THE ANKLE SPRAIN RECOVERY PROCESS FOR JUNIOR FOOTBALLERS BY COMPUTERISED DYNAMOMETERS

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Abstract. A sprained ankle is one of the most common joint injuries. This traumatic and painful injury is caused by abnormal stress on the capsular ligament complex and occurs secondary to a movement that forces it to stretch beyond its normal range without losing permanent contact between the joint surfaces. In the United States, the incidence of ankle sprain in the general population (between 2002 and 2006) was 2.15 per 1000 person-years, the highest rates being associated with the age of 10 to 19 years. For people aged 15-24, the incidence was considerably higher in men compared to women, while for those over 30, the incidence was higher in women than men. Epidemiological statistics showed that almost half of all ankle sprains occurred during athletic activities. The motivation for choosing this topic is to highlight the benefits of using the Biodex System 4 Pro in the recovery program for junior footballers with grade II ankle sprains. The assessment made by this device provides information on joint mobility and muscle strength; therefore, the programs used in the recovery process can be performed without putting pressure on the joint and within the range and speed parameters set by the physiotherapist (especially passive, isotonic, isometric and isokinetic ones in the eccentric or concentric mode). The study has shown that Biodex is very helpful in the recovery process because it offers the possibility to work in the isokinetic mode, which reduces the functional recovery period and ensures the return to sport in a minimum time.

Keywords: ankle sprain, computerised dynamometer, recovery.

Introduction

A sprained ankle is one of the most common joint injuries. This traumatic and painful injury is caused by abnormal stress on the capsular ligament complex and occurs secondary to a movement that forces it to stretch beyond its normal range without losing permanent contact between the joint surfaces.

According to the World Health Organization (WHO), the incidence of ankle sprain in the general population of the United States (between 2002 and 2006) was 2.15 per 1000 person-years, the highest rates being associated with the age of 10 to 19 years. For people aged 15-24, the incidence was considerably higher in men compared to women, while for those over 30, the incidence was higher in women than men. Epidemiological statistics showed that almost half of all ankle sprains occurred during athletic activities (Waterman et al., 2010).

In the Czech Republic, the occurrence of athletic injuries was followed up for 1 year in a population of 398 football players of different ages (14 to 42 years) and skill levels (from local teams to first-league teams) and it was found that, out of the 686 sustained injuries, 74.2% affected the lower limbs, with the highest prevalence in the knee (30%) and the ankle (19%) (Chomiak et al., 2000). Price et al. (2004) explain that increased competitiveness, training loads and exposure time are associated with higher risk of injury in football players.
Ekstrand and Tropp (1990) also examined the relationship between exposure time and ankle sprains on a sample of 639 senior football players from divisions 1-6, who were followed up for 1 year, and found that the injury risk was higher in upper divisions. Thus, the above authors identified that the incidence of ankle sprains ranged between 17% and 20% per 1000 hours of exposure, which is why they recommended taking preventive measures to decrease the incidence of injury (or re-injury) occurrence.

One of the most common football injuries is the sprained ankle, which occurs at a rate of about one injury per 10,000 people per day. The incidence of an ankle sprain in football ranges between 17 and 20 injuries per 10,000 hours of exposure. However, people who have suffered a sprained ankle at least once should take preventive measures to protect their ankle and avoid recurrence (Aslan et al., 2014).

The purpose of this study is to identify the effect of using the Biodex dynamometer for the treatment of ankle sprains on Romanian junior football players.

Classification of ankle sprains

According to the Orthopaedic Sports Medicine Institute (2021), there are two basic classifications of ankle sprains: anatomic classification (considering the severity level of damage to tissues in the ankle) and functional classification (considering the level an injury affects a person’s ability to walk or put weight on the ankle). In anatomic terms, injuries are divided into three levels of severity as follows: grade I ankle sprain (the lateral ligaments are strained or overstretched); grade II ankle sprain (the partial tearing of one or more lateral ligaments); grade III ankle sprain (the complete rupture of one or more lateral ligaments). In functional terms, injuries are also divided into three levels of severity, but the focus is more on the movement capability. Thus, patients with grade I ankle sprains can walk and put full weight on their ankles, patients with grade II ankle sprains can walk with a visible limp and patients with grade III ankle sprains cannot walk at all. These grading systems can predict timelines for patient recovery, which range from 1-2 weeks (grade I) to 6-8 weeks (grade III).

Tiemstra (2012) believes that the value of exercise cannot be overlooked. It is true that a damaged ankle takes time to heal, but strengthening the surrounding muscles can help recovery and prevent recurrent sprains. After a few days of rest, most people can start exercising their injured ankles if the sprains are mild or moderate. Simple mobility exercises and strength training are needed to help the ankle heal properly. Any other workouts should be adjusted to the damaged ankle in order to minimise reinjury or overload the ankle.

Most ankle sprains are associated with inversion injuries, which account for about 25% of musculoskeletal injuries, and 50% of them are sport-related (Van den Bekerom et al., 2012). In the study by Garrick (1977), lateral ligaments were involved in 80% of all ankle sprains. Amendola and Drosdewech (2002) claim that the anterior talofibular ligament is responsible for all lateral ankle sprains, the calcaneofibular ligament is responsible for 50% to 70% of injuries, and the posterior talofibular ligament is involved in less than 10% of cases. High ankle sprains, also called tibiotalar syndesmotic sprains, are less common (Evans & Schucany, 2002).

Exercise can restore strength and balance while preventing the muscles in the area from weakening, which can reduce the risk of another sprain. Once the swelling has gone down
and walking is comfortable, it may be a good idea for patients to start exercising their ankles. The most important factor following an ankle injury is to rest. When a sprained ankle is diagnosed, the patient should rest for a few days. Some home treatments may be helpful in the recovery process.

Injury-associated swelling can be diminished by elevating the ankle above the level of the heart. Swelling and pain can also be reduced by applying an ice pack wrapped in a towel to the affected region for about 10 minutes every few hours. Ibuprofen (Advil) and Acetaminophen (Tylenol) are two over-the-counter medicines that can help relieve pain. Most people with mild to moderate sprains only need a few days to recover. The patient can begin with gentle workouts to help the ankle recover in just a few days. It normally takes 6 weeks for the ligaments to heal. The rehabilitation phase is as crucial as the rest phase because it helps the injured ankle to regain strength. Range of motion, strength, flexibility and balance are the most significant aspects of ankle sprain healing that the patient needs to take into account. Each of these functions is essential for maintaining the health of the ankle joint. Various workouts will focus on one or more of these elements.

Exercise therapy is an important component of the recovery process. Exercise strengthens the ankle and helps prevent recurrent sprains and other problems. The workouts should not cause pain, although they may produce some discomfort. Anyone who feels pain in the ankle during exercise should stop and get some rest. The ankle will be stiff and will have a limited range of motion after an injury. Exercises are necessary to help restore the normal range of motion. The ankle must be robust to support body weight when daily activities are performed.

Strength training is essential and most people can start it as soon as they can stand on their ankles without feeling an increase in pain or swelling. Improving ankle flexibility is also critical because it allows the ankle to move and stretch as needed to support body weight. The ankle is also important for maintaining balance. Exercises that strengthen and enhance ankle control can help a person maintain balance.

Football, the most popular sport on the planet today, also has a high injury rate at both professional and amateur levels. Elite football players experience between 13 and 35 injuries per 1000 competitive player-hours, most of them (up to 74%) resulting from direct player contact (Walls et al., 2016). An analysis of these injuries shows that about 80% are due to trauma, while 20% are due to overuse (Dvorak & Junge, 2000). Ankle sprains are the most common injuries that affect footballers at a rate of about one injury per 10,000 people a day.

Alcocer et al. (2012) describe several devices used for ankle sprain rehabilitation, which are divided into three categories as follows: a) low complexity devices, b) intermediate complexity devices and c) high complexity devices. Low complexity devices include elastic bands (multi-shaped strips of resistive elastic used for muscular strengthening), roller foams and Wobble boards (both used to improve balance and proprioception). Intermediate complexity devices contain various electromechanical systems that allow patients to gently move and stretch their muscles and tendons; these machines help restore the range of motion and improve flexibility in the ankle muscles, but their major disadvantage is that patients work in a continuous passive motion (CPM) mode, thus playing a passive role in their own rehabilitation process. High complexity devices not only help in ankle rehabilitation but also contribute to the entire lower limb rehabilitation.
The Biodex device incorporates a system with large storage capacity, which transmits and generates reports aimed at assessing patient’s progress throughout the rehabilitation period.

Biodex is a multi-mode computerised robotic instrument used to measure muscle strength around the joints, but also as part of a rehabilitation exercise to improve strength in various joints. There are 5 modes that can be used: isokinetic resistance, reactive eccentric, passive motion, isometric and isotonic. (Centre for Hip Health and Mobility, 2015)

Biodex System 4 Pro maintains an unrivalled level of performance, precision and safety. Biodex equipment has the highest correlation coefficients for dependability, accuracy, sustainability and repeatability, which is not surprising. It provides reliable, accurate and objective data for sports and orthopaedic medicine, paediatric medicine, neurorehabilitation, industrial medicine and researchers. Biodex technology offers efficiency, safety, decreased joint compression stress and reproducibility, which we aim to emphasise through our research. The isokinetic performance of Biodex has been found to be positively correlated to function. Only Biodex isokinetics allows the patient to test and train with the isolated joints and surrounding muscles in biomechanically correct positions and at speeds that replicate function. It also allows the therapist to determine the patient’s need, progress and outcome with the highest level of accuracy and reliability regardless of the exercise mode used (IPRS Mediquipe, 2021).

Biodex technology offers efficiency, safety, decreased joint compressive stresses and reproducibility, which we will try to emphasise in this research. It has been found that the isokinetic performance of Biodex has a favourable relationship with function (Table 1).

Table 1. A literature review of ankle sprain recovery

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Treatment method</th>
<th>Output measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ilie et al. (2019)</td>
<td>1 male patient aged 36</td>
<td>Isokinetic mode of the Biodex System 4 Pro dynamometer</td>
<td>Assessing joint function, gaining range of motion (ROM), strengthening knee stabilisers</td>
<td>A reduction in recovery time of at least 20% for a patient with meniscus tear</td>
</tr>
<tr>
<td>Riccio et al. (2019)</td>
<td>19 patients</td>
<td>Biodex dynamometer</td>
<td>Side-to-side knee extension strength deficits</td>
<td>There was no statistical difference in knee ROM between sides; however, thigh circumference was slightly smaller in the injured extremity (median difference, 1.7 cm at 15 cm above the patella and 4.0 cm at 50% of the length of the thigh). In total, 5 out of the 19 patients (26%) had a significant quadriceps extension strength deficit on the involved leg compared with the contralateral side.</td>
</tr>
<tr>
<td>Power et al. (2011)</td>
<td>24 participants</td>
<td>Biodex dynamometer</td>
<td>Dynamic contractions using the isotonic mode of the Biodex dynamometer</td>
<td>Intraclass correlation coefficient (ICC) confidence intervals for velocity and power at baseline ranged from 0.85 to 0.97 and 0.95 to 0.99, respectively. After lengthening contractions, ICC confidence intervals ranged from 0.82 to 0.90 and 0.93 to 0.96 for velocity and power, respectively.</td>
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</table>
After a period of immobilisation, the passive mode can be used to reap the benefits of continuous passive motion. Mild range-of-motion training can help speed up the healing process and restore the typical ROM required to function in this mode. When combined with other modes, the passive mode allows the structures surrounding the joint to act as a pump, thus moving blood, lymph and waste products out of the joint, which reduces inflammation. By managing the Biodex System in this mode, the range of motion can be progressively increased in a certain direction while maintaining safe torque levels and appropriate velocities. (Nordex et al., 2008)

Angular velocity of the isokinetic system during workouts is the same but torque differs if maximum resistance training needs to be performed. The reliability and accuracy of these assessments depend on the patient and their level of education. However, through proper education and strict compliance with the test instructions, it is possible to successfully control the confounding variables. Isokinetic devices have provided increased opportunities to study dynamic muscle function in scientific work. In the isokinetic mode, velocity is controlled by the dynamometer, which allows the patient to accelerate up to (but no more than) the maximum speed value selected for each direction of shaft rotation (accommodating resistance). The unique mode of acceleration and deceleration provided by Biodex puts an end to joint trauma, allowing patients to train at more functional speeds. The patient can freely slow down or change direction of movement at any point within the range of motion. This is especially important for the ankle complex when muscle strength is unbalanced. In the passive mode, the dynamometer offers continuous motion at constant velocity; direction changes occur only when reaching the range of motion limits. When the Start button is pressed, the dynamometer initiates motion without requiring the patient’s active engagement. (Physiology, Exercise & Nutrition Group, 2020)

The unique acceleration and deceleration modes of the Biodex device puts an end to joint trauma, allowing patients to train at more functional speeds. The patient can freely decelerate or change the direction of movement at any point throughout the range of motion. This is especially important at the ankle complex where muscle strength is unbalanced (Holmback et al., 2000).

In the isometric mode, the dynamometer maintains zero velocity at any point in the range of motion; no significant change occurs in joint angle or total muscle length (Physiology, Exercise & Nutrition Group, 2020). Multi-angle isometric mode can be used before, during and after surgery, as well as following periods of immobilisation. This mode allows

<table>
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<tr>
<th>Pelegrinelli et al. (2018)</th>
<th>14 participants</th>
<th>Biodex System 4 dynamometer</th>
<th>Isokinetic dynamometer in the concentric mode at 60, 120 and 300°/s for knee flexion/extension</th>
<th>Statistically significant peak torque/body mass deficits for the knee extensors at 60 and 120°/s and for the knee flexors at 60°/s in the injured knee of the ACL group compared to uninjured controls; extension ROM was also lower for the ACL group at 60°/s.</th>
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<tbody>
<tr>
<td>Gaston et al. (2000)</td>
<td>130 patients</td>
<td>Biodex dynamometer</td>
<td>Isokinetic peak torque, total work and the average power for knee flexion and extension</td>
<td>40% of normal power two weeks after fracture raised to between 75% and 85% of normal one year later, with the return of power of the flexors being better than that of the extensors.</td>
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</table>
convenient strengthening and assessment at particularised angles that are secure for both pre-operative and post-operative patients.

In the isotonic mode, the dynamometer requires the patient to meet a minimum selected torque limit to move the arm. Thus, velocity is variable but torque is constant. (Physiology, Exercise & Nutrition Group, 2020) In the later phases of rehabilitation, various concentric contractions should be performed to isolate only one muscle group. This mode allows velocity to vary while providing constant force and concentric or eccentric muscle contractions (Van Driessche et al., 2018).

In the reactive eccentric mode, the dynamometer responds to the torque exerted by the patient by moving against the applied force. To initiate shaft motion, the patient is required to meet a minimum torque threshold corresponding to 10% of the pre-set torque limit. If the patient exceeds the torque limit value selected for either direction of motion, the shaft stops rotating until the patient’s force output is reduced to the desired range. (Physiology, Exercise & Nutrition Group, 2020)

The patient is therefore required to exceed a specified torque value to achieve motion and to keep torque output at the specified level to continue motion. This loads the muscles around the joint, producing a pre-load and thus stabilising and protecting it. Reactive eccentric mode allows for direction changes at any point in the range of motion (Fox et al., 2008).

Therefore, the system uses concentric and eccentric contractions, providing the opportunity to generate passive, isometric, isotonic and isokinetic movements. It can accurately set the pain-free movement space and perform standard movements at the exact points where the pain occurs. In this way, the range of motion is quickly reached.

As a result, the crucial aspect in managing an ankle sprain rehabilitation program is individualisation. Individualised training programs can supplement various strength training techniques and help post-adolescent footballers address imbalances. Individualised resistance training programs, in terms of strength deficit, are also hypothesised to normalise isokinetic parameters, decreasing any discrepancies between the lower limbs.

Proper patient placement and stabilisation as well as alignment of the machine’s axis of rotation with the ankle joint and gravity compensation are conducted according to Biodex Medical Systems instruction manual and are identical to those described in the literature (Daneshjoo et al., 2013).

Before the isokinetic assessment, each patient performs a warm-up session for 10 to 15 minutes, which consists of moderate pedalling on a stationary cycle ergometer and dynamic stretches for the major muscle groups of the lower limbs.

Continuous ankle dorsiflexion and plantar flexion movements are used to assess the concentric isokinetic torque of the tibialis anterior and gastrocnemius. Patients will perform three sets of sub-maximal efforts with gradually increasing load (50%, 75% and about 100% of maximum capacity), followed by a set of maximal concentric contractions. The same protocol will also be performed with the opposing leg. After the third submaximal test, a 30-second break is given, and a 3-minute break is provided when the machine setting for the opposite leg is changed. A standardised voice encouragement will be offered to the patient before each maximal effort, as well as visual feedback of the recorded torque.

The Biodex System has numerous advantages: it is the most comprehensive, user-friendly and abundant operating system developed so far for human rehabilitation and performance; it
is a smart and instinctive operating system that adjusts to the user’s way of training and thinking. Another important advantage is that it motivates patients with screen charts and icon graphics, thus routing their performance and inspiring them through a rehabilitation plan. Patients can be confident that the plan is saved and documented through each part of the rehabilitation structure. Thus, each patient’s need, progress and outcome can be perfectly and precisely communicated. The new system interface of Biodex System 4 Pro makes the device extremely easy to use for all skill levels, bringing the clinical advantages of this technology to every application. It is easy and fast to use, having new touch systems for easy operation. It also has an “Easy to follow” category for inexperienced patients to use the program.

Audio and visual support aims to demonstrate the exercise and assess patterns.

A special advantage of the device system is that it uses Isomap as a type of report. Isomap is the ability of the Biodex System to accumulate the whole range of the patient’s neuromuscular performance. This means that most people with an advanced experience towards the Biodex System can offer the patient the experience of the Isomap feature. A huge advantage of the Biodex System is given by the isokinetic mode, which is safe and where the resistance is equal to the force applied.

Joint compression forces decrease as speed increases, and muscle soreness is minimal. This is efficient. The working muscle group can be loaded to its maximum capability throughout the range of motion, muscle fibres increase, and the strength of the ligament and bone complex is improved. This mode also identifies physical disabilities and strength deficits depending on the range of motion and speed of movement. It also correlates to functional activities and is consistent with exercise principles such as progressive loading, specificity and training speed range.

The other types of movements also have a lot of advantages: for example, isometric contraction requires very little or no equipment at all, helps fight atrophy, maintains neural connection and can be performed anywhere at any time.

The advantages of isotonic contraction are: a rapid increase in strength, improved muscular endurance with the movement performed, the fact that functional activity gets closer and closer to the initial range of motion.

Each type of contraction has a variable number of advantages but the most important ones that should be kept in mind are: safety, efficiency, adaptable resistance, psychological overflow and the ability to train at fast and contractile velocities.

However, there are also a small number of disadvantages that differ from one person to another. Thus, the isotonic type of contraction provides maximum loading only in the weakest part of the range of motion, does not develop accuracy at fast functional speeds and makes it difficult to train at faster, more practical velocities (Tsiros et al., 2011) (Table 2).

Table 2. Advantages and disadvantages of Biodex

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantage</th>
</tr>
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<tbody>
<tr>
<td>1. Objective and qualitative assessment of movement parameters</td>
<td>1. Expensive</td>
</tr>
<tr>
<td>3. Biofeedback</td>
<td></td>
</tr>
<tr>
<td>3. It can be used for any patient and in various pathologies</td>
<td></td>
</tr>
<tr>
<td>4. It takes up little space</td>
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</table>
In the two days preceding the measurements, the athletes will not be subjected to any additional load. The absolute and relative peak torque values for the dorsal and plantar flexors of both legs are included in the analysis. Differences in bilateral leg strength are calculated using the net peak torque; these differences can be accurately measured by means of the Biodex device (Daneshjoo et al., 2013).

Methodology

Participants

The research participant (G.J.) was a 17-year-old junior football player at the FC Rapid team, who suffered a grade II ankle sprain during the last match. The patient complained of pain in the lateral part of the ankle, the anterior talofibular ligament (ATFL) and the peroneus longus and brevis tendons, which run behind the lateral malleolus. The ankle had a huge oedema and a small hematoma from the lateral malleolus to the toes.

Ultrasound scanning of the anterolateral ankle showed a partial tear of the ATFL and AITFL (anterior inferior tibiofibular ligament), fluid accumulation and fascial fluid infiltration, which indicated that it was a grade II ankle sprain (Figure 1).

![Figure 1. Ultrasound scanning of the sprained ankle (before recovery)](image)

We also reviewed case studies and meta-analyses published in the national and international literature to identify the main methods for the rehabilitation of a sprained ankle.

The Biodex device is used for dynamic muscle assessment. Passive range of motion was determined using the System 4 Pro version (Figure 3):
- The initial assessment was performed at slow motion (20 degrees per second);
- The intermediate assessment was performed at slow motion (60 degrees per second);
- The final assessment was performed at low speed (90 degrees per second);
- The isokinetic assessment was performed at 120 degrees per second.
During the recovery process, other methods were also used, such as TECAR Therapy, Cryotherapy (Game Ready), ERGON Technique (Myofascial Release Therapy), Dry Needling and Flossing Therapy.

There are many devices that can help the ankle sprain recovery process, which we divided into three categories as follows: a) low complexity devices; b) intermediate complexity devices; c) high complexity devices.

The treatment consisted of 10 TECAR and Biodex sessions for each, 4 ERGON Technique sessions, 3 Dry Needling sessions and 5 Flossing Therapy sessions.

The international ethical guidelines were respected: the participants’ informed consent was obtained, and the anonymity and confidentiality of the data were ensured (Descombe, 2014; Predoiu, 2020).

Results

Table 3. Patient data

<table>
<thead>
<tr>
<th>Patient</th>
<th>Initial ROM</th>
<th>Intermediate ROM</th>
<th>Final ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>affected leg</td>
<td>affected leg</td>
<td>healthy leg</td>
</tr>
<tr>
<td>G.J.</td>
<td>23.3(^\circ)</td>
<td>48.1(^\circ)</td>
<td>63.2(^\circ)</td>
</tr>
<tr>
<td>Difference</td>
<td>39.8(^\circ)</td>
<td>30.0(^\circ)</td>
<td>0.0(^\circ)</td>
</tr>
</tbody>
</table>

As seen in Table 3, the difference between the initial ROM assessment of the healthy and affected legs was 39.8\(^\circ\). After two weeks, an intermediate assessment was performed, and the difference between the healthy and affected legs was 30.0\(^\circ\). The final assessment took place after another two weeks, and the difference between the healthy and affected legs was 0.0\(^\circ\), meaning that the affected leg was fully recovered (Figure 2).
Discussion and conclusion

Patients can be confident that, through each part of the rehabilitation structure, the plan is safe and documented. One of the crucial goals of the Biodex System is to provide patients with documented data and thus help them to accurately communicate their needs, progress and outcomes. The new system interface (Biodex System 4) is user-friendly for all skill levels, bringing the clinical advantages of this technology to every application. It is easy and fast to use, having new touch systems for easy operation (Yang et al., 2020).

It also has an “Easy-to-Follow Category” for inexperienced patients to use the program.

The audio-visual support has the role of demonstrating the exercise and assessment patterns. A special advantage of the Biodex System is that it contains an Isomap guide. Isomap is the ability of the device to store the whole range of the patient’s neuromuscular performance. This means that most therapists with advanced knowledge of the Biodex System can offer their patients the experience of the Isomap feature. A huge advantage of the Biodex System is the existence of the isokinetic mode, which is safe because resistance is equal to the force applied. Joint compressive forces decrease with the increase in speed, and the production of muscle pain is minimal. The effectiveness of the Biodex System is also emphasised by Lee et al. (2020), who state that the working muscle group can be loaded to its maximum capability throughout the range of motion, muscle fibres are increased, and the strength of the ligament and bone complex is improved. This mode also identifies physical disabilities by capturing strength deficits depending on the ROM area and velocity. It correlates with functional activities and is consistent with exercise principles such as progressive loading, exercise specificity and training speed.

The other types of movement also have a lot of advantages, for example, isometric contractions require very little or no equipment, help fight atrophy, maintain neural connection and can be performed anywhere at any time. In addition, they provide a rapid increase in strength, an improvement in muscular endurance and, through the movement
involved, the functional activity gets closer and closer to the initial range of motion. Each type of contraction has a variable number of advantages (Miner et al., 2022), among which we mention: safety, efficiency, adaptive resistance, psychological overflow and the ability to train at fast and contractile velocities.

However, there are also a small number of disadvantages of isotonic contractions, which differ from one person to another, for instance: maximum loading appears only in the weakest part of the range of motion; lack of accuracy at fast functional speeds; difficulty to train at faster, more practical velocities (Tsiros et al., 2011).

Concentric ankle inversion and eversion peak-torque measurements had a high intertester and intratester reliability using the Biodex isokinetic dynamometer. In addition to the position of 20-degree plantar flexion in the ankle joint used in previous studies, the neutral position for this joint is also highly reliable. It is confirmed that the learning effect is an important element in the isokinetic assessment that requires a significant interval between repeated measurements. Future studies should be considered for the learning effect when using this system. However, individualised guidance for ankle sprain rehabilitation could provide various changes in player recovery. Strength is also a major goal in the rehabilitation of a sprained ankle that is associated with ligament injury, but it is not the only one because rapidity and stretching are also factors that ensure competitive success. Based on these elements, a well-designed program will represent a huge benefit for players to return to sport.

The computerised dynamometer is successfully used to assess muscle strength, guiding the length of the recovery process and reducing the risk of reinjury on the playing field. This type of dynamometer is produced by Biodex System 4 PRO, a device that plays a major role in helping athletes regain their full range of motion, rebuild their strength, protect their joints and, most importantly, achieve muscle balance in all its sections.

The assessment made by this device provides information on joint mobility and muscle strength; therefore, the programs used in the recovery process can be performed without putting pressure on the joint and within the range and speed parameters set by the physiotherapist (especially passive, isotonic, isometric and isokinetic ones in the eccentric or concentric mode).

The study has shown that the Biodex System 4 Pro (together with the other modern therapies mentioned in the current paper) is very helpful in the recovery process because it offers the possibility to work in the isokinetic mode, which reduces the functional recovery period and ensures the return to sport in a minimum time.

According to this study, only the isokinetic mode of the Biodex System allows patients to test isolated joints in biomechanically correct positions and at function-replicating velocities. It also facilitates the development of muscle strength with extremely high accuracy and reliability during any dynamic assessment (Biodex, n.d.).

Authors’ Contribution

Both authors have equally contributed to this study and should be considered as main authors.
References


