in a 23-year-old professional male athlete specializing in decathlon on a national level. The lesion was treated with US-guided infiltration therapy with botulinum toxin (BTX) and platelet-rich plasma therapy (PRPt) to the longus adductor (LA) and rectus abdominis (RA) muscles. The magnetic resonance imaging control performed at 24 weeks after BTX infiltration and PRPt showed a total restitution ad integrum of the lesion area. At a 3-year follow-up, the subject no longer complained of pain and was restored to his pre-injury level of sport.

Conclusion: The distention of LA and RA obtained by BTX infiltration coupled with PRPt allowed PPAC to heal. The BTX infiltrative therapy coupled with PRPt may represent a new and promising treatment for PPAC lesions.

Keywords: Botulinum toxin, pre-pubic aponeurotic complex, groin pain.

Introduction

The pubic symphysis joint consists of a fibrocartilaginous disc inserted between the two articular surfaces of the pubic bones. The joint is able to resist tensile, shearing, and compressive forces with limited mobility [1]. An important anatomical structure of the symphysis is the pre-pubic aponeurotic complex (PPAC). The PPAC is formed by the interconnection between the tendons of the adductor longus (LA), adductor brevis gracilis and pectineus muscles, the aponeurosis of rectus abdominis (RA), pyramidalis and external oblique muscles, the articular disc, the anterior pubic periosteum, and three of the four pubic ligaments (i.e., superior, inferior, and anterior pubic ligaments) [2-5]. The PPAC forms a fibrous capsule which lines the anterior of the pubic symphysis. A schematic view of the anatomical structure forming the PPAC is shown in Fig. 1. The PPAC represents an area of biomechanical weakness which endures considerable stress forces during athletic movements involving pelvic torsional movements and single-stance maneuvers [1,5,6].

The most frequent clinical situations involving PPAC injuries are represented by two different anatomical damages:

i. Injury of the PPAC afferent to the LA – RA – pyramidalis aponeurotic plate complex [2,7]

ii. PPAC avulsion from the anterior pubic bone [7,8].

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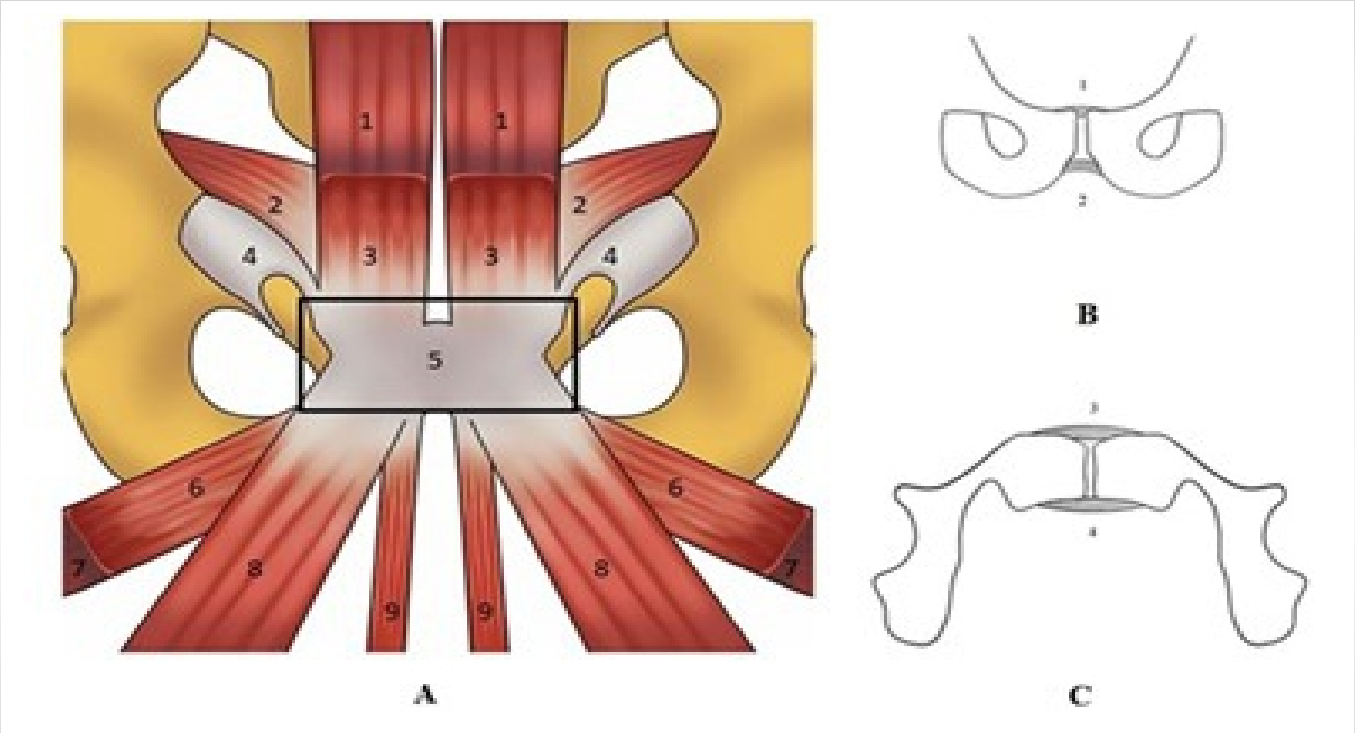

Figure 1: A schematic view of the tendon structure forming the pre-pubic aponeurotic complex (PPAC) (box a) and a schematic view of the pubic ligaments in coronal view (box b) and axial view (box c). The PPAC is formed by the anterior, the inferior, and the superior pubic ligaments. Legenda box a: (1) Rectus abdominis; (2) tranversus abdominis and internal oblique; (3) piramidalis; (4) external oblique; (5) pre-pubic aponeurotic complex; (6) pectineus; (7) adductor brevis; (8) adductor longus; and (9) gracilis. Legenda box b and c: (1) Superior pubic ligaments; (2) Inferior pubic ligament; (3) Anterior pubic ligament; and (4) Posterior pubic ligament.

Furthermore, it is important to remember that the majority of cases of adductor muscle avulsions are often associated with PPAC injuries [5, 7]. The botulinum toxin (BTX) type A, a neurotoxic protein produced by the bacterium Clostridium botulinum, has been used successfully for improving the outcome of flexor tendon repair [9-11] and in long-standing adductor-related groin pain [12, 13]. In this case report, the use of BTX is described in the conservative treatment of PPAC injuries. To the best of our knowledge, this is the first study describing the use of BTX in PPAC injuries.

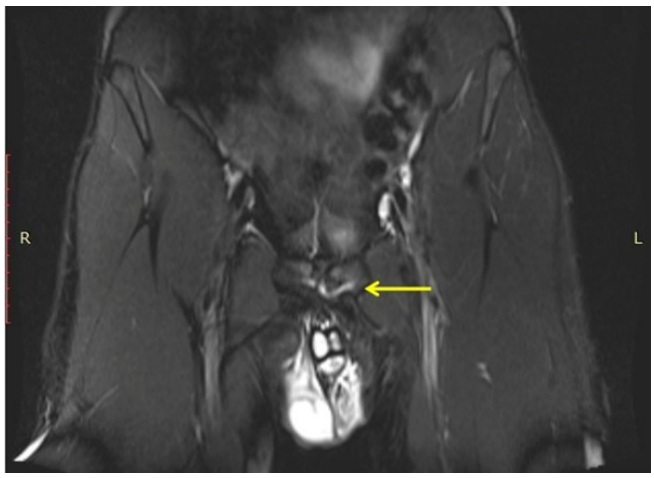

Figure 2: Magnetic resonance imaging in coronal STIR view shows a hyperintensity signal zone (arrow) starting from the middle of the pre-pubic aponeurotic complex and propagating unilaterally on the left side.

Case Report

Medical history

A 23-year-old professional male athlete specializing in decathlon on a national level came to our clinical evaluation complaining of intense pain in the right zone of the symphysis, which started 12 months earlier. The onset of the clinical framework was progressive. At the time of the clinical examination, the intensity of the pain made normal training sessions impossible. During the period, from symptom onset up to our clinical evaluation, the athlete had undergone a conservative program with a negative outcome.

Clinical assessment

Upon clinical assessment, the patient complained of intense pain in all adduction movements of the left leg (7/10 on the Visual Analog Scale [VAS]). The pain was more intense in

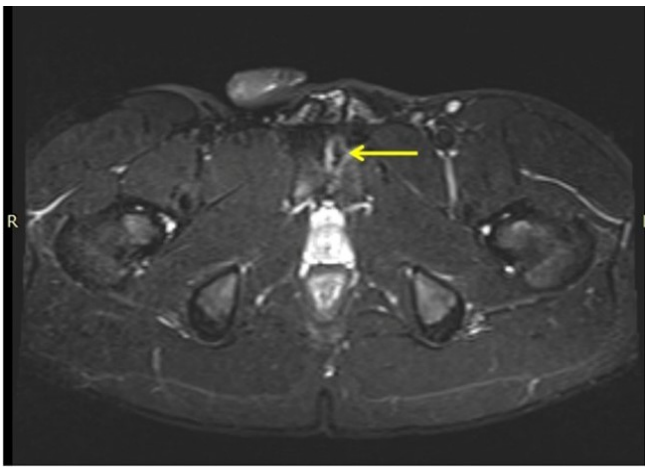

Figure 3: Magnetic resonance imaging in axial STIR view shows a hyperintensity signal zone in the left pubic branch suggesting pre-pubic aponeurotic complex injury.

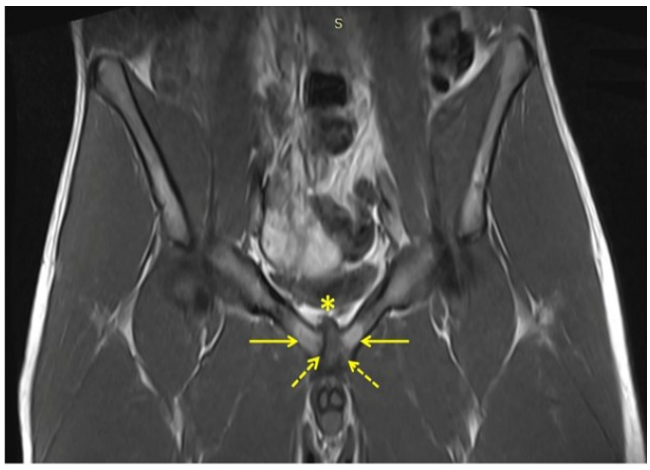

Figure 4: Magnetic resonance imaging in coronal T1 view shows central symphyseal disc protrusion (asterisk), bilateral fatty infiltration (continuous arrows), and irregularities of the symphysis (dotted arrows). These radiological signs indicate severe pubic osteopathy [15].

movements involving an eccentric contraction of the left adductor muscles (8/10 on VAS). Palpation of the PPAC afferent to the LA – RA – pyramidalis aponeurotic plate complex was extremely painful (9/10 on VAS). The score of the Copenhagen Hip and Groin Outcome questionnaire (HAGOS) was 54 [14].

Imaging

Magnetic resonance imaging (MRI) assessment showed a hyperintense signal zone in the fluid-sensitive sequences (T2 and STIR) that propagated unilaterally toward the left from the middle of the PPAC (Fig. 2 and 3). Furthermore, the MRI revealed several radiological signs of severe osteopathy (i.e., central symphyseal disc protrusion, fatty infiltration at symphysis level, and irregularities of the symphysis) compatible with a situation of severe symphysis osteopathy (Fig. 4) [15].

Medical treatment

Since the clinical examination and imaging techniques indicated a PPAC lesion specifically a lesion of the left part of the PPAC afferent to the LA – RA – pyramidalis aponeurotic plate complex, we proposed US-guided infiltration therapy with BTX to the left LA and left RA muscles supported by platelet-rich plasma therapy (PRPt) directed at the site of the PPAC lesion.

An interventional radiologist with 15 years of experience in musculoskeletal diseases performed the BTX infiltration through US-guided procedures with a Terason USmart 3200 scanner (Teratech77 Terrace Hall Ave. Burlington, MA 01803) equipped with a 12-5 MHz high-resolution linear broad-band array transducer. A 22-gauge common hypodermic needle (2, 5–4 cm long) was employed to inoculate a total amount of 150–200 units of BTX-A (Dysport® 500 units, C. botulinum type A toxin-hemagglutinin complex) in three discrete

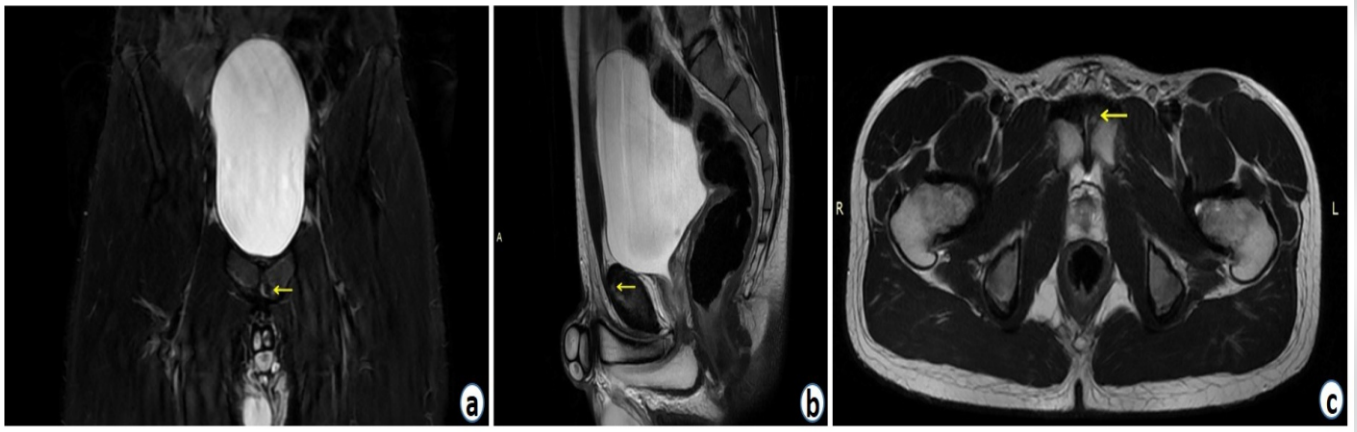

Figure 5: Magnetic resonance imaging in coronal STIR view (box a), sagittal T2 FR FSE view (box b), and axial T2 FSE view (box c) shows an important improvement in the pre-pubic aponeurotic complex lesion although not completely stabilized.

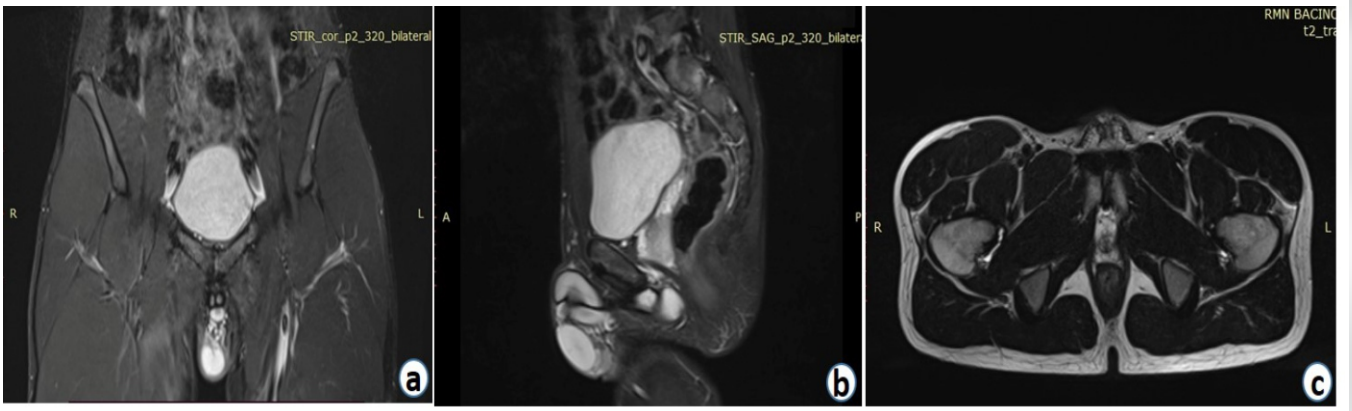

Figure 6: Magnetic resonance imaging in coronal STIR view (box a), sagittal STIR view (box b), and axial T2 view (box c) shows a total restitution ad integrum of the injured area.

injections into the axial plane of the proximal, medial, and distal parts, of the left LA and left RA muscle bellies [16]. The dose was reconstituted to give a solution containing 100 U/mL. The toxin was injected only when the needle was located in the correct position choosing the proximal, middle, and distal third of the LA and RA muscle of the left side [16].

At the same time, a PRPt was performed according to the following protocol:

i. Withdrawal of 60 cc of venous blood from the right median cubital vein

ii. Centrifugation of the blood sample (GPSÒ III Mini Platelet Concentrate Separation System Including ACD-A) from which ~6 cc of platelet-rich plasma was obtained

iii. Infiltration of the blood product under ultrasound guidance into three points identified by ultrasound, respectively, as the central, medial, and lateral areas of the PPAC

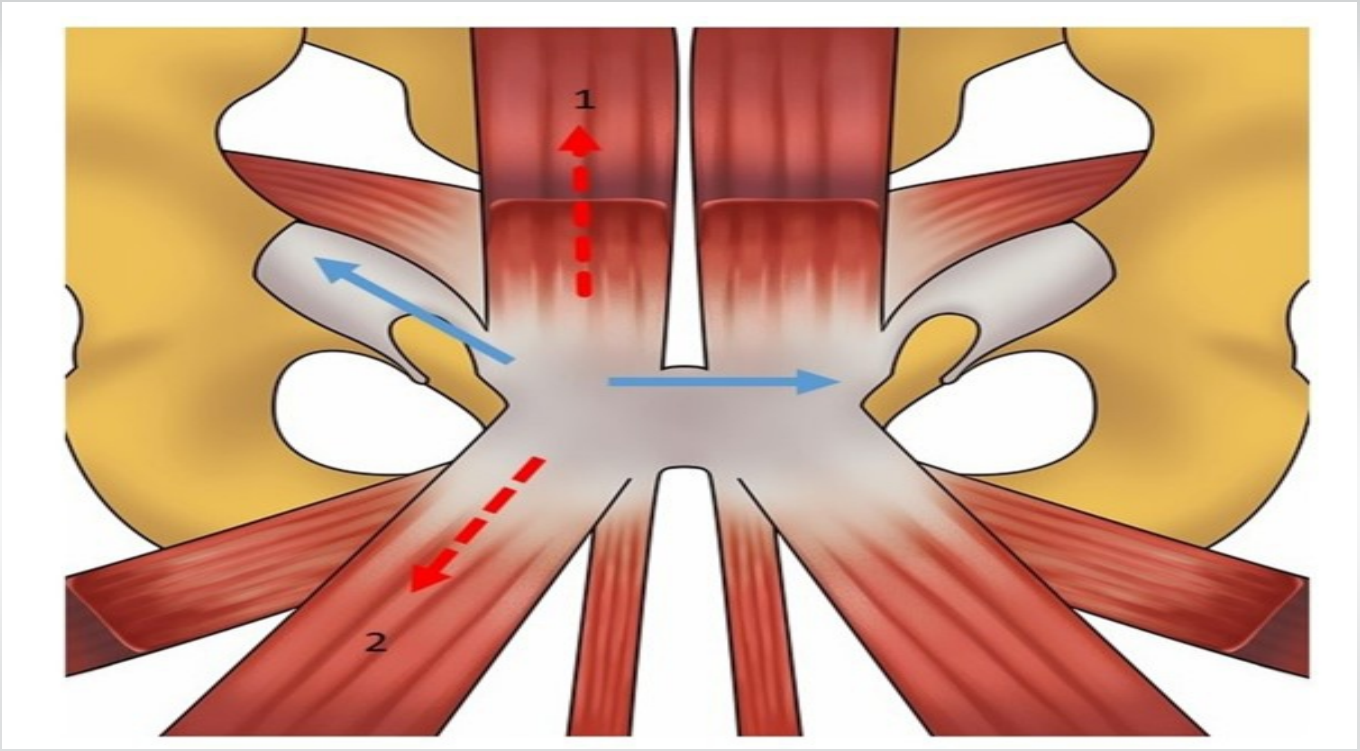

Figure 7: The vectors and the shearing forces to which the pre-pubic aponeurotic complex (PPAC) is subjected. The red dotted arrows represent the vector forces while the blue arrows represent the shearing forces. In specific, the vector forces are represented by the force generated by the rectus abdominis muscle (vector facing up) and by adductor muscles (vector facing down). During the pelvis rotation and extension, the up-facing vector creates the postero-superior tension while the down-facing vector creates the infero-anterior tension. The shearing forces are the result of applying a tangential force to a surface while the base remains stationary and is equal to the tangential component of the force applied over the contact area. The shearing forces tend to cause an opposite but parallel sliding motion of the planes of the PPAC. It is important to note that the composition of shear forces and normal forces can result in a bending movement, while the composition of multiple shear forces can result in a torsion movement.17 Torsional movements can be the main cause of PPAC injuries. Legenda: (1) Rectus abdominis; (2) Adductor longus.

lesion. For each point, 2 cc of product were inoculated.

BTX infiltration was performed only once, at the beginning of the medical treatment, while PRPt was performed both at the beginning of treatment, in concomitance with BTX infiltration, and after 20 days. All procedures were performed without complications.

After medical treatment, the patient undertook a 24-week rehabilitation program based on the following points:

i. Careful and progressive bilateral strengthening of the adductor muscles

ii. From the 5th week onward after BTX infiltration and PRPt, a return to online running was introduced, carefully and progressively, into the rehabilitation program

iii. Specific training for the 400 m and the 1500 m sprints was gradually introduced from the 12th week onward after BTX infiltration and PRPt

iv. Specific training for the 100 m sprint, discus throw, and shot put was gradually introduced starting from the 15th week after BTX infiltration and PRPt

v. Specific training sessions for the long jump, the high jump, the 110 m hurdles, the pole vault, and the javelin throw were gradually introduced from the 20th week onward following BTX infiltration and PRPt.

Two MRI controls were performed 12 and 24 weeks after the first infiltration treatment. The MRI control performed at 12 weeks after the first infiltration treatment showed an important improvement in the PPAC lesion which, however, did not appear completely stabilized (Fig. 5). The second MRI control performed at 24 weeks after BTX infiltration and PRPt showed a total restitution ad integrum of the lesion area (Fig. 6). Furthermore, the HAGOS score recorded was 100.

The clinical examination performed after 24 weeks showed a complete resolution of the clinical framework. After 24 weeks, the subject had returned to sports activity without restrictions. At a 3-year follow-up, the subject no longer complained of pain in the area of the previous PPAC lesion and has returned to his pre-injury level of sport.

Discussion

The PPAC represents an area of anatomical weakness particularly during athletic movements involving pelvic torsions and single-stance maneuvers [6]. Since the PPAC is formed by the interconnection of structures having different force vectors, it is subjected to the traction of antagonistic force vectors (Fig. 7) [17]. The intrinsic elasticity of the PPAC is ascribable only to the modest amount of elastic fibers contained in the superior pubic ligament and in the inferior pubic ligament [1], whereas the anterior pubic ligament does not seem to contain the yellowish fibers indicative of elastic fibers [1]. Therefore, given the limited presence of elastic tissue, the PPAC can be considered to be an intrinsically rigid anatomical structure [1]. This rigidity, added to the strong stress inflicted on the region during athletic activities by important shearing forces, may result in its separation from the pubic bone or an avulsion injury [5, 7]. These injuries may be acute or arise from overuse [5, 7]. PPAC lesions also show an intrinsic inertia toward biological repair. Indeed, the opposing mechanical tensions to which this complex is subjected, mainly those of the RA and the LA, limit its ability to self-repair [7, 18]. The BTX is a neurotoxic neurotoxin protein produced by the bacterium C. botulinum and related species. To date, seven serotypes of BTX have been identified and alphabetically labeled from A to G. All of the serotypes show a similar chemical structure and, except for the C2 subtype, are neurotoxic [19]. BTX causes a temporary dose-related weakness, paresis, or paralysis of skeletal muscle by blocking the release of acetylcholine at the neuromuscular junction. The toxin starts to take effect within 2–3 days, and the maximal effect is achieved after about 2 weeks. These effects last for an average of 12–16 weeks after which, the motor end plates recover completely and the neurotransmission mechanism restarts [19]. It is important to underline that BTX, when inoculated, has the ability to directly reach the neuromuscular junction. Therefore, this characteristic allows the clinician to carry out the inoculation without necessarily having to search for the muscle motor point [16, 20]. Furthermore, BTX possesses limited adverse effects as it presents a fairly good safety profile. The most important adverse effect is the unintentional diffusion into adjacent anatomical sites that may cause weakness in and around the target area. Other rare systemic adverse effects may include allergic reactions, generalized weakness, and influenza-like symptoms. BTX must be used with caution in patients with existing paresis, such as myasthenia gravis, Lambert–Eaton syndrome, amyotrophic lateral sclerosis, and other types of myopathies or motor neuropathy [20]. There are several studies in the literature on the use of BTX in improving the outcome of flexor tendon repair [9-11]. In these cases, the chemical denervation process induced by BTX is used to partially weaken the flexor muscles and decrease their traction force on the tendons. This decrease in tendon tension could facilitate the processes of tendon repair [9-11]. BTX is also used, with the same rationale, in abdominal wall hernia repair [21]. Indeed, during abdominal wall hernia repair, the linea alba is reapproximated bilaterally and needs time to remodel and tie together. In inducing lateral paralysis BTX, enables the linea alba to heal by eluding, for a substantial period of time, the constant forces of lateral traction. This decreases both hernia recurrence and separation of the reapproximated linea alba [21]. The use of

BTX in PPAC lesions is based on these same physiological principles. In the case of PPAC avulsion, afferent to the LA – RA – pyramidalis aponeurotic plate complex, BTX may decrease the tension of the LA and RA to the point of favoring PPAC repair. Another important advantage of BTX is its ability to modulate pain by inhibiting substance P and calcitonin gene-related peptide [22]. Furthermore, in this case report, the use of BTX was paired with PRPt. The medical protocol followed in this study employed PRPt to improve the tissue reparative processes in optimal biological conditions, that is, in the absence of excessive mechanical stress to the PPAC which would have decreased its reparative capacity.

Conclusion

The BTX infiltrative therapy coupled with PRPt may represent a new and promising treatment for PPAC lesions. However, there is a lack of specific studies in the scientific literature on the use of BTX in PPAC injuries and therefore it would be desirable to see the implementation of study protocols, preferably randomized controlled trials that focus on assessing the use of BTX in the interesting possibility of treating PPAC lesions.

Clinical Message

The PPAC lesions have an intrinsic inertia toward biological repair and for this reason, the outcome of the classic conservative treatment may be unsatisfactory. The infiltrative therapy proposed in this case report may represent a new and promising treatment for PPAC lesions.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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