Joanne Rouvali

ONLINE NETWORK MOBILITY EXERCISES FOR MALE HOCKEY PLAYERS DURING AN ADOLESCENT GROWTH SPURT

Degree Programme in Physical Therapy

2016

Satakunnan ammattikorkeakoulu
Satakunta University of Applied Sciences

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Rouvali, Joanne
Satakunnan Ammattikorkeakoulu, Satakunta University of Applied Sciences
Degree Programme in Physical Therapy
March 2016
Supervisor: Törne, Mari
Number of pages:32
Appendices:

Key words: Mobility Exercises, Adolescent Growth Spurt, Hockey

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Why do adolescents going through a growth spurt, competing heavily in sport, need to do mobility exercises, what exercises are appropriate for this stage in growth and can we support their compliance to prevent possible injury with a mobile phone and online network?

Adolescent boys in the midst of a growth spurt increase in a short time height and weight which challenges mobility. Tissues are at risk of injury for physical changes in tissue, lack of active movement control and over use or load. Efficiency in movement is a basal need and that need is heightened with physical stress and load increase as in hockey. Mobility exercises are simple yet essential for wellbeing and longevity in sport participation.

Training mobility is not a new concept nor an unused one but it is the exercise often bypassed if suppressed for time, lack of interest or knowledge. Training mobility is specific as is the individual training, due to life style, sport, and physiological, biological, and training history. Regaining neuromuscular efficiency through mobility training is worth the time and effort when the option of injury and its repercussions are concerned. With online network availability, direction of exercises are visually ready to support improvement in mobility.

TABLE OF CONTENT

1 INTRODUCTION 4
2 PURPOSE OF THE THESIS 5
3 PUBERTY 5
3.1 Physiological Development 5
3.2 Sensitive Period 6
4 EFFECTS OF PUBERTY ON TISSUES 8
4.1 Bones 8
4.2 Joints, Tendons, Ligaments 9
4.3 Muscles 10
4.4 Fascia 11
4.5 Motor Skills, Coordination, and Balance 12
4.6 Mobility 13
5 TRAINING MOBILITY 16
5.1 Stretching Before and After Training 16
5.2 Functional Mobility 16
5.3 Flexibility 17
5.4 Fascia Concept Training 18
5.5 RehabilitativeTraining 20
6 HOCKEY AND PUBERTY 20
6.1 Hockey movement analysis 20
6.2 Effects on training 21
7 MOVEMENT 22
7.1 Kinetic Chain 22
7.2 Planes of Movement 22
7.3 Elastic energy storage 22
7.4 Mechanoreceptors 23
7.5 Terms and Dysfunctions in Movement 23
8 MOBILITY EXERCISE PROGRAM 24
9 THESIS PROCESS 27
10 DISUSSION 28
REFERENCES 29
APPENDICES

1 INTRODUCTION

Mobility is a prerequisite for wellbeing and long term participation in sports. Flexibility is a component of mobility which begins to decrease already at the age of 10 and is multiplied during the growth spurt. Skipping mobility training particularly when doing heavy physical training results in muscle imbalances and tension. Training mobility assists in upholding range of motion and improving extensibility of tissues ultimately developing neuromuscular efficiency and function. (Jones 2013) The ultimate product is decreased loading in joints from consistently repeating movements in poor posture, fatigue, and muscle activation. These will result in tissue injury which the body will treat with inflammation, pain, and tensing of muscles or spasm. Adhesions or “scabs” if you like will develop creating additional joint motion alterations and finally structural changes if mobility training is not initiated. (Jones 2013)

Half of pediatric patients of chronic injuries are reported as due to over use (McLeod et.al. 2011). Overuse injury is repetitive stress causing inflammation, muscle strain, tissue damage and even fracture. Typically injury occurs if there is a sudden increase in intensity or weights and with poor mechanics, will over time cause friction in joint structures. (Jaakola & Tapio 2015, 96) Time spent training in a flexed position, sitting at a desk in school and still in free time is bound to develop some muscle imbalance.

Why do adolescents going through a growth spurt, competing heavily in a sport, need to do mobility exercises, what exercises can be done to improve mobility for this stage in growth and can we support their compliance to prevent possible injury through online network availability such as mobility exercise direction visible on the mobile phone?

2 PURPOSE OF THE THESIS

The purpose of this thesis is to assist coaches in supporting parents and boys amidst an adolescent growth spurt who heavily train and compete in hockey to understand why they should do mobility exercises, what are the basics of mobility training, and present a few visual, live examples that are available on a phone. Muscle extensibility is a muscle with strength (Ahonen 2011). In sports the responsibility of training mobility is often left to the young athlete or parents (Jaakola & Tapio, 2015, 96-97).

3 PUBERTY

3.1 Physiological Development

Physiological development during a growth spurt means more than just the changing of the human beings organ system but its structure and its function (Komulainen 2016). Generally between 12 and 17 years of age, height accrues from 10 up to 30 cm. and weight anywhere from 8 to 30 kilograms. There are great increases in strength and skin surface area. (Stang & Story, 2005, p.1-5) Muscle cells can develop to fast twitch or slow twitch (Komulainen 2016). Growth increases muscle and connective tissue about a joint which ultimately slows down mobility development. In the spine, mobility is at its best around 7-13 years of age after which shoulder and hip joint mobility begin to decline. (Jaakola & Tapio, 2015, 96-97) This is individual. Stressed tissues result in stiffness and muscle imbalance leading to muscle tightness in the lower extremities and spinal region. Competitive sports may trigger problems such as lumbar spine pain, articulation dysfunction, and possibly spondylolisthesis or disc prolapse which is highly probable in hockey. (Riseley Physiotherapy Pt Ltd., 2012)

Maturation presents itself through cognitive, psychosocial, and biological changes, the latter is described in stages called Tanner Stages. Tanner stages three and four refers to boys 14 to18 years of age. The growth spurt generally occurs during the fourth Tanner stage and lasts about two or three years. Peak growth velocity becomes apparent two years after puberty onset. (Faigenbaum 2009, S60-S79)

Nearly all nerve cells exist at birth, however it is possible for more to develop however slow. Development is more so the growth of existing nerve strains and support systems. Sensory and movement stimulations with variety develops the nervous system and furthermore, motor control. After puberty this slows down. (Komulainen 2016) The process of puberty is a neural hormonal process beginning at the central nervous system. Onset of puberty by hormones are affected by genetics, diet, exercise, obesity, illness, stress, and possibly chemical exposure.

Emotionally low self-confidence and low self-esteem and aggressive behaviour may arise. Other developmental areas include operational thought, psychosocial development, and physically in addition to weight and height increases, bone mineralization, muscle composition, cardiovascular and aerobic development. (Faigenbaum, 2009)

3.2 Sensitive Period

Biological maturity (kypsyminen) can be seen in stages of development called sensitive periods. Specific skills improve naturally and become established due to periods of tissue development, maturation and background in training. (Jaakola & Tapio 2015, 56)

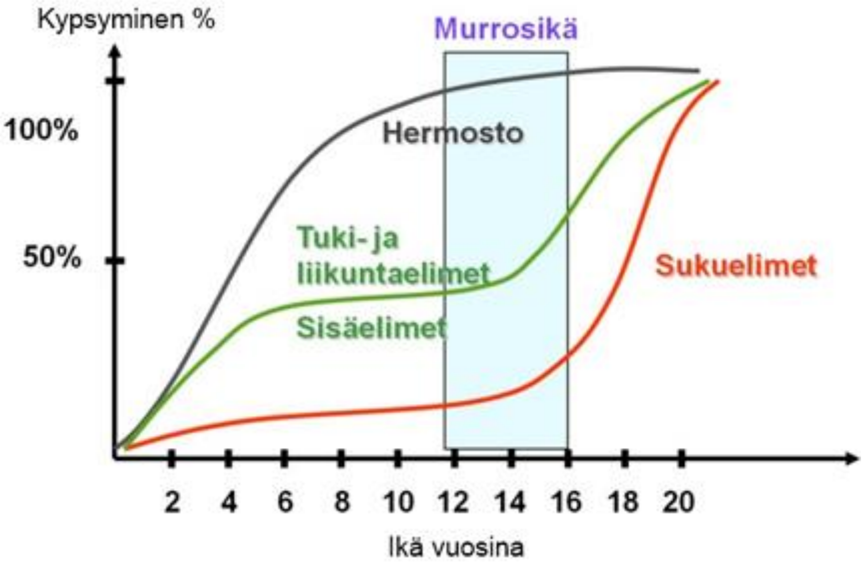

Figure 1. Biological Maturation. (Mero, A. ym. 2004.)

Figure 1. Shows puberty (murrosikä) taking place at 12-16 years of age (ikä vuosina) and the growth spurt taking place at about 14-18 years of age (Mero 2004). At this time neural (hermosto) development is at its peak. The musculoskeletal-organ system (tuki- ja liikuntaelimet ja sisäelimet) also increases visibly in height and weight as does for a child in their first few years of life. These differences are also visible concerning the sexual organs (sukuelimet) which greatly affects self confidence. Individual development differences are vast and this increases the challenge of coaching teams with large numbers of athletes even up to 3 year differences in biological maturity. (Jaakola & Tapio 2015, 56)

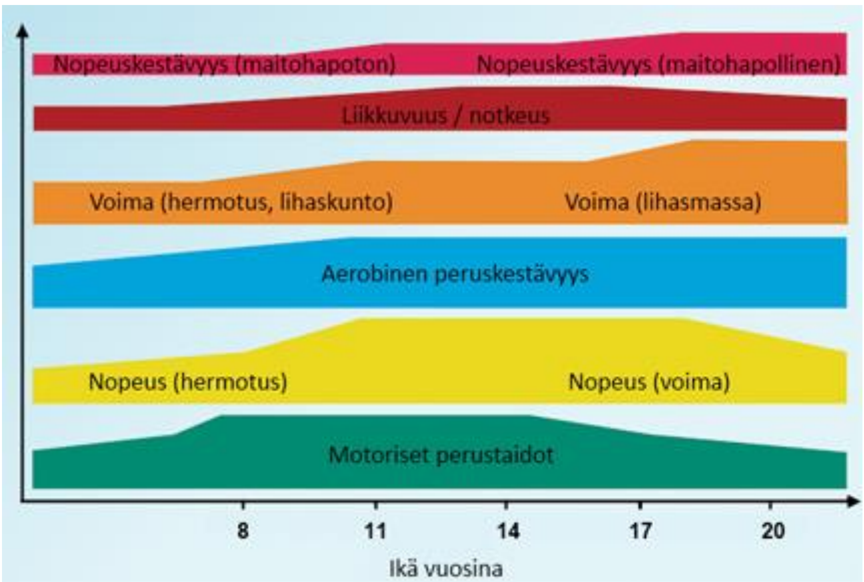

Figure 2. Sensitivty periods for physical attributes and focus in adolescence (Hakkarainen H. yn. 2008.)

Figure 2. only gives a general time line when developement is most feasible, by no means impossible or too late (Jaakola & Tapio 2015, 56).

4 EFFECTS OF PUBERTY ON TISSUES

4.1 Bones

Bones are clear visual indicators of the adolescent growth spurt. The growth of the anatomical body begins distal and works proximal. Hands and feet increase size, followed by the length of distal extremities then proximal. Lastly, the spine develops followed by the shoulder girdle. (Anton 2011) Growth develops slowly at first, followed by a growth spurt which slows down and eventually stops in which time variation exists (Komulainen 2016).

The strength of bone is compromised yet all the while developing during the adolescent growth spurt. Bones are made of compact bone on the surface and spongy bone on the interior. A growth plate exists near the neck of both ends of the bone where length increases and cartilage develops. This area, more prone to injury and fragile is weaker than the tendons and muscles attached particularly during great increases in growth. Bone mineralization is best increased before and during puberty. (Atanda 2011, 285-291)

Inflamed tissue common during the adolescent growth spurt are found at the apophysis of the heel, tibia, and patella. Severs disease is tension of the achillies tendon on the apophysis of the heel which is agitated by heavy physical activity and excess weight bearing. Minimizing aggravating activity and stretching calf muscles decreases symptoms. (Atanda 2011, 285-291) Osgood-Schlatter disease is an inflammation with referred pain below the knee due to traction of the patellar tendon on the apophysis of the tibia. Symptoms are aggravated with excessive jumping or direct pressure. Removing excess load, improving flexibility about the joint as well as mobility about the hip and ankle joints, and increasing strength of weak muscles decreases symptoms. (Atanda 2011, 285-291) Also, Sinding- Larsen- Johansson disease, with referred pain at the inferior part of the patella can be dealt with increasing flexibility of the hamstrings, quadriceps, and achillies tendon. (Atanda 2011, 285-291) Figure 3. by D. Klemm, depicts the inflamed locations below.

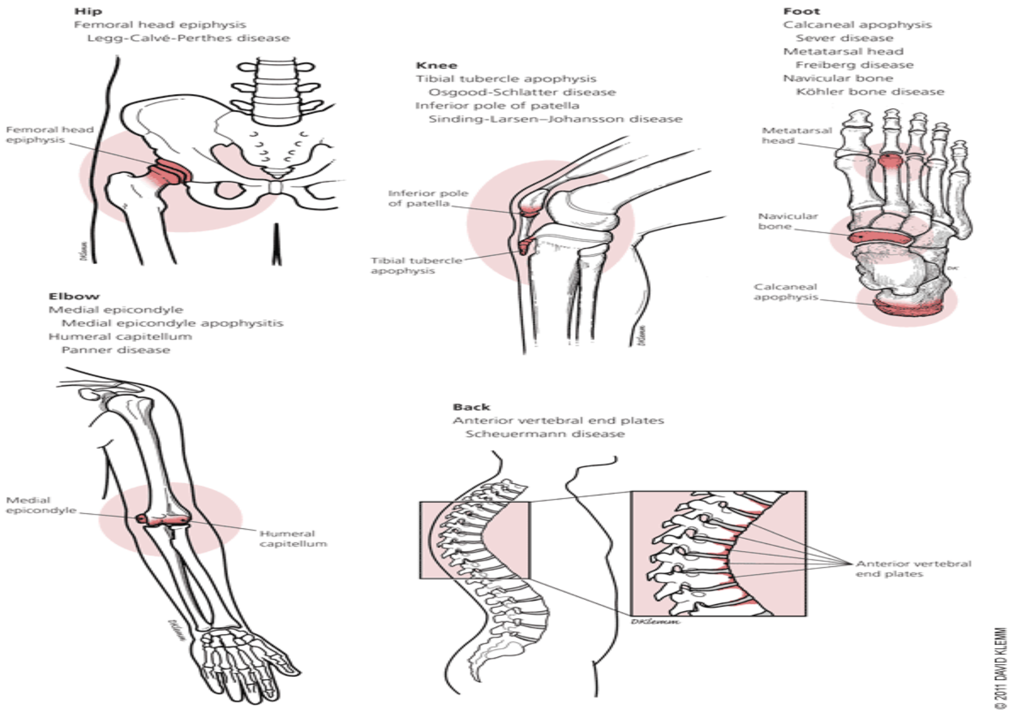

Figure 3. Locations of Inflammation in premature bone by David Klemm (Atanda 2011, 285-291).

4.2 Joints, Tendons, Ligaments

Connective tissue is challenged and ever changing during the adolescent growth spurt. According to a cross-sectional cohort study, males did not demonstrate increased joint laxity between the pre-pubertal and post-pubertal stage, rather there is a progressive decrease in laxity at the onset of Tanner stage 2. Changes in the joints restrictive compliance during puberty may affect injury, occurance rate, grade, and type. (Quatman, Ford, Myer, Paterno & Hewett 2008, 257-263)

The growth spurt has a positive effect on tissues as well. Joint and tendon tensile strength increases with stimulation through growth and physical exercise develops the positioning of the connective tissue and their proprioception. Low impact jumping and agility exercises may increase the development of elastic structures. (Komulainen 2016)

Range of motion none the less is compromised during the adolescent growth spurt. A prime example is the multiple degrees of movement in the hip. When an infant squats, he weighs on the heels with feet aligned with the shoulders, hips are set below parallel, has a stable lumbar spine with upright back and head in neutral, and the knees do not reach past the toes (Ziu 2013). Mobility exercises are intended to regain and uphold that mobility previously attained. It is important not to undermine the available range of motion of the hips. The pelvic girdle is the point where forces are relayed. How much tension a tendinous tissue can uphold is power and mobility is a component. (Ziu 2013)

4.3 Muscles

Increase is muscle size and strength during the adolescent growth spurt brings along with it symptoms of its own. The human body, with above 600 muscles, weighing about 42% of the body of which 75% is water. Pressure or immobility felt in muscles after excessively heavy training is the filtering of extracellular fluid due to possible micro tears as there are no lymph nodes in skeletal muscle tissue. (Wiliams & Wilkins 2002)

Muscle cell number increase is a genetic factor. Cell size or hypertrophy is affected by growth hormones and testosterone and strength training. Muscle cell types 1 (slow) and 2 (fast) is affected by which one is stimulated as well as inherited. The development of the muscle is dependent upon the maturity of the nervous system. (Komulainen 2016)

Bone length grows prior to muscles leaving them tight during a growth spurt. Stiffness and strain is experienced as pain due to the pressure in the muscle, the former presenting gradually, followed by swelling and restriction in motion. Fatigue is a by-product. Sympathetic stimulation, posture, balance of hormones, neural and circulatory function, and efficient respiration can all decrease symptoms of fatigue. (Wiliams & Wilkins 2002)

The main sensory organ of the muscle, muscle spindle fibers, sense lengthening of muscle and responds with stimulation to contract. These microfibers embedded along the muscle fiber itself is stretched with the muscle where after stimulation procedes to and returns from the CNS with what is often felt as a micro spasm or a tight feel. (Jones 2013) A prime example is when the pelvis is rotated anteriorly lifting the posterior side lengthening the hamstrings in conjunction. The muscle spindles response is a contraction in the same muscle. The hip flexors, overactive adductors, TFL, internal rotators are other overstimulated muscles while hip abductors and external rotators are weakly stimulated. (Jones 2013)

4.4 Fascia

During the growth spurt fascia is something to consider in the ever changing body. Fascia is connective tissue which envelopes other soft tissues throughout the whole body. Of three layers the deepest is tightest and consists the greatest amount of sensory tissue. Myofascial lines lead in multiple directions. Loading will deem the fibers two directional shape into a crimping pattern and lack of loading results in multidirectional shaping without crimping as seen in Figure 4. (Schleip R, 2013) For changes in crimping pattern and directional shape to occur tissues must be loaded above daily tension. Lack of movement or active overstimulation increases cross links decreasing elasticity and thus glide of the tissues over each other finally forming adhesions. (Schleip R, 2013)

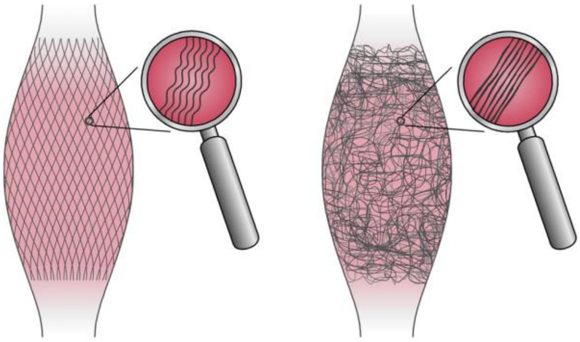

Figure 4. Loading Response of Fascia (Schleip R, 2013

4.5 Motor Skills, Coordination, and Balance

The growth spurt is well known for deficits in balance, coordination, and motor skills. The sensory system affects the ability to balance through receptors of the visual, balance, and kinesthetic systems. Due to change in visual leverage and proprioceptive information, balance or control of the bodies position and the ability to neutralize external forces such as changes in weight or imbalance also while moving. (Jaakkola & Tapio 2015, 70-76)

In a standing position ones center of gravity is approximately at the height of the naval. The base of support is how wide your stance is. Posture affects static balance while coordination affects dynamic balance. Balance can be trained through cutting down the size of the base of support, mobilizing the base of support, combining direction of movements or adding external forces. During the growth spurt, players often play upright. (Jaakkola & Tapio 2015, 70-76)

The ability of muscles to work together smoothly in a coordinated fashion is momentarily lost in an adolescent growth spurt. The loss of coordination and mobility together may develop into poor mechanics and technique and result in skill learning difficulties and poor sport performance. This will then overload tissues and increase injury risk and there in loose time from training. Coordination is weakened in a growth spurt but may be developed if it is challenged. New movement models can be stored into the memory of the brain and muscle. (Jaakola & Tapio 2015, 70-76)

Motor skills refers to movement control with an intended direction. Movement is a reaction response possessing balance and a set rhythm. Successful movement includes timing of movement initiation, body awareness of surroundings as well as body control. Skill consists of the muscle groups movement preparedness and sport specific technique as well as their transfer from training to motor control requires the coordinated work of the senses, neural system, and muscles thus producing fluid, energy efficient, intentional movement called coordination. Repetition done correctly.
Motor control is affected by the changes in receptor information. A movement model is designed from whence a movement begins with the final result in mind. (Jaakola &Tapio 2015, 63)

4.6 Mobility

Mobility is not a local rather a global concept, where musculature is used for functional movement. Mobility depends on stability, coordination, multiple joints, usually weight bearing functions in multiple positions under variable speeds. (Brooks & Cressey 2013, 27) Multiple methods of training is required as the development of mobility is facilitated by strength and conditioning also trained or performed throughout full range of motion. Individual limitations are identified and can then be addressed with corrective flexibility exercises. Mobility is significantly influenced by systemic restrictions such as fascia, core strength, posture and to top it all off an ever changing or growing body. (Brooks & Cressey 2013, 27-28)

Intrinsic factors such as weakness in eccentric control and higher center of gravity, as well as extrinsic factors from overuse or lack of diversity in movement induce chances of retaining injury. Athletes in a growth spurt would benefit from doing additional mobility drills throughout the week. The goal is to move efficiently, although the means are many. Options for stimulation include being ground based or standing, open/closed chain, unilateral/bilateral, upper/lower/full body movements as well as isolated/integrated skills. Mobility training increases not only circulation but activates motor patterns. (Brooks & Cressey 2013, 29)

Research states that mobility exercises improve performance in sprints, plyometrics, agility and dynamic range of motion. Injuries are cut down while stimulation of primary or stabilizing muscles are retrained. Puberty is prime time to improve mobility and gross motor skills. Used before exercise, it is improves motor learning. This smooths the transfer from corrective/rehabilitative exercise to performance /high intensity training. Mobility exercises with resistance improves functional stability. (Brooks & Cressey 2013, 29)

Mobility refers to the range of motion of joints. Factors affecting mobility of a joint include the joints mobility as well as muscle and joint mobility around the particular joint. Mobility is affected by genetics, environment, age, hormones and neural factors. The most important concern is how well an individual controls joint range of motion actively, that is without assistive aides but rather with one's own muscle strength. **(**Soanjärvi) Optimal range of motion is when active range of motion nearly reaches passive range of motion.

Mobility exercises are intended to prevent tight muscles or muscle imbalances. Muscles do not become tight just from sport activities but how youth spend their time outside of training such as siting in school or at a computer desk and staring into a phone for extended moments of time. (Jaakola & Tapio 2015, 96-97) Mobility makes proper technique and clean repetition possible. Without proper technique, power diminishes, more energy is required, and physical development comes to a standstill. Poor technique is compensated with strength and appears clumsy. When there is an attempt to increase development, the use of strength, speed and repetitions are increased leading to risk of overuse injury, this leads to fatigue and the circle goes round. Movement is taken from where it is available. (Kyllönen 2008)

Improving mobility requires practicing different mobility and muscle balance exercises. More importantly focused and controlled sports specific exercises are excellent for mobility. After warming the muscles, one can do dynamic, pumping, mobility and activation exercises. The spine and required joints specific to the sport are of great importance. Individual mobility training is recommended twice a week at 30-60 min. or daily at 10-20min. Variety is the key. (Soanjärvi) Training in an optimal spring type stretch under progressive forces may prevent injuries. Appropriate time for training could be before or after training. (Brooks & Cressey 2013, 27-28)

Direction of mobility and force reaction are important elements in the musculoskeletal system. Movement travels through the pelvic girdle from the trunk to the extremities requiring stability in the joints. Movement control is a musculoneural systems function. Lack of movement control in the pelvic girdle has shown to refer to pain and overuse injury in the lower extremities, pelvis, and back. (Lahtinen 2014)

The sensitive period for mobility is 11-14 years when maximal mobility particularly passive can be reached. From there it needs to be upheld and developed into active mobility. Generally mobility in children is exeptional however, studies show that mobility begins to decrease already at 10 years of age. Mobility is easy to up keep once attained and is worth the effort later paying off. (Jaakola & Tapio 2015, 70-76)

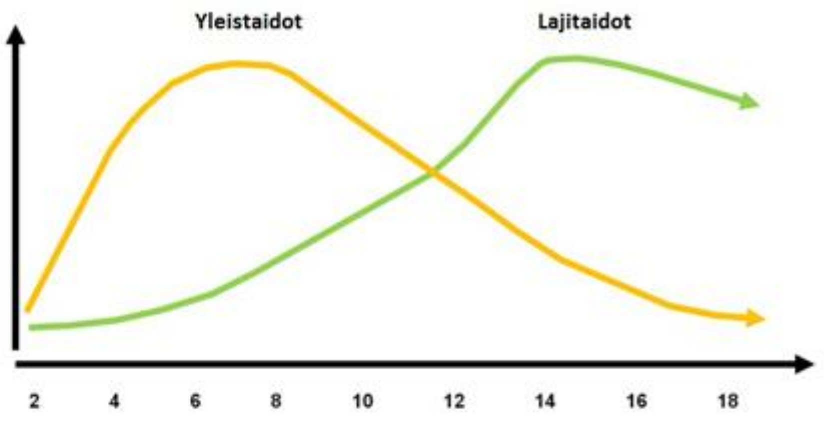

Figure 5. General Skills and Sport Specific Skills Training with Focus According to Age (Hakkarainen, H. Varmentaja-lehti 1/2007).

In Figure 5, it can be seen during the growth spurt that focus is on sport specific skills (lajitaidot) and repetition of general skills (yleistaidot). Sensitivity skills in handling while controlling ones balance during demanding changes of direction are focused on. Of great important is correcting technique to a specified situation and learning new techniques. (Jaakola & Tapio 2015, 70-76)

5 TRAINING MOBILITY

5.1 Stretching Before and After Training

Before training, stretching is short, static or dynamic with gentile flexibility, lasting 5-10 seconds with the intention of checking the condition of the muscle and activating the neuromuscular system. Here coordination and speed/power developing movements are in place. After training, stretches in between 20-30 seconds are used with the intent of recovery of the muscle to a relaxed length and increasing circulation and metabolism. These stretches should be gentile and focus on the feel of the stretch is important as too strong stretches may slow down recovery of neural tissue and cause micro tears in muscle tissue. (Jaakola & Tapio 2015, 97-98)

Stretches lasting from 30 sec. to 3 minutes can be done either 2-3 hours after training or as an individual training session. The goal is to increase mobility particularly to assist muscle and tendon tissue to keep up with bone growth during a growth spurt. Focus is particularly on muscle groups with movement restrictions and stretching should always follow a good warmup for the muscles. Long stretches are done on recovery days to allow muscles to relax and with proper technique or position so as to stretch the intended area. Long stretches and strong changes in muscle length affect the neuromuscular system so that the positional sensory receptors activity in the muscle, joint, and tendon are momentarily not in service. If done before training, balance, coordination, and movements requiring power and speed will greatly be affected possibly resulting in loss of balance, muscle cramps or injury to muscle-tendon tissue. (Jaakola & Tapio 2015, 98)

5.2 Functional Mobility

Functional mobility trained through active dynamic exercises is intended to affect the entire kinetic chain, not just a specific muscle group. Functional mobility exercises additionally develop balance and coordination which traditional stretching does not develop. These exercises are more transferable to the specific sport. Through these exercises, the weakest movement link is more visible. Then, through traditional active or passive stretching, the elasticity of specific muscle groups with restricted ROM can be developed. (Jaakola & Tapio 2015, 99)

Sport Specific Mobility training is intended to obtain and maintain normal physiological range of motion. Requirements in mobility are more demanding due to the competitive nature of sports, however, once obtained movement is feasible preserving energy for movement control and fine motor activity. This further prevents injury from repetition with poor technique and compensations due to muscle and structural imbalances or restrictions. Advisable to be used before training, sport specific exercises activate the neural system, load, and require more maintenance. Precisely during a growth spurt if training is not versatile, muscle tissue is overloaded. (Jaakola & Tapio 2015, 99)

5.3 Flexibility

An element of mobility and flexibility is soft tissue extensibility allowing full range of motion about a joint. However, flexibility does not indicate core strength, balance, or coordination which are prerequisits for functional movement. Chances are muscle imbalances exist. Maximal flexibility is not desired for functional movement. Mobility consists of flexibility and expresses the ability of the nervous system to control movement at full range with efficiency. (Vega 2013)

Neuromuscular efficiency and function improves with range of motion and soft tissue extensibility furthermore relieves loading on joints. Lack of variety in movement loads soft tissues well, however not holistically and therefore leads to injury. Tissue repair begins with inflammation followed by pain, muscle tension, spasm, and adhesions. (Jones 2013) The adhesions are weak and inelastic therefore restrictively altering muscle and neural activation. This leads to the issue where antagonist and force couple recruitment also begin to alter joint motion further and if not treated is left with more permanent structural changes and the circle goes round. (Jones 2013)

According to Davi’s Law, demand and mechanical stress models or heals soft tissues. Elasticity or resilience and strength improves with challenge however over-loading will produce edema and fibrosis along the length of the muscle inducing compensation from where movement is available. The soft tissue will shorten and weaken, reducing neuromuscular efficiency and joint function. Remodeling will continue with the currently available mobility with synergistic muscles. Under demanding physical stress of competitive sports, this will only lead to more injury. (Jones 2013)

Corrective flexibility is static stretching to correct muscle imbalance and develop range of motion about a joint. Static stretching effects the relaxation of a muscle through reciprocal inhibition which physiologically relaxes the antagonist muscle when the agonist muscle is contracted. Autogenic inhibition is used as well, where the GTO organ is stimulated in a tight muscle to relax the same muscle through myofascial release. Corrective flexibility training is appropriate for use in stability. (Jones 2013)

Active flexibility uses active-isolated stretching to increase tissue extensibility and neuromuscular efficiency through reciprocal inhibition through full range of motion such as in a straight leg raise. These exercises are appropriate when strength is adequate. (Jones 2013)

Functional flexibility is dynamic stretching appropriate when compensations do not exist in movement. In other words, extensibility, neural control and efficiency in technique should exist throughout the entire range of motion. With functional flexibility power should be available to be trained. (Jones 2013)

5.4 Fascia Concept Training

Muscle is softer than tendon, so it will elongate. Dynamic muscle loading activates the muscle for a moment in a lengthened position which is the most optimal in stimulating fascial tissues as can be seen in Figure 5. Exercise volume or repetitions are exempt. Only few are needed to reach an optimal effect. It is recommended therefore to train with soft elastic bounces at the end ranges of available motion. Volume of fascial tissue is two thirds water. In mechanical load, stretched or compressed, water is pushed out and once released returns. (Schleip 2013)

Remodeling is accomplished by training elastic storage capacity, counter movement, slow and dynamic stretching, rehydration and proprioception. With loading from multiple directions and springy movement, muscle isometrically contracts while fascial fibers lengthen and shorten. (Schleip 2013) This training improves fiber shaping and pattern through its own elastic mechanism. In Figure 5, active eccentric workloads stimulate multiple facial components, surpassing usual muscle work and classic stretching. Muscle tissue is softer in an inactivated form of stretch and will absorb most of the stretch. (Schleip 2013)

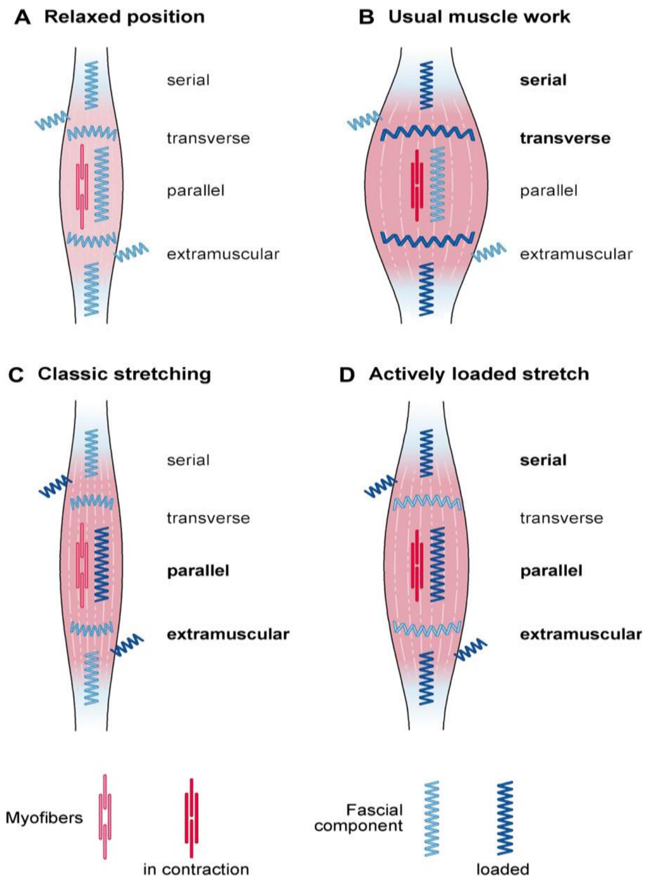

Figure 5. Loading of Fascial tissue (Schleip R, 2013).

5.5 RehabilitativeTraining

Active rehabilitation is sometimes called therapeutic exercise. It is a tailored program which uses a variety of methods including rest, exercises and physiotherapy to speed up the return to full function and to enable athletes to maintain fitness while resting the injured area. It educates the athlete in technique and posture, so that any mistakes which contribute to the injury are not repeated. Aims are resolving pain and inflammation, regaining full ROM, mobility, and strength, improving balance or coordination, and technique. A program usually involves, strength, postural re-education, stretching, flexibility, functional training to correct technique, massage, US etc.(Lowth 2014)

In rehabilitation, range of motion is the first priority in returning to sports activity. ROM precedes mobility which permits intensive physical activity while preventing injury. Exercises begin with flexion and extension proceeding to rotational movements. Active mobility progressed with intensity and resistance follow. Mobility increases by lengthening muscle which increases range of motion. This prevents muscle imbalances and thus injury to joints. These exercises can be continued as part of daily training. (Walker 2014, 40-54)

6 HOCKEY AND PUBERTY

6.1 Hockey movement analysis

The hockey stature in play is a combination of hip flexion, shoulder protraction, and immobilized ankles. Mobility is greatly restricted affecting gait pattern, altering movement, and predisposing injury. Joints must be opened up to regain mobility lost. (Starrett 2014)

According to research literature, skating is characterized by two-foot gliding, striding with variable intensities, and struggling for puck and position. Fast skaters have wide strides using hip abduction, quick recovery after push-off, deep knee flexion at initiation of push-off, and greater hip flexion. Shoulders abduct and adduct in coordination with the hips. Faster skaters have a wider stride, greater distance between strides, greater hip abduction angle, shorter recovery time, lower knee flexion angle, lower hip-skate forward inclination, and lower trunk angle. The biomechanical position of the hockey player is highly stressful where excellent coordination and balance not to mention endurance is necessary. (Bracko 2004)

6.2 Effects on training

The adolescent growth spurt begins from the feet and hands and works towards the center of the body. With this constant change of center of gravity, there is a change in core strength as well as posture. As the muscle become tight and pain is felt in the joints, proprioception is momentarily lost or overstimulated to some extent. This affects coordination of movements, skill in handling a puck or accuracy in making a goal. Skating posture becomes upright and weight shift from leg to leg decreases. Technique will need to be reassessed to develop speed, acceleration, and agility. (Anton 2011)

Preseason conditioning increasingly focuses not on skill but on prevention of injuries. Conditions result in injuries are highlighted during a growth spurt. Contact, repetition or sudden increase in load general to the sport, or related to past injury affect body positions and function which impact the kinetic chain. Abnormal gait patterns develop as well as restricted rotation of the thoracic spine increases instability in the lumbar spine. Also, restricted range of motion in the hips, general tendency of feet to externally rotate and medially pronate at the arch are typically seen. Reasons leading to these restrictions result partially from repetitive skating position and movement, mechanical compensations and restrictions, dominance of synergistic muscles and the inactivation of primary muscles (Jones 2013).

7 MOVEMENT

7.1 Kinetic Chain

The kinetic chain anatomy constitutes of muscle and other soft tissues mapped as muscle function chains. These chains, frontal and posterior, run laterally from shoulder to the feet, along the spine splitting medially along the legs, and crossing from the shoulder to lateral side of the opposite leg just below the knee. Information and power are produced and relayed through these chains as a single bound system. Training mobility here lies its focus on practicing movement derived from muscle functional chains. (Paavola 2012, 1-55)

7.2 Planes of Movement

Movements develop from four planes which are sagittal, frontal, transversal and diagonal. A basic example of a sagittal positon is a forward lunge, a frontal position is a lateral lunge and a transverse position is rotation about the trunk. Often these occur in unison. The knee generally moves in the sagittal direction. In the frontal and transversal the majority of movement needs to be available from the ankle and hip. The hips sagitally move in flexion and extension and work in frontal and transversal directions in abduction and rotation. The lumbar and thoracic spine in the sagittal plane flex and extend while in the frontal and transversal plane produce lateral flexion and rotation which also is possible with sagittal movement in forward flexion or extension. (Paavola 2012, 1-55)

7.3 Elastic energy storage

Elastic energy is stored when muscle is stretched eccentrically and released when shortened concentrically. The frontal chain stores energy when standing in full extension and arms overhead. The dorsal lateral chain is a lunge forward while reaching laterally while a diagonal dorsal chain is a lunge forward with dorsal rotation. (Paavola 2012, 1-55) These are examples of where mobility or the lack there of is affected by the available movement of one as well as its neighboring joint ultimately affecting total elastic energy stored and efficiency in movement.

7.4 Mechanoreceptors

The nervous systems ability to recruit muscles for producing and reducing force such as when dynamically stabilizing through all planes of motion is defined as neuromuscular efficiency by the National Academy of Sports Medicine (Jones 2013). The concentric, eccentric, and isometric movement under CNS control along the kinetic chain determines muscle balance and imbalance by mechanoreceptors in the muscles and tendons. Under excessive stress or tension, the Golgi Tendon Organ is stimulated resulting in an inhibitory response relaxing the same muscle. (Jones 2013)

7.5 Terms and Dysfunctions in Movement

Synergistic dominance is due to the weakness, increase in length or inactivity of a primary muscle dominated by a secondary muscle. These typically have a single function, are local, function to stabilize, and are smaller with slow twitch. (Jones 2013) A primary example would be tightness of the hip flexors resulting in the inactivation of the gluteus maximus. For extension to occur, synergistic or supporting muscles compensate such as the hamstrings. This leads to dysfunction about the joint and ultimately injury such as muscle strain. (Jones 2013)

Relative flexibility is the tendency, in functional movement, to find the path with optimal efficiency. An example of such would be excessive external rotation during a squat at the feet or when pressing overhead, excessively arching ones back. (Jones 2013)

Muscle imbalance refers to changes in length and tension about a joint due to postural or emotional stress, over use and repetitive trauma, as well as lack of proper technique, core strength or neuromuscular efficiency (Jones 2013).

Arthro-kinematic dysfunction is restricted muscle and neuromuscular activity about a joint due to forces derived from synergistic muscles as a result of imbalances in length and tension as well as couple relationships (Jones 2013). This inefficiency in movement is a domino effect due to one initial positional change altering joint motion and increasing stress along the kinetic chain, eventually leading to pain and possibly further alterations.

8 MOBILITY EXERCISE PROGRAM

Mobility exercises, during a growth spurt when muscle tightness is greater, can be done individually as longer sessions or in multiple short ones. Passing warm up prior to training is not an option. Core muscles must be warm. Exercises may be done upright or on the floor. Multiple movement patterns exist to choose from such as open or closed chain. Exercises may be done unilaterally or bilaterally using the upper, lower or entire body. Particular areas may be improved by isolating or integrating specific skills. The point of focus is efficient movement, developing motor skills, preparing mentally and physically for an upcoming event, practice, or game. (Brooks & Cressey 2013)

To ease or simplify a complex task, focus on the final result of the action or task at hand. Exercises that are commonly known are excellent for use as testing mobility. Stability and mobility at all anatomical levels should be checked and documented for injury risk. Very common and well known exercises include the Inchworm, Deep Squat, Standing rotation, Inline lunge, and Pushup. These will take into consideration ankle, knee, hip, thoracic and shoulder mobility. (Paavola 2012)

These are similar to common exercises from the Functional Movement Screen. Other similar exercises can be found in Ashtanga Yoga when mobilizing through an asana as well as in Fascial Technique training.

A point to remember is that during a growth spurt, a youths global self-concept, perceived physical competence, cardio-respiratory and muscular fitness, BMI, flexibility, physical activity or sedentary behavior is ever changing and individual, and finally, distorts the accuracy of the athletes athletic skills as well as others perceptions of them. (Jaakkola & Tapio 2015)

Following, in Table 1, is a chart of a variety of mobility exercises from different sources with the area being affected. These few of many exercises were chosen for desired effect and interest of comparison. From here, the coach may choose tests or exercises to assess where mobility is lost and direct the athlete which exercise he should focus on from his mobile phone.

The online network video is edited with Sony Vegas Pro with the help of the coach requesting this thesis and my son who is performing the mobility exercises. The video contains some direction and in length is 3min. 30 sec. with 10 mobility exercises. The link with the exercises is available to be distributed by the coach.

Table 1. Chart of Exercises (Paavola 2012, Jaakola & Tapio 2015, Brooks & Cressey 2013, Scleip 2013, & Räisänen 2013)

	Discover Movement	Nuoren Kiekkoilijan Treenikirja	Functional Movement Screen	Mobility Training For Young Athletes	Ashtanga Yoga / Fascia Technique
	Ankle, Thoracic	Back Hamstrings			
Deep Squat	Ankle, Hip Knee, Thoracic		Hips, Knee, Ankle, Shoulders, Thoracic Spine		
Standing Rotation	Ankle, Hip				
Leg Swing		Adductors, Ankle			
Lunge	Knee Hip			Hip (spider man)	Hip, Ankle (extended/in line)
Cradle Walk		Gluteal Muscles, Hip			Hip. Glutes, Hamstrings

Active Leg Raise (supine or standing)			Hip, Hamstrings, Calves (supine)		Trunk, Ankle Stability, Hip Flex/Strength
Lateral Lunge with Rotation		Adductors, Spine			
Scissor Kicks Supine/Prone Side		Hip, Spine			Fascia (Hip, Spine)
Posterior Medial Lunge with Rotation		Abductors, Lateral Chain			
Lunge with Extension		Hip Flexors, Hamstrings, Posterior Chain			
Lunge with Rotation		Hip Flexors, Spine			
Ear Pressure or Forward Bend Pose		Spine Note! Do with control			Spine
Push-Up (to lateral)	Thoracic		Trunk Stability		Shoulder, Spine (extension)/ Fascia
Dog Pose w/ push up and rotation/cross reach		Calves, Hamstrings			Calves, Hip Hamstrings, Shoulders
Hurdle Step			Hips, Knees, Ankles		
In-line lunge			Shoulder, Hip, Ankle		
Rotary Stability			Trunk Stability		
Shoulder Mobility			Shoulder, Scapular, Thoracic Spine		
Bridge (Pose)				Hip	Anterior Chain, Wrist, Shoulder

Myofascial Release		Thoracic (foam roll/tennis ball)		Calf (roll, tennis ball), Barefoot (strength/proprioception)	Fascia Foam Roll
Scapular Wall Slide				Shoulder. Scapular Stability	
Front Stretch Pose					Shoulder, Ant. Chain, Wrist / Fascia

9 THESIS PROCESS

The thesis process began with searching for a topic in the first planning seminar, followed by developing a plan as well as the assignment of an advisor in the second planning seminar. Here the first topic was chosen which was concerned with exercises for youth wheel chair basketball players. For a number of reasons this did not follow through. In the fall of 2014, during the third planning seminar, the second topic was chosen which was sitting posture for daycare personnel. This also did not follow through. During this time researching and opponent responsibilities were the point of discussion. Then, in the beginning of 2015, the opponents present their second phase and writing begins. The third topic was chosen in August of 2015 which is the current one, Online Network Mobility Exercises for Boys Playing Hockey During an Adolescent Growth Spurt. This topic was delegated by a coach on behalf of parents with children playing hockey during an adolescent growth spurt. At this point, observing the boys training and mass gathering of information on the topic was done until the February of 2016 when the writing and discussion of wanted information was completed in addition to the video put on line with my son Jeremy Rouvali presenting the exercises. The maturation exam and defense of the thesis was presented on the 22nd of March 2016 with date of planned graduation in April of 2016.

10 DISUSSION

Many thesis have been written about mobility as it has become quite popular in the last few years. Research has opened up different methods of training mobility such as fascial training. The fascial training concept is presented in addition to other conventional methods pointing out benefits in attempt to pull together a holistic approach. Positively, more information is available about mobility to coaches through cooperation and mobility has more so become a part of training. Due to the increased number of children participating in competitive sports, coaches are being challenged when individual improvements need to be addressed particularly in the growth spurt when change is occurring all the time. Time is limited as well, so athletes are left to warm up and down as well as do mobility exercises on their own. The need for mobility exercises is not new. Many thesis on this topic often reiterate in results however, the problem of interest and compliance on the part of the athlete. This thesis leans on the fact that multiple hours are spent off training on a personal electronic device and education is the number one producer of change. If becoming a professional athlete is the goal, then reading this thesis may be an eye opener.

A future topic could be to give athletes in the midst of puberty an interesting lecture discussing the concept of mobility and what it means and requires to become a professional athlete. Also, a study on combining hockey and gymnastics training would be beneficial for children beginning sports at an early age as compliancy is something easier learned at a younger age.

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