

Bases of 15s rugby player's physical training in Finland

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<p>This portfolio work is systematic literature review about physical demands 15 aside rugby and conditioning methods for it. These papers are included in appendices with simplified guide to laws and terminology of rugby union game. Papers are aimed to give aid for the advanced men's 15 aside union rugby players and their coaches in Finland.</p> <p>Work starts with the introduction of the work with targets and how the work is executed. Second chapter includes a short history of rugby union game, rugby in Finland, and about scientific approach used in rugby. There are short abstracts of two different papers about the physical demands in men's 15 aside rugby game and methods for conditioning in men's 15 aside rugby.</p> <p>Rugby is a physically demanding ball game which lasts 40min each way. Athletes need to have great fitness, when they continue the battle until the end. The game is full of contact while defending team tries to avoid losing the ground and attacking team is invading to the opponents half. The physical demands of rugby goes higher with the level of the game. Physical conditioning for players need to be well coached to avoid injuries and to be successful in the long term.</p> <p>This work is created with approval of Suomen Rugbyliitto (SRL) and intended for their use. It can lead to the other works and projects for the further rugby player and coach development in Finland. The knowledge of training rugby in Finland relies on IRB courses, individuals who have experienced rugby abroad, and to those who have been born in the country with strong rugby culture. Still, approach can be quite from amateur bases. On the another hand, Finnish sports and sports science is well known in the world, but on the another hand it don't involve rugby. Respectively, I wanted to combine the science of rugby from the world and my personal understanding of sports from Finland, and deliver it into the form that is understandable for people involved in elite rugby in Finland.</p> <p>As the results of this work are the list of different conditioning methods for rugby players, the update of the physical conditioning, and yearly training plan for the Finnish seasonal structure. Comparing the physical test results between Finnish top rugby players and the top of the world it is possible to recognize. Finnish rugby should target the improvement to power, endurance and positional physical training to lead short and long term results.</p>	

Theseus

rugby, method, training, coach

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1 Introduction

The spark for this work came from my concern about players who want more from rugby. Can we offer something to them here in Finland? The target of this work is to serve rugby players who are aiming for more as an athlete, to develop themselves as a person, to challenge a position in the national team in Finland or even preparing themselves for moving abroad to play. We want to have more of these kind of trained athletes in our National Teams. Then we can start to expect to get our selections higher in International Rugby Board's (IRB) ranking.

IRB educates coaches in strength & conditioning courses level 1 and 2. These courses are really good in examples and materials, even online. This is all good, but we look the rugby from the different angle in Finland. Our history in rugby is short, our culture is different, and our game season is shorter because of long winter. We need to adjust all available to our use. I wanted to open more of the rugby's physical demands, where those demands come from, and to give a wider perspective in this work. There is also extra training methods what players can especially use in their own time training. It was needed, because we don't have a possibility to arrange many conditioning sessions in team trainings. That is a challenge here in Finland, because of amateur level of the sport. Players who want train more and develop themselves suffers from this. Here is some methods for them. Season structure is different than in most of the rugby countries too, and also periodization of training is need to be different. There was a need to find the best ways for the planning physical training to Finnish season structure.

In portfolios part 3 and 4 are short introductions for the papers in appendices. In these parts I rise main topics, what have come up in literature and papers and I want bring more on the table. These are the main big topics where we need to look at if we want have a safer game. Increased amount of collisions and raised intensities need to be our concern because danger of injuries. Coach's responsibility is to prepare players for it. Now when we play more and rest less during the game comparing to earlier. Our training habits should change and there is a positional and role needs for different endurance training. Resistance training will be big topic if

we want develop our national team to the next level, but also avoiding injuries. All the players need resistance training to play rugby safely.

1.1 Target group

We have rugby players in Finland who are spending hours and hours in the gym, racing on the running track, wrestling, play another ball sports aiming to develop themselves as a rugby player. These athletes can use all their time searching ways to improve and guessing what would be the best for them. The selected papers are aimed to help the players who have trained one year four or more times in a week to get the platform for more intense training. Also it's easier for the club coaches to support their players in their higher targets by studying these papers.

1.2 Target and execution to this work

The target to this work is to give aid for the advanced players and coaches. We are in a special situation here and we need to adjust our activity to it. Teams need to have their training periodization for the Finnish seasonal structure. Players need to have tools to use in their own time training. These are the main points what I cover in this work, but also the reasons, the demands of the game why players should train like this. This should be the base for physical conditioning in Finnish 15's rugby with IRB strength & conditioning courses. From here we can produce material for the needs what will come up.

This work should help making difference between effective trainings. What are the physical demands of a rugby player? What kind of methods work for improving abilities needed in rugby? Is all the work that coaches and players have been doing really effective and if yes, how does it affect? Can we learn something from the scientific approach in sports? I try to answer these questions in two papers **Physical demands of men's 15 aside rugby union game** (appendix 3.) and **Condition methods of men's 15 aside rugby, Finnish amateur players for the national team level** (appendix 4.) by finding hard evidence from the sport science and giving my selection of ways and methods to improve rugby players to the higher level.

I went through IRB's materials, papers related to rugby from internet, and read literature about rugby conditioning and physical performance. Few books have been on top of others and greatly admire their editors. Complete Conditioning for Rugby from Dan Luger and Paul Pook was the first eye opener, when I bought it 2010. They are both experienced in rugby conditioning, but Paul Pook especially is well know about his innovative approach to rugby conditioning. He has trained elite athletes in other sports too, which gives broader perspective to physical conditioning. Second important book was Tudor Bomba's books about periodization of training. These books helped to put together the seasonal training plan for the Finnish rugby season. Third and most affective for the physical demands paper was the Rugby Science what was published in the end of 2014 from Graig Twist and Paul Worsfold. They have found a good way to connect the theory from more than five hundred studies and applied in practice.

I had also a privilege to have one month school training in Sport Lab in same premises with Kilpa- ja Huippu-urheilun Tutkimuskeskus (Kihu) in 2014. That was a valuable time to discuss and ask questions from top researcher in Finland. It was also possible to see top athletes in action, what helped to realize connections between theory, science and practice. I got also advice from the University's sports faculty in Jyväskylä for the resistance training part. Conditioning Methods and Periodization of Training courses in Coimbra University were really good platform to start producing this work.

2 Rugby union game

Rugby Union game is played between two teams fifteen players each side. Every player has their special role in the team. It is a thrilling and very fast game where every player need to know how to pass the ball, run, tackle and handle skills for their special roles. Rugby is a game of invasion where attacking team simply tries to push the ball opponents half by running with the ball, but also kicking tactically over the defenders and trying to get hold of the ball again. Rugby is a tactical game where is a lot of planned patterns of play, but it also is problem solving game like most of the ball sports. It is a collision sport which is really demanding physically because not only players need to be strong in wrestling, collisions and tackle situations, but also fast in sprints and have great stamina to last whole rugby game. (Greenwood 1997, 3-20; Twist & Worsfold 2, 2015.)

Game lasts two times 40 min with 10 min half time. The field (Appendix 1.) for the game is 68m-70m wide and 94m-100m long. In the both ends of the field is try line. When player puts the oval shape rugby ball to the ground it means five points on the score board and after team has scored they can try two point conversion kick (place kick). Player can do a field goal by kicking (drop kick) the ball through the posts and score three points. Successful penalty kick (place kick) also means three points for the team kicking team. The game is judged by the referee in the field with assistant referee on each side of the field. (IRB 2014.)

2.1 Short history of Rugby Union

Rugby is a football game that has been played since 19th century. There have been a lot of rugby football kind of games where ball is carried also with hands through the history. Example the game “Harpastrum” already in Roman Empire which have found to be stolen from the Greeks. Yet the name for the game has come from the incident in Rugby school in England 1823. Boy named William Webb Ellis took the ball in his hands and carried it to the goal. This is the tale what is told, but it seems that other pupils were more related to this rugby kind of game in the school. Still, The Rugby World Cup trophy for the winner of the tournament is named after

him. (Smith 1999, in Implementation of a new sport – The strategy and difficulties of introducing rugby as a school sport in Finland Flörchinger 2002; Trueman 2007.)

Football was the first game to establish its rules and association in the beginning of the 19th century. Rugby followed later and Rugby Football Union (RFU) was established in 1871. Rugby Football Union was fully amateur and in “The Great Schism” 12 clubs from Northern England who wanted to pay to their players formed Northern Rugby Football Union (NRFU) which later turned as a Rugby League. These payments were more of a compensation for lost salary. Many of the players were working Saturdays. The laws of the game started to change in these divided unions. Rugby Union is played in Finland. (Rookwood 2003, Trueman 2007.)

Rugby Union turned into a professional sport 1995 which changed it quite a lot (Trueman 2007). Top level rugby is professional in domestic leagues in many countries and the very top club teams are playing against each other in leagues over the borders ex. European Champions Cup in Europe and Super Rugby 15 in New Zealand, Australia and South Africa.

It is a growing sport all around the globe and in 2013 there was 2,36 million registered players and non-registered estimated to be 4,6 million (IRB 2013) in 119 countries. 1,5 million were females. It is quite an increase altogether from 5,5 million in 2012 (IRB 2012). Even though there is a big increase in non-registered players, it creates good base for professionalism by increased rugby followers in the world, as the biggest rise has happened in new rugby countries through new “Get in to Rugby!” program. Project reached 200 thousand participants in small developing rugby countries (IRB 2013).

Rugby have been in Summer Olympics four times between 1900 – 1924 only two or three countries taking apart. United States won two gold medals, Australia and France one (Jukola 1947, Implementation of a new sport – The strategy and difficulties of introducing rugby as a school sport in Finland Flörchinger 2002). Rugby game is back in the Olympics, when Rugby sevens was selected to the Summer Olympics 2016 and 2020 which is a big promotion for rugby.

Rugby Union is one of the most played ball game in the world and the Rugby World Cup tournament also is one of the biggest sport events. The World Cup in Australia had 3,2 billion TV audience in 2003 (IRB 2007). Next world cup will be in London 2015. IRB expects TV audience to rise to 4,2 billion in there (IRB 2012). It will be the eight official tournament in rugby history, where twenty qualified countries compete against each other. The biggest rugby countries to challenge for the title are England, France, Australia, Wales, Scotland, Ireland, Italy, Argentina, and New Zealand and South Africa where rugby is their national sport. The World Cup tournament is held every four years. (IRB 2014.)

2.2 Finnish Rugby Federation

1960's Tahko Pihkala invented a game named Salamapallo which is close to rugby. Tahko Pihkala had visited in Scotland and wanted to bring rugby game to Finland. He did not find contact game to be so familiar for Finnish and invented a game Salamapallo which is close to rugby but without contact. Salamapalloliitto (Salamapallo Federation) was established 1968 and those were the first steps for **Suomen Rugbyliitto** (Finnish Rugby Federation). There was small and number of clubs in Finland playing against each other in 80's. Games were also played against other Scandinavian teams and visiting naval teams. There was National team activity in that too, but early 90's activity degreased and arranged fixtures hardly existed. Rugby started again in Helsinki 1999 when enough interested players join to throw the ball around in the park and Helsinki Rugby Union Club was formed. Soon other club followed in Jyväskylä 2000 and then other clubs started to emerge. Finnish Rugby Federation was established 2001 when it became a member of **International Rugby Board** (IRB) and **Federation Internationale de Rugby Amateur - Association Europeenne de Rugby** (FIRA-AER). (Flörchinger 2002; Suomen Rugbyliitto.)

Rugby Union is a growing minor sport in Finland. Finland had 2,701 players all together enjoying rugby in 2013 (IRB 2013). There has been a growth from the year 2002 when Men's played their first championship with five teams. 2015 there are 10 teams in men's championship and 6 in 1st Division. Women started to play their official games 2006 and league contains six teams now. Finland has a national team in men's and women's 15 rugby, women's

sevens rugby team and U20 boys team. Women's sevens team has been most successful. They finished in 18th position in Europe 2014. (Suomen Rugbyliitto.)

2.3 Rugby culture in Finland

Rugby is a social sport with a competitive environment and offers a hobby for many. There are plenty of players who are happy to have a good time in the training few times in a week, to have a ball game in the park, and have few pints in the pub after. Rugby culture in Finland is not that characteristics as it is around the world. Still the idea as a hobby is the same. Come together and enjoy the game. There are players who feel themselves more as an athletes in Finnish rugby too. They have passion to improve themselves as an athlete, reach to the top of their capabilities, and to be selected for the national selection.

It seems that the sport activity is more important than the social part in Finland compared to the old rugby countries. Games and trainings comes first and maybe socializing comes after. Good amount expatriates brings reminder about rugby culture from abroad. There are two main social rugby events every year in Finland, where Finnish rugby family can meet. Jyväskylä Snow Rugby is in February or March and Midnight Rugby Tournament in Helsinki in the middle of June. (Flörchinger 2002; Midnight Rugby Tournament 2015; Snow Rugby 2015.)

2.4 Science in rugby

Increased amounts of rugby followers brings good money for the professionalism. The pressure for the development is again higher but also establishes new possibilities. There is money for the research and more and more new information has been available since 1995 when rugby union became professional sport. To give a picture first television contract from the Super League brought South Africa, New Zealand, Australia Rugby Unions 340 million pounds. The demands of the game has changed also, the laws of the game have changed, and

information from the research can become obsolete quite fast. (Luger & Pook 1-2, 2004. Ryan 2008.)

Normal ways of measuring internal loads during the match is difficult. Wearing oxygen mask on the field is impossible and getting reliable blood samples from all the players is hard to arrange. There is some researches where blood samples have been taken from small group of players before the match, at the half time and after the match to collect information. It gives accurate information from on players' internal loads in the game but in small amounts. Normal Heart rate (HR) monitors or Firstbeat's EPOC (Excess post-exercise Oxygen Consumption, expressed in ml/kg) monitoring are easy tools to collect large amounts of information about internal loads (Firstbeat). It is not as accurate as lactate samples from the blood, but it is easy way to deliver feedback to the athlete. (Keskinen, Häkkinen & Kallinen 2004, 51-124.)

Development of GPS (Global Positioning Systems) tracking system has brought needed information on the movement analyses during the rugby game. Multiple camera systems offers information on the external loads for the individual development, making differences between roles and playing positions. It gives new valuable information by HR monitoring for the conditioning in rugby and understanding the demands of the game. (Twist & Worsfold 55-64, 2015.)

Monitoring internal physical loads during the game is challenging. When we come back to the training situations and training loads it becomes easier. We can stop the activity during the session to collect accurate information on athletes' training loads through blood samples, or even find out the maximal oxygen uptake (VO₂ max) in the laboratory. This information coaches can use for accurate training plan. Feedback about the internal training loads can be collected easily with HR or EPOC monitoring. Normal tests used for the other athletes apply for the rugby players as well. (Keskinen, Häkkinen & Kallinen 2004, 51-124, 208-210.)

3 Physical demands of rugby: Abstract for appendix 3.

This paper tries to clarify the physical demands of rugby game. New technology GPS and multiple cameras can bring new information about the external demands on loads and intensities as a team and individual role on the field. Through this new information we can improve the physical activity in the team training and in the training also made in players own time.

Difference between now and before professionalism is huge. Game has developed and players have developed. Ball stayed alive ~13% (10,4 min) more 2013 than 1977 in 80 min game. This changes many things in physical demands on the game. Many things happens in ten minutes. Demands for the physicality between playing roles have increased and specified but anthropometry has stayed quite much the same. (Dawson 2013, IRB 2013, Luger & Pook 2, 2004.)

3.1 Distances covered and movement intensities during the game

Players are running different amounts during the rugby game, different intensities and cycles. This data is easy to collect when we have good equipment for it. We know this now because GPS tracking is available during the game. Prop forwards runs less (~5158m) amount than back row players (~6083), Scrum half covers the greatest distance (~7098m) during the game. Backs have been staying more time in high speed zone over 20km/h than forwards (b 524m, f 313). Backs entranced to the high speed zone more frequently during the game (b 34, f 19 times). This tells us about the flow of the game. Forwards are used in short sprints where they don't even find their high speed before the contact and backs are used to chase the kicks and have more space to accelerate to the high speed zone. This all we expected, but now we know for sure. (Cahill et al. 2014; Duthie et al. 2005; Gabbett et al. 2012b; Waldron et al 2011. The Science of Rugby Twist & Worsfold 2-5. 2015; Hendricks et al. 2014.)

3.2 Collisions have big role in rugby today

Amount of tackles have increased from 46->126/game in Six Nations Tournament between 1996 – 2015 (Five Nations Tournament before). There can be 125 rucks and mauls in the game, and 14 scrums in international level where players take part. In those contact situations and other collisions forward can take more than 1400 impacts and back player over 700. This really brings our attention to safety. (IRB 2013, Luger & Pook 1-2, 2004.)

Players are training to be stronger and powerful every day. When we calculate all this training and amount of collisions we need think how to play this game safely. Players need to be fit enough to play cycles between 4 - 45 (or even more) seconds and recover from those in ~43 seconds to full fit. During those cycles players need to be strong enough to resist forces from opposite team players and stay explosive to move effectively on own body weight. (Luger & Pook 1-2, 2004. Twist & Worsfold 4-5. 2015.)

4 Condition methods in rugby: Abstract for appendix 4.

Condition methods in rugby have been made for advanced players and coaches. They need a broad understanding of methods used for physical conditioning. The variety in methods is quite wide and need good understanding what kind of training individual can train and what will be beneficial. Many of the trainings are quite basic and good to almost any healthy player. Using maximum weight methods and Olympic lifts in training programs need experience in gym training before starting. Plyometric training can be harmful if the techniques are not corrected before intensive power training. (Beachle & Earle 2008, 84-87, 387-388, 422-425.)

4.1 Resistance training is important in rugby

Muscle tissue takes the edge of from the impacts in collisions. That is the reason already for the rugby player to go to the gym. Getting stronger by getting bigger muscle size through hypertrophy is a good way start with. These kind of body building methods doing longer sets slowly, also are a safe to begin gym training before explosive movements and bigger weights. When players are more advanced there is little need to do movements in the gym slowly if they are not injured, warming up, or learning a new technique. Power training is essential for developing neural pathways in muscles to be stronger and faster in the rugby field. Force, velocity and power are the crucial components of successful rugby player. Power training divides more cyclic training for the backs and more acyclic for the forwards especially in the pre-season. (Appleby et al. 2012; Argus et al. 2010; Baker 2001b; Baker and Newton 2008a; Corcoran 2010; Coutts et al. 2007; Hansen et al. 2011b, *The Science of Rugby* Twist & Worsfold 19-20. 2015.)

Doing resistance training with own body weight is important to avoid injuries. It is recommendable to do most of the strength training with whole range of movements. This is better to do without extra weight, but same time movements can more complex too. Own body weight is better in safety, in less time consuming, needs of little or no facilities, and less need of equipment than gym training. Players can build their own training sessions that can

include intensive functional movements, but can come down to important slow motion neck and upper body movements. These kind of trainings are easy to arrange also as a team session. (Koivuranta 2015.)

4.2 Players needs mixture of endurance training

Like Dan Luger 2007 has named rugby fitness training as a fuel mixing training. During the game players need be as explosive as possible through anaerobic energy system, but as lactic acids appear and aerobic energy system need to help in recovery. Rugby players, especially forwards, also need to train lower pace interval trainings to ensure the base for the other training in the beginning of the training season. Too long aerobic training can reduce the power production and it is not recommendable. Endurance training should follow the cycles of play from 5 – 62 second work periods and 43 second recovering cycles. This varies between players roles in the set pieces. (Luger & Pook 1-8, 183-215.)

4.3 Programing physical training

In the long *transition phase* (off season) players should concentrate increasing aerobic endurance and get wanted body composition. Smaller players should get some weight by increasing muscle mass and bigger players need to adjust their fat percentage after competition phase and transition phase. *Preparation phase* should concentrate player's power development and general rugby fitness. *Specific preparation phase* is game fitness and power training for playing roles. Competition phase need to be power and strength maintenance in training wise. (Bomba & Haff 2009, 125-135.)

5 Discussion

Rugby have changed a lot in twenty years. After going through the rugby literature this became clearer. We are playing different game now and we need to adapt to it. The state of rugby is quite good in Finland. Clubs are running and Finnish national teams both men and women are

in good trails. National teams have good coaches and they have long term plans, hopefully patience too. When these motivated athletes bring their experience and sporting lifestyle back to the clubs there is an effect to many. Coaches just need little bit resources to start something bigger.

Finnish rugby players are quite far away from the top if we look at the references, but that physical development is the best way we have. Greater physicality comes with the training and good long term training plans. Solid systematic testing and monitoring plans in to the national teams and from there step down to the club teams. The results what clubs have collected it is not systematic and it has a little value at the moment. There is a clear challenge what we need to improve. *Appendix 5-8* we can see the collected results from two main clubs in Finland. It is really hard to get players motivated to be tested for use of their own personal development.

When we compare results from our top players to the top of the world (*Appendix 3. The Physical demands of Rugby, Appendix 1-3*) the biggest difference is in aerobic endurance levels. All measured NT players are below “>need to improve” column comparing to their own playing positions, and still there is distance to the top. The Bleep Test is common test everywhere and we can compare a little to give a little idea. In strength levels Finnish top players are quite close to the lowest international levels. Strength training culture is in place and if players get good aid for the next step many will reach the international level. Few ideas for the next steps for the physical development. Power training should be included to whole year training plan, concentrated endurance training in the beginning of the general preparation phase, positional training plans, also more demanding training, monitoring and testing for the National Team players.

It takes too long time to wait everything happening through IRB resources. After going through all the material for this work it is a lot to share. As a result of the work we can keep a good collection of training methods, the update for physical conditioning knowledge and training plan for Finnish seasonal structure. Using this material as a base, there is plenty of chances to arrange courses and workshops for the coaches and players in training camps. We are looking too much to the next match and long term planning for the player development

stays as a state of vision. Finnish rugby should put players to work to themselves by given them clear targets and methods to get there.

This kind of literature review should be done with someone else or in small group. That would give possibility go through more material and having active discussion about ideas. Documents in appendices were almost ready when I shared those with seven rugby coaches and experienced players who knows men's rugby in Finland and understands rugby conditioning. Discussion was resourceful.

It was nice to hear good feedback. There is good facts in the documents and good points risen. Pretty fast discussion was "What next?" There is material for new, and more accurate productions. I was meant to attach a document about testing and monitoring players in Finnish rugby, but time frame didn't give possibility to do it. Creating testing procedures for the national team would motivate players to increase the level of physical performance in Finnish rugby. I know it's time consuming and challenging that way, but I can also see the long term development for the game.

Other ideas suggested that could be beneficial was injury prevention work and strength training for beginners. Injury prevention and training for beginners are quite big topics to cover shortly. Collisions in the rugby game appeared a lot in the paper, and it should be written open as own review. Somehow these ideas should get down to the field where can be sure that it is used. How we can motivate people to come to develop themselves, when we are arranging courses and workshops for the coaches and players? Someone should be a person to get people interested to see the reasons to good and efficient training. This is the only way to have healthy athletes and so on long term development.

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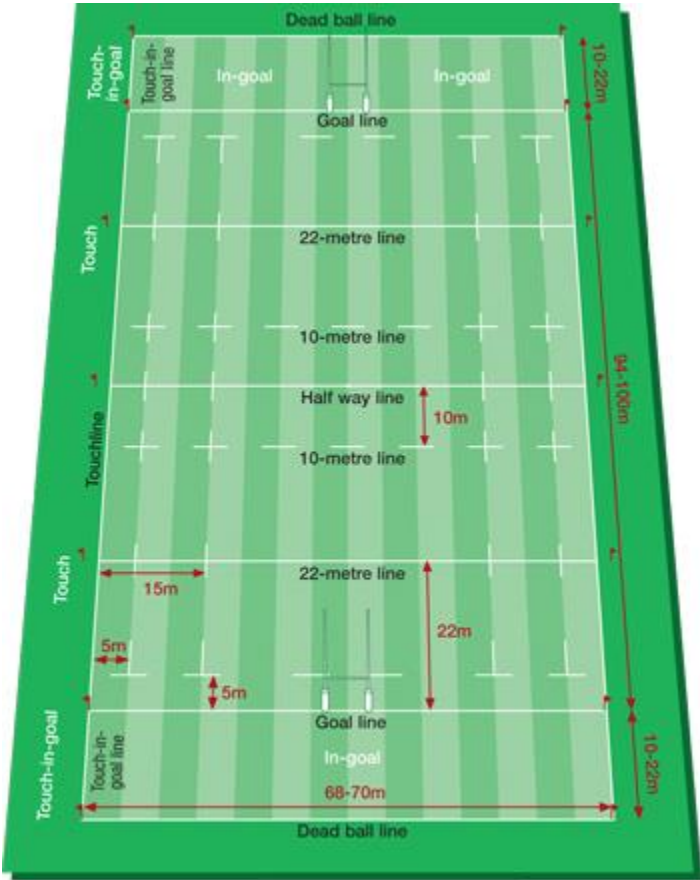
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7 Appendices

Appendix 1. Rugby field



The Plan

Appendix 2. Understanding Rugby a simplified guide to the laws

There are two variations within rugby union, the fifteens game and the sevens game. The guide here reviews only the fifteens game. The rules may vary for age grade rugby. This guide is offered to help those who are new to fifteen Rugby to follow and enjoy the games which you are reading about and watching on television.

Players

Rugby teams are made up of fifteen players plus up to seven substitutes.

Equipment

Players may wear thin, soft padding to protect their shoulders and heads as well as mouth guards.

Referee

Officials include a referee, two touch judges, and an official in charge of substitutions of players.

Score

Points are awarded for a 'Try' (5 points) and the subsequent Convert Kick (2), a Penalty Kick which goes over the goal post crossbar (3), and a Drop Kick during play which goes over the goal posts' crossbar (3). A Try is similar to a touch down in Football, except that the ball must be touched down on the ground. I know what you're thinking: In Rugby a Try is awarded for a successful score, and in football a touchdown is awarded when it isn't touched down? Right! In Rugby the Convert Kick must be attempted from a place in line with where the Try was scored.

Forward pass

During play, all players may pass, kick or run with the ball. A forward pass is illegal, so the ball must be passed sideways or backwards to another player. 'If the ball cannot be thrown forward, how does a team advance?' you may ask. Well, very often, the ball is passed to a player who has the opportunity to run through the opposing team's defense.

Tackles

Any player with the ball may be tackled, but blocking by team-mates is not allowed. When a player is tackled to the ground, play continues if the tackled player passes the ball without delay or places the ball on the ground and lets go of it. The tackler must release the tackled player and both players must then get up or roll away from the ball. All other players must stay on their feet at a tackle. If players interfere by 'going to ground' to prevent a fair contest for the ball, a penalty

kick is awarded. If players accidentally 'go to ground' after the ball has been fairly contested, they too must roll away or get up again. Now the above can look chaotic as players from both sides try to win possession.

Ruck

They usually come into contact and form a 'Ruck' over the tackle situation where each team tries to push the opponents back so that possession can be gained. Players not taking part in rucks must get to their side of the rucks without delay or they are off-side. Because of this, when the ball is won from a ruck, there is room to play - and play continues.

Maul

Often, a player with the ball is held by an opponent but not tackled to the ground. When other players join in it is called a 'Maul', which is similar to a ruck - except nobody's on the ground and the ball is being held in the hands of a player who is trying to get it back to his team. Sometimes the ball is deliberately kept in a maul if a team can drive up the field. When such a drive stops, the team with the ball must pass it out without delay so that play may continue. If this does not occur, a 'Scrum' (described below) is awarded, and the opponents are given the throw-in.

Scrum

For minor stoppages (e.g. a forward pass or the situation described above) the game is restarted with a Scrum. Eight rather large (!) players from each team bind tightly together and crouch in a shoving position before being allowed to engage their opponents. Legal binding in a scrum forbids more than three players from each team to make contact with the opponents, so the usual pattern for each team is to have three players in the 'front row', four in the 'second row' and one player bound in at the back. Because the players are crouched, a tunnel is made between the front rows. The ball is put back into play when it is thrown into the centre of the tunnel so that each team has fair opportunity to gain possession, using only legs and feet. Players in a scrum must stay in the scrum until the ball comes out. Players not in the scrum must go behind the back player of the scrum to allow the team which wins the ball room to play on.

Penalty and free-kick

For cheating at restarts a Free Kick is awarded. The opponents must go back 10 metres and the team given the free kick may kick the ball in any way (punt, drop kick, tap), but they cannot score directly from it. A Free Kick may also be awarded to a defending player who calls for one when catching the ball within 22 metres of the Goal-line. For serious offenses, including foul play, the game is restarted with a Penalty Kick. Opponents must go back 10 metres until the ball is kicked, and the ball may be kicked in any way (this time including field goal for three points).

Line-out

If the ball is kicked into touch from a Penalty Kick the kicking team is awarded the throw-in. With the exception of the Penalty Kick to touch, when the ball - or a player carrying it - goes into Touch the game is restarted with a 'Line-out' where the ball is thrown in by the team which did not put the ball into Touch. You've guessed it - the same bruisers who take part in the scrums take part in the Line-out. It is formed when these players from each team form two lines a metre apart across the field near the touch-line. The ball should be thrown straight into the gap between the lines, and the players jump to gain possession. To add a little spice to the contest, jumping players may be supported at or above waist level by teammates. Jumpers may catch the ball or throw it to another player waiting to catch it. All other players not involved in the line-out must move 10 metres back towards their goal-lines so that, when the ball is won, the teams have room to continue playing.

Off-side on kick

One last point: When a player kicks the ball, all team-mates in front of the kicker are in off-side positions and cannot run towards the opponent who catches the ball until the kicker (or another player who was behind the kicker) runs by them, putting them back on-side.

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8 The Terminology of Rugby

Advantage Law - Allows play to proceed after an infringement in the case of the non-offending team receiving an advantage.

Attacking Team - The team in possession of the ball.

Backs - Players who spread out and attempt to run the ball delivered from a scrum or lineout.

Dead Ball Line - The limit to which a try can be scored beyond the goal line.

Defending Team - The team not in possession of the ball.

Drop Kick - A kick made after the ball has reached or bounced off the ground. Worth three points if it clears the goalposts; also used to restart play after a score or certain other occasions.

Forward Pass - A violation that usually results in a scrum to the non-offending side.

Forwards - Players who pack in a scrum or throw and jump in a lineout.

Free Kick - A relatively minor law violation that allows the non-offending side to restart play in an unopposed fashion. Opponents must retreat 10-meters and wait for the non-offending team to kick the ball through the mark. A free kick cannot be taken for goal.

Infringement - A breaking of a law.

Intercept - To catch a pass intended for a member of the opposition.

Knock On - The accidental hitting of the ball from the hands or arms toward the dead ball line. Results in the same scenario as a forward pass -- a scrum to the non-offending team.

Lineout - Restarts play after the ball goes out over the touchline. The team that didn't touch the ball last has the throw-in.

Mark - The place where the referee signals play will be restarted. For example, the referee marks where the scrum will take place, or where the penalty has occurred.

Offside - Players in front of a member of their own team who was last in possession of the ball, or in front of established lines at a scrum. Lineouts of loose play are said to be offside. In some instances, one can retreat to an inside position without penalty; other times the infraction is automatically a violation.

Pack - Forward unit of a team, engages in scrum and lineouts.

Penalty - Awarded after a serious infringement of the laws. Offenders are required to retire 10-meters while the opposition is given possession to restart play unopposed. Many times the non-offending team will attempt a kick at goal, worth three points.

Put In - Rolling the ball down the center of the scrum tunnel.

Ruck - A ball-winning activity following a tackle and release; a ruck is formed if a player from both teams is in physical contact over the ball.

Scrum - A way to restart play where a bound group of players form a tunnel with the opposition.

Sevens - An abbreviated game of rugby that follows the same laws but for the number of players and time of the contest. A 7s team fields only seven players; each half is seven minutes long. Much like a game of three-on-three full court basketball, it's a wide-open contest.

Set piece - A term for scrums and lineouts.

Support Players - Players who position themselves to increase the ball transfer options of the ball carrier.

Tap Kick (or "tap move"): - A gentle kick to oneself, followed by a pick up, used to restart play after either a penalty or free kick is awarded.

Throw In - Throwing the ball down the middle of a lineout.

Touchline - The side boundary of the field (sideline).

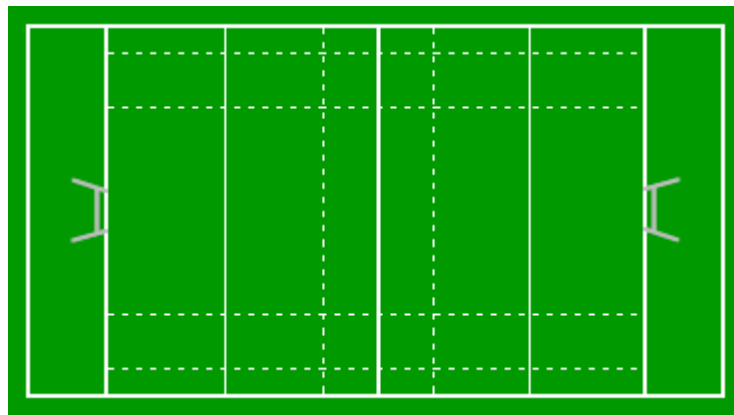
Try - Forcing the ball onto the ground with downward pressure over the opposition's goal line.

22-meter Line - Balls kicked out of bounds from behind the "22" restarted by a lineout where the ball went out; balls kicked out of bounds from in front of the 22 are restarted by a lineout where the ball was kicked. The exception is a ball kicked out of bounds immediately after a penalty has been awarded; the lineout is held where the ball went out and the non-offending team retains the throw-in.

9 The Pitch & The Players

10 The Pitch

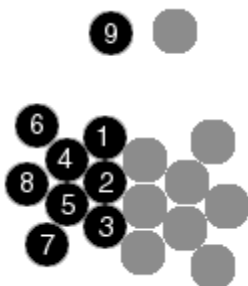
The field that rugby is played on is called a pitch. The pitch is expected to be 100 metres long by 69 metres wide. The sidelines are called touchlines and there are two in-goal areas, which are expected to be 10 to 22 metres deep with a tryline marking the front and a dead ball line at the back. The goal posts are located on the try line and are 5.6 metres apart with a crossbar set at 3 metres. The height of the posts varies according to the club's wishes.



Other important lines on the pitch include the half way mark at 50 metres. A dashed 10 metre line set each side of the 50 metre line, which is used to judge kickoffs, and a solid 22 metre line marked 22 metres from each tryline. Other lines include two dashed lines set at 5 and 15 metres marked parallel to each touchline. These lines are used mostly to identify the zones for lineouts.

Rugby union is played in different variations depending on the number of players on the field for each team. The typical game is played with fifteen players per side and lasts 80 minutes, with 40 minutes being played in each half. An abridged version is also very popular but is played with seven players per team over two seven minute halves. A less often played version is called tens and is played with ten players per side.

11 The Players



Teams in a fifteens match will consist of two groups of players, the forwards and the backs. Each position has a specific number and responsibilities during the two 40 minutes halves of a match. The players are as follows:

12 Forwards - the group of players normally numbered 1 through 8 who bind together into scrums, lineup for lineouts, and commit themselves to most rucks and mauls.

#1 Prop - (loosehead) Responsibilities are to support the hooker during scrums and 2nd rows during lineouts.

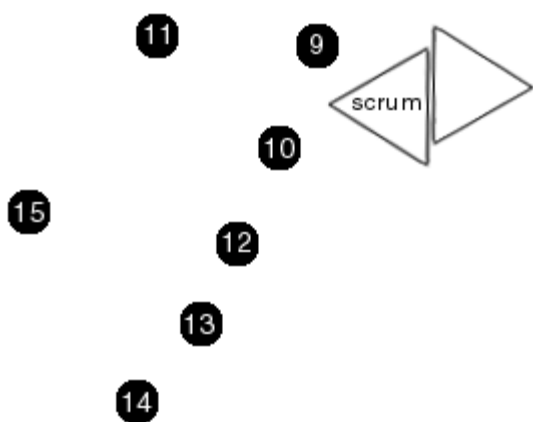
#2 Hooker - the front row forward wearing No. 2. The player is supported on either side in the scrum by props and is required to gain possession of the ball in the scrum by hooking or blocking the ball with one of his/her feet. The hooker will normally also be the forward throwing the ball into the lineout.

#3 Prop - (tight head) Responsibilities are to support the hooker during scrums and 2nd rows during lineouts.

#4 & #5 - Lock - either of the two forwards normally wearing No. 4 and No. 5. Typically the largest players on the field, they have primary responsibility for being the power in scrums and securing the ball in lineouts. Due to their size, they are also normally powerful forces in all loose play, rucks, and mauls. Also known as Second Row.

#6 & #7 - Flanker - either of the two forwards wearing No. 6 or No. 7. Also called wing forwards or breakaways they bind to the scrum outside of the locks just behind the outside hip of the props. They can play always on the same side of the scrum or can specialize on either the weakside or strongside. The players with the fewest set responsibilities, their job is to aggressively pursue the ball, gain possession, and take off running. Also known as Breakaway Forward.

#8 Number 8 - the forward who wears the jersey with the No. 8. This player binds into the scrum normally at the very base between the two locks. His/her responsibility is to initiate attacks by the forwards from scrums or to provide a stable ball from the scrum for the scrumhalf.



13 **Backs - the group of players normally numbered 9 through 15 who do not participate in scrums and lineouts, except for the scrumhalf.**

#9 Scrumhalf - the back wearing No. 9 who normally feeds the ball into a scrum and retrieves the ball at the base of scrums, rucks, and mauls. Can also be called the halfback.

#10 Flyhalf - the back wearing No. 10 who normally receives the ball from the scrumhalf. Also called the Outhalf, Outside half or 1st 5/8th, he/she will call plays for the backline, pass the ball to other backs, or provide most of the tactical kicks. Also known as First 5/8th.

#11 & #14 - Wing - either of the two backs wearing No. 11 or No. 14. Each will normally stay on the same side of the back line they are on throughout the match and are typically expected to be the fastest sprinters in the side. Wingers also have key duties during defense helping the fullback cover kicks and counterattacking.

#12 & #13 - Centre - either of the backs wearing No. 12 (inside) or No. 13 (outside). Powerful runners who are the heart of the back running attack and defense. The inside centre can also be called the 2nd 5/8th.

#15 Fullback - the back wearing No. 15 who normally plays deep behind the backline. In offense the fullback is a dangerous attacking position hitting holes unexpectedly at pace, in defense the fullback has primary responsibility for covering all tactical kicks down field by the opposition.

Appendix 3. Physical demands of men's 15 aside rugby union game

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Physical demands of men's 15 aside rugby union game

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1 Introduction

This paper tries to clarify the physical demands of rugby union game. New technology as GPS and multiple cameras can bring new information about the external demands in loads and intensities as a team and from individual role on the field. With this new information we can improve the physical activity in the team training and also the training at the players own time.

I try to clear out these demands of rugby by going through documents, literature and notes from the live game situations. Literature from sport science gives valuable information from physical performance to create physical activity also. Some set references about physical demands in high level are found in appendix. References shows well the physical differences between roles and positions in the field. This is really important to understand about rugby game today.

The most accurate information comes from the highest level of rugby. Still, when we are using this kind of information, there is need to remember our own aims and how references can reflect to activity in our level. These physical references works as it is and gives frames how high level players are doing. All the player don't have the need to be in these frames to be successful, but gives good idea about the direction. Everyone is an individual and has strengths and weaknesses. References gives a direction where to look and to give motivation for those athletes who reaches higher levels. This gives also a platform to plan our conditioning programs, player monitoring and testing rugby players.

2 Rugby is demanding physical game

In the rugby game we have fifteen athletes aside, fifteen individuals for different roles. There are slightly different roles between others, but some of the roles can differ a lot in physical demands. In the 80 min game there can be 25 tackles, 46 hits to the ruck, 22 scrums and lifts in 24 line outs in the highest international level. Players can cover from five to eight kilometers in the game which include more than 200 intervals. This requires visible power, speed, agility and mobility. Also it needs fast strong muscles, flexible joints, muscles and ligaments, good cardiovascular function and fluid changing system. (Luger D. & Pook P 2004, 2-3.)

Players are expect to handle the ball and run fast in longer cycles of play with less rest in rugby game today. Ball was in play ~44% from the 80min game in Six Nations 2013 international game between Scotland and Wales, as compared to 1977 when ball was only 31% in play (IRB 2013, Luger & Pook 2, 2004). Players need to be able to perform in their roles even when they have huge amount of fatigue. This increases a need of good physical fitness.

The amount of collisions have increased dramatically in modern rugby. This brings extra attention to our physical demands today. In Five Nations Rugby the average amount of tackles per team increased almost 100% (48 -> 86) from 1996 to 2002 and still increasing. 2015 in the second round matches the average was ~125 tackles per team. Average amount of rucks and mauls per game were 180 and scrums 14 in Six Nations 2013 (IRB 2013).

2.1 Speed, agility and quickness

Speed is classically diverted to *reaction speed*, *explosive speed* and *movement speed* (Mero, Jouste & Keränen 2004. 293-298). Agility and quickness we can consider to be combination of these three in situations where movements, directions, levels and positions changes rapidly. Quicker and faster the player is in game situations, better the player he is.

Type of speed	definition
Reaction speed	Ability to react quickly to stimulus. Time used from stimulus to beginning of activity.
Explosive speed	Fast, single movement
Movement speed	Fast movement from place to another - <i>Maximal speed (100%)</i> - <i>Submaximal speed (96-99%)</i> <i>(Supramaximal speed (>100%))</i>

(Mero et al. 2004. 293-298.)

2.1.1 Reaction speed and explosive speed

Reaction speed is all the time present in the game situation. Players get information through their senses which they need to react. All the successful ball handling, game sense, and contact is connected to good reaction speed. *Explosive speed* is a step further from reacting a stimulus. We can have a look at one single jump in the line out. There player needs to create huge amount of force to lift him up in the air from where his mates can help him higher. This force comes from the speed of movement what player can create. Same pattern happens in every single movement what we can separate, for example fend off, kicking and first step to the tackle when intended. This kind of explosive speed is needed for all players, but differs in skills needed by the role in the rugby field.

2.1.2 Movement speed

Movement speed is essential for every rugby player. Movement speed can be divided in *acceleration speed* phase, *maximum speed* phase and *speed endurance* phase in this order. The duration of each phase depends from the individuals abilities. Hit up forwards needs good *acceleration* for many repetitions. They need velocity to create momentum as much as they can, to win contact situation with tackler and vice versa (Hendricks et al. 2014). In the high level professional game back player (nr 10) was entering impact 798 times when forward (back row) amount was greater with 1274 times entering impact (*picture 1*). Good acceleration is important to train for all players to reach their maximum speed phase from various starting positions as fast as possible (Luger & Pook 5. 2004). (Taplin 56-57. 2005.)

Picture 1. Light impact = Hard acceleration/ declaration or change of direction. Light-moderate impact = player collision, contact with the ground. Moderate-heavy impact = tackle. Very heavy impact = scrum engagement (in old rules). Severe impact/ tackle/collision.

TABLE 6. Game impact and body load data per position and half.*†

Variable	Player position	
	Back	Forward
Light impact (5-6g)	349 (168; 169)	563 (201; 317)
Light-moderate (6-6.5g)	328 (152; 171)	398 (174; 188)
Moderate-heavy (6.5-7g)	55 (25; 30)	143 (37; 97)
Heavy (7-8g)	38 (15; 23)	101 (24; 71)
Very heavy (8-10g)	24 (15; 9)	56 (19; 35)
Severe (10 ⁺ g)	4 (2; 2)	13 (6; 7)
Total no. of impacts	798 (377; 401)	1,274 (461; 715)
Total body load (AU)	31,402 (16,483; 14,372)	119,103 (35,477; 78,058)
Body load/min	376 (392; 344)	1,426 (843; 1,883)

*AU = arbitrary units.

†Values inside parentheses are those for first and second halves, respectively.

(Cunniffe, Proctor, Baker & Davies 2009.)

In Cunniffe et. al study (2009) they used GPS tracking fly half (nr 10) and back row player's movement during the top level rugby match (*picture 2. and 3.*). Fly half was able to entrance

more times (34) to the sprinting zone (>20km/h) than back row player (19) (*picture 2.*), but amount of entrances to the high-intensity running zone were almost equal (fh 43, br 46). In calculation we can see the average ~15m for the fly half player and ~16m for back row per time in the sprinting zone. Both were ~7m per time in the high-intensity running zone (18-20km/h). This means that both roles are running approximately same distances in high-speed and sprinting zones during the game. Fly half are still doing sprints more frequently.

The maximum speed were 28,7km/h for back and 26,3km/h. International level players should accelerate 10m in 1,8 seconds or below (*Appendix 1.*). Rugby players sprint rarely more than 30 meters at the time and reach their *maximum speed phase*. These situations occur when kicked ball is chased by centers (12-13) or back three 11-14-15). Most of the sprints are under 10m and biggest forwards hardly ever reach the sprinting zone and their *maximum speed phase*. This highlights the importance of *acceleration speed*. Study shows also the need of *speed endurance*. Cycles of plays lasts normally 5 to 62 seconds and in the average of 23 seconds. These cycles includes movements in the different speed zones. (Luger & Pook 6,139-140. 2004 Cunniffe et al. 2009.)

Picture 2.

Game Demands of Elite Rugby Union

TABLE 3. Distance (meters) covered by each player in designated speed zones.*

Distance (m) within speed zone	Player position	
	Back	Forward
Standing and walking: 0–6 km·h ⁻¹	2,802 (1,247; 1,314)	2,409 (1,124; 1,110)
Jogging: 6–12 km·h ⁻¹	1,956 (794; 1,054)	1,856 (722; 948)
Cruising: 12–14 km·h ⁻¹	673 (332; 330)	746 (310; 362)
Striding: 14–18 km·h ⁻¹	978 (532; 439)	1,011 (479; 481)
High-intensity running: 18–20 km·h ⁻¹	292 (172; 120)	342 (138; 177)
Sprinting: >20 km·h ⁻¹	524 (241; 283)	313 (157; 159)

*Values inside parentheses are those for first and second halves, respectively.

(Cunniffe et al. 2009)

TABLE 5. Number of entries/surges by players into each speed zone.*

No. of surges within speed zone*	Player position	
	Back	Forward
Surges below 6 km·h ⁻¹	207 (88; 111)	220 (91; 112)
Surges between 6 and 12 km·h ⁻¹	229 (133; 158)	315 (132; 159)
Surges between 12 and 14 km·h ⁻¹	123 (54; 66)	125 (57; 61)
Surges between 14 and 18 km·h ⁻¹	116 (63; 51)	109 (53; 51)
Surges between 18 and 20 km·h ⁻¹	43 (26; 17)	46 (20; 24)
Surges above 20 km·h ⁻¹	34 (20; 14)	19 (10; 9)

*Numbers of surges per speed zone are not exclusive locomotor efforts but rather the number of times players reached speeds above designated speed interval.

(Cunniffe et al. 2009.)

2.1.3 Agility and quickness

Good agility and quickness abilities are more important for the back players whom role is more evasive when carrying the ball, but important for all players for injury prevention. Players with the ball and their supporters can rarely run straight line during the match. More often they need to use their agility and quickness to change direction, dodge, and evade from the contact. From tackler’s point of view player needs to be able to react to the rapid movement of the ball carrier. Good line out jumper has quick movements back and forth to lose his opposite jumper in the set piece. (Luger & Pook 140-141. 2004.)

2.2 Strength and power

Strength and power are maybe the most important parts of rugby fitness. Strong and powerful players are more equipped to fight safely in the contact situations. Rugby players in high level are involved in collision every 1-2 minutes and heavy collision from 2 to 5 minutes depending of the playing position (Gabbett et al. 2012b, The Science of Rugby Twist & Worsfold 2-3. 2015). Tackling, being tackled, rucking, mauling, and scrummaging involve great challenge against opposite player or players. These situations need great power for lower limbs and strong support from middle section to deliver the created force. Strong upper body is needed to protect shoulder and neck area. Players need to be trained with good muscle stability and muscle control, training only power is not enough. Roles in the field specifies what kind of strength they need most. (Luger & Pook 8. 2004.)

Type of strength	definition
power	<p><i>Explosive strength</i>: acyclic movement which lasts only seconds</p> <p><i>Speed strength</i>: cyclic movement last <10 seconds</p>
Maximum-strength	Maximum force created in one repetition
Strength-endurance	Long lasting production of force >20 seconds

(Häkkinen, Mäkelä & Mero 2004. 251-273)

2.2.1 Power

Explosive strength is needed in situations where velocity of movement is essential. The distance for passes and kicks are partly related to the amount of strength, but also good mobility, and skill. All the situations where *explosive speed* is needed in the game equals to *explosive strength* and *speed strength*. Tackling, jumping, accelerating, and bursting through the tacklers are skills needed for every role on the field. Excellent level of *explosive strength* in the legs is needed especially for the line out jumpers. (Twist & Worsfold 2015, 19.)

2.2.2 Maximum-strength

Tight five forwards need the biggest amounts of maximum-strength in their lower limbs for the scrum. Lifting in the line out demands good maximum-strength in the upper body. Mostly assessed 1 repetition maximum movements for rugby players are bench press, back squat and power clean. Typical range of results are 110 – 190kg, 140 – 250kg and 100 – 140kg (Appendix 2). Results varies in age, size, playing position, and history in training. (Baker & Newton 2007; Harris et al. 2007; Bevan et al. 2010, McGuigan et al. 2010, The Science of Rugby Twist & Worsfold 19-25. 2015.)

2.2.3 Strength-endurance

Scrum is the most dangerous part of the game. It can last 5-20 seconds and eight players each side are pushing forces from 600 kilos to 1000 kilos (Mälkiä 2007). Muscles around the spine needs to stay strong from every player in the scrum to keep body positions stable and in the same line whole time. This gives the optimal direction to deliver force, compete, and complete scrum safely. Same *strength-endurance* demands we can find from the maul situations, where the forces are not that huge, but can last even longer than scrums. Some occasion wrestling in the ruck can last longer than 10 seconds. We can argue whether it is more *strength-endurance* dominant or *maximum strength*.

2.3 Endurance

Rugby game lasts 80 min with 10min half time as we have mentioned before. In Cunniffe et. al study (2009) they measured *mean heart rates* 172bp/min from fly half and 169bp/min from back row player. These are around 80-90% from maximum heart rates (HR). International rugby players covers different distances in the game depending the playing roles, front row 5158m, second row 5755m, back row 6038m, scrum half 7098 , inside backs 6545, and outside backs 6276m. 88-95% of the game is spent low intensity movements (walking, standing and jogging) and approximately 2,2-3,6% of time to high intensity movements (Sprinting, striding, tackling, rucking/mauling and static efforts). Activity cycles average is 23 seconds and rest periods average is 43 seconds. This tells the demand of different kind of endurance needed in rugby. References for endurance demands in appendix 2 & 3. (Cahill et al. 2014; Duthie et al. 2005; Gabbett et al. 2012b; Meier et al. 1993; Waldron et al 2011. *The Science of Rugby* Twist & Worsfold 2015, 1-2; Luger & Pook 5-6,183-188. 2004.)

Type of endurance	definition
Aerobic endurance	Long lasting stride in low pace <aerobic threshold (aprox. 50-70% from max HR)
velocity endurance	Economical pace and speed >aerobic threshold (aprox. 70-90% from max HR)
Maximum endurance	Maximal cardiovascular function >anaerobic threshold (aprox. 95-100% from max HR)

Speed endurance	<p><i>Anaerobic endurance</i> >anaerobic threshold (aprox. 90-100% from max HR)</p> <ul style="list-style-type: none"> - <i>Alactic endurance</i> 5-15s performance - <i>Lactic endurance</i> 15-90s performance
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(Nummela, Keskinen & Vuorimaa 2004. 315-361.)

2.3.1 Anaerobic and aerobic energy production

When we play different time periods with high intensity (HR 90-100%), we use different production of energy. *Anaerobic energy production* can produce energy from body's *glucose* without oxygen for the first 15 seconds. Muscles use Adenosine Triphosphate (ATP) stores for 1-6 seconds and secondly *phosphocreatine* stores (PC) for 5-10 seconds.. This is called *alactic energy production*. When ATP and PC stores are empty, and intensive work continues body start to demand oxygen for energy production. Energy comes from breakdown of *glycogen* from muscle or *glucose* from blood to the *pyruvate* in *glycolysis* process after 15 seconds. (Beachle & Earle 2008, 22-25.)

When work load is not intense, body can circulate pyruvate back to the energy production with an aerobic pathway. This is called *aerobic energy production*. When intensity stays high longer than 15s, and body can't circulate enough oxygen for the muscles, body starts to transfer pyruvate to *lactic acid* temporarily. This way produced energy is called *lactic energy* and body can work over 60 seconds with it. Muscles will store *lactic acid* to wait to convert back to *pyruvate* and with oxygen back to energy. (Beachle & Earle 2008, 26-32.)

2.3.2 Fuel mix conditioning

Dan Luger defined high intensity work in the rugby field used both anaerobic and aerobic systems for energy production separately or at the same time – hence a term *fuel mix* (2004). *Average rest periods* during the international games are 43 seconds, which is too short for full restoration of ATP or CP stores in glycolysis. Demand of the rugby game is to recover quickly from the fatigue of changing high intensity working periods. Good *cardiovascular function* helps body to circulate oxygen to avoid lactic acid to appear, but help the body to transform it back to the energy. Players are trained in *fuel mix conditioning* to be able to work in good level for whole 80 minutes, and warm up routines, and also to be able to recover for the next training. (2004.)

2.3.3 Positional endurance

All the players need to have good level *aerobic endurance* for the recovery from the fatigue of training and games. In the game backs are spending more time standing because of scrums and line outs, but they are entering little more to the high speed zones. Forwards are more involved in high intensity working cycles in the game (front row 11.9%, centers 5.7%). This makes *fuel mix training* complicated to separate from mean HRs which are quite equal during the game (fh 172, br 169 beats)(Cunniffe et al. 2009).

When we have a closer look to the game we can see the difference in resting periods for the players even if it is hard to see from the HRs. Considering that bigger forwards are in scrums and line outs while backs have time for standing and walking, meaning more time for recovery, after game starts (after scrum or line out), backs are running attacking patterns and chasing kicks, while forwards need to recover during the game is on. This makes a difference in recovering demands between player positions. Forwards are more involved in collisions (tackles, rucks and mauls) when backs are striding back to their attacking positions also. We can still understand that forwards need more *aerobic endurance training* than backs, and in *anaerobic endurance training* another way around. (Cahill et al. 2014; Duthie et al. 2005; Gabbett et al.

2012b; Meier et al. 1993; Waldron et al 2011. The Science of Rugby Twist & Worsfold 2015, 1-2; Cunniffe et al. study 2009.)

2.4 Flexibility and mobility

Flexibility (in another words mobility) is important in rugby as it is in any other sport. Mobility in human body means *range of motion* (ROM) in joints. Athlete can heritage good mobility, but age, external conditions, hormonal, and neurological factors affects the athlete. In sports we define mobility as *passive and active mobility*. Good active mobility is combination of muscle strength and flexibility of ligaments, joints, and antagonist muscles which can be trained. The movement range is bigger in passive mobility when external force is used for stretches. Mobility need to be controlled, and better if active and passive ROM are close to each other. Good mobility gives possibility to clean movements, complex movements, and affects positively in force production. (Mälkiä 2007, Kasva urheilijaksi 2014.)

Type of mobility	definition
passive mobility	<i>Range of motion</i> reached with external force (gravity, own body weight, equipment..)
Active mobility	Mobility reached with own muscle strength without external force - <i>Dynamic mobility</i> . Joint reaches maximum range of motion rapidly.(example side-to-side leg swing)

	<ul style="list-style-type: none"> - <i>Static mobility</i>. Joint stays a period in maximum range with muscle strength (example laid back leg raise)
--	--

(Kasva urheilijaksi 2014.)

In the rugby field maybe the biggest problem is bad mobility that causes injuries, weaker skills, and reduced force production. Dan Luger (2004) defined most common problems in rugby players; these are tight hamstrings and gluteus, short hip flexors and rigid shoulders. These have led to several new problems as; reduced stride length, poor posture, muscle imbalances, impaired reach in tackle situations and reach for the ball, because reduced movement efficiency causes athlete to lose energy. As an example, tight gluteus; when running, hip flexor tries to contract to lift knee up, but antagonist muscle gluteus don't stretch, and fights back. Running is in larger amounts about relaxing and flexing muscles, and in small amounts contraction. (Luger & Pook. 55-57, 2004.)

3 Characteristic anthropometrics of rugby players

“Rugby game is for every shapes and sizes” is well known proverb, when we introduce rugby. There are 15 different positional roles in the field, and these vary in physical activity too. Different activities demand certain measures to be more successful. *Scrum half* position player need to have a really good balance and low position to be able to pass the ball from the ground well behind the rucks and scrums. It is a beneficial to be short instead of being tall like *lock* players. They need to be tall to reach higher than others, to catch the ball in the kick off and line out situations. It is important to recognize these measures to give aid when trained positions are chosen. There are always many variables which are needed in different roles, and characteristic anthropometrics in playing roles are the easiest to use for choosing positions, and still important to be successful.

3.1 Body composition and weight

In the rugby field there are players in different shapes and sizes. Normally bigger players are forwards numbers 1-8. They usually have bigger *percentage of fat* in body mass and *lean body mass* is measured to be higher than backs. International level forward players have higher body fat percentage ($11,1 \pm 1,2\%$) when backs have smaller percentage ($10,0 \pm 2,3\%$). In Duthie et al. study (2005) with Super 12 Rugby players, average weight in forwards was ($107,6 \pm 8,0$) and backs ($89,0 \pm 6,6$). Decent amount of body fat have been seen as a cushion in protecting from injuries. (Mälkiä 2007.)

3.1.1 Heavier players

Bigger players are used as a ball carriers more the smaller players. It have been studied (Hendricks et al. 2014) that bigger players are the ones who successfully pass the gain line the most. This is tactical issue what coaches use for these players, and with the momentum they are mostly successful. Numbers 1-5 (Tight five) are used as “hit up forwards” to get the ball over the gain line close from the breakdowns, and numbers 6-8 (Back row) as “wide running

forwards”. (Hendricks et al. 2014; Gabbett et al. 2012b, *The Science of Rugby Twist & Worsfold* 4-5. 2015.)

3.1.2 Smaller players

In Hendricks et al. study they found that the tacklers are smaller players than ball carriers (2014). Still, the momentum in the “front up” tackle was the same, because the velocity of a tackler was higher than the ball carrier. Backs, usually smaller players, are quicker, more agile to avoid contact and can run distances faster than forwards. In modern game there are exceptions in this learned concept. Big players can play backs, if they are fit and fast enough. The best example is Jonah Lomu, one of the greatest wingers of all, who’s weight was 120kg and height 1,96m, but spent only 10,8s in 100m sprint. Smaller players can play number 6-7 (flanker) or number 2 (hooker) roles, when they are strong enough to play in characteristic forward game, where there are more collisions with bigger players in rucks, mauls and scrums. (Hendricks et al. 2014; *Twist & Worsfold* 3-4. 2015.)

3.2 Differences in height

Seems that the height plays an important role in rugby union game. The statistics shows it clearly from top rugby nations professional teams which are collected by Peter Dawson 2012-13. In all countries, the shortest players were number nines (scrum half) and their average heights are between 175cm – 179cm. Second shortest are number twos (hooker), or number 10s (fly half), depending of the country. Clearly tallest were number 4-5 (locks), between 197cm – 200cm when second tallest were number eights, 190cm – 194cm. Rest of the players in the rugby team goes in height average 180cm – 191cm. (Dawson 2013.)

3.2.1 Tall players

Height brings more reach for the players and tall players are picked to the roles where long reach is an advantage. 43/59 line out throws were thrown to lock players in three RBS Six nation 2015 first round matches. 4/5 line outs throws stolen were locks who are the tallest

players in the field (RBS Six Nations 2015). Statistics shows it clearly that high level teams relays in reach in the line out situations, when players are lifted up in the air to compete of the ball possession. These same players are also often used as target when ball is kicked in the air in 22 drop outs and kick offs. Receiving team is trying to position these tall players where ball is expected to land and lift them up to catch the ball.

After entering a tackle, maintaining, or re-gaining possession is probably the primary objective of the player. Players mass and height may aid in protecting the ball from the opponent in this (Hendricks et al. 2014). Forward players carried the ball 301 times in three RBS Six nation 2015 first round matches. ~46,51% carries were made by lock or number 8 players (locks 68/301 ~22,59%, number 8 72/301 ~23,92). So, we can see that three tallest players are selected to the ball carrier roles, and maintaining possession in the tackle situation. These players completed 48 of any kind of passes during the game. (RBS Six Nations 2015.)

Good reach is essential for number 8 for picking up the ball from behind the scrum, when the ball doesn't come out clearly. Number 8 picking the ball up from behind the scrum explains a little the big a mount ball carries in the game. 25 (52,08%) of those 48 passes were made by number 8 and two locks only did 23 passes. (RBS Six Nations 2015.)

3.2.2 Short players

Shortest players in rugby field are the scrum halves, who are picking the ball from the ground from the rucks and scrum, carrying their weight on their feet. Scrum halves passed the ball 461 times in three RBS Six nation 2015 first round matches (RBS Six nation 2015). Most of the passes are from the ground and are game opening passes. Pass need to be accurate and hard to give best options to continue the game as wanted. These passes need really good balance and low body position to be completed quickly and accurately. Needed abilities come more naturally from short players. Gap between the steps are shorter in short players, and enables rapid movements in various game situations, where quick reaction and movement is needed.

Fly halves can be quite short as well. Almost the same abilities are needed to play fly half position as scrum halves. Players who are training to play fly half can cover both positions quite often. Hooker's smaller size is an advantage in open game. Smaller hooker can bring extra running meters and used as an extra back row player.

4 Summary

Collecting information about today's rugby game really highlighted few clear things to me. Game has changed to be much more physically demanding in 20 years' time. We can visualize it from the TV, but this work can give little more insight for it. Players have time to build their body, to be specified instrument for the game and role. This makes the game tougher, but also safer and more enjoyable now. Professionalism is a clear reason for it, but game would have changed even without it, just at slower pace. I think that we are close to the peak now, where we can develop this game through physical conditioning. Characteristics in playing roles have stayed more or less the same. Players are just bigger, because of increased demand of physicality in collisions.

We are not that close to start to pay for our players here in Finland. Still, some players are training almost like professionals, but at the same time we have grass roots beginners on the same field with them. Now, when we know more about the demands of the rugby game, and we have agreed those in the top level, how about here in Finland? New players for this sport need to meet the same physical demands when they face our well trained and experienced players. That is challenging all the time, but also worrying. Coaches should give advice for the experienced ones of course, to keep them developing to their targets. Coaches should be really clear also about the physical demands of the game for the newer players at the same time. Persons who are responsible for the activity need to make sure that it is essential to be strong, mobile, and fit enough to ensure the safe game for all players.

5 Appendix

Appendix 1. Sprint references for international level. www.protrainingprograms.com

SPEED	PROPS	2	4&5	LOOSE FWDS	9&10	¾'s
10 metres	1.75	1.72	1.8	1.7	1.68	1.65
40 metres	-	-	-	5.3	5	4.9

Appendix 2. Maximum strength references for international level.

www.protrainingprograms.com

SQUAT:

RATING	FORWARDS			BACKS		
	> 190 cms	110-125 kgs	95- 110kgs	>100kgs	90- 100kgs	<90kgs
World Class for your position	TBC	240	220	240	200	180
Graduation level – maintain and move on	TBC	220	200	210	180	160
Adequate for international football – but needs improvement	TBC	190	180	180	170	145
Needs to improve	TBC	170	150	160	150	130

BENCH:

RATING	FORWARDS			BACKS		
	> 190 cms	110-125 kgs	95- 110kgs	>100kgs	90- 100kgs	<90kgs
World Class for your position	160	180	180	160	160	140
Graduation level – maintain and move on	150	165	165	150	140	132.5
Adequate for international football – but needs improvement	140	150	150	140	130	127.5

CLEAN:

RATING	FORWARDS			BACKS		
	> 190 cms	110-125 kgs	95- 110kgs	>100kgs	90- 100kgs	<90kgs
World Class for your position	130	140	150	140	130	120
Graduation level – maintain and move on	120	130	140	130	122.5	115
Adequate for international football – but needs improvement	110	120	130	120	115	110
Needs to improve	100	110	120	110	110	100

Appendix 3. Aerobic endurance references for high level www.protrainingprograms.com

RATING	TIGHT 4			6, 8 & 2			7 & 9			¾'s & 10		
	VO2	3K	BEEP	VO2	3K	BEEP	VO2	3K	BEEP	VO2	3K	BEEP
World Class for your position	55.1	11.4	12.5	57.3	11.06	13	60.8	10.3	14	58.5	10.55	13.5
Graduation level – maintain and move on	54	11.42	12	55.1	11.4	12.5	58.5	10.55	13.5	54	11.06	13
Adequate for international football – but needs improvement	50.5	12.45	11	51.9	12.24	11.5	55.1	11.4	12.5	57.3	11.42	12
Needs to improve	48.5	13.1	10.5	50.5	12.45	11	54	11.42	12	51.9	12.24	11.5

Appendix 4. www.englandrugby.com, www.mensfitness.co.uk

England Rugby Anaerobic test

The test is made up of five sets of sprints around cones set 5m, 10m and 20m apart. The aim is to complete each set of reps as quickly as you can so you have a lower total time, as well as longer rest periods to catch your breath. You need two stopwatches: one a running clock to measure overall time and the other to time how long you take to complete each set (you'll probably need someone else to take care of this).

The first set, which is one rep, starts when the clock is at zero. The second set, which is two reps, starts on 45sec. The third set of two reps starts at 2min 15sec. The fourth set of four reps – known as 'the killer' – starts at 4min. The final set of just one rep starts at 6min 15sec.

At the end of this you should have five times, one for each set. Add these together to give you a total time that it took to complete the test.

England Rugby Fitness Test Standards						
Categories	England Anaerobic Test (secs)					
	Props	Hookers	Locks	Back Row	Half-Backs	Centres & Back 3
World Class	244	240	244	233	205	206
Performance	252	247	250	240	212	213
Exit	260	254	256	246	217	219

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Appendix 4. Conditioning methods in men's 15 aside rugby, Finnish amateur players for the national team level

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1 Introduction

Rugby Union is a complex sport where good physical abilities are needed in different game situations. Skill of reading the game, use of the right ability and skill needed in the right place at the right time is important. This kind of game sense and “game reading” comes with experience. The physical fitness level needed for the players is the first of the requirements to be reached in developing rugby countries like Finland. This will lead to a good training culture with healthy habits, and help the players straight from the beginning. In this assignment I have tried to find ways which suits to our needs in Finland, to our level and to our season structure to take the step to next level in world rankings.

We have played 15s rugby union games since 2002 when men’s championship started in Finland. Finland started to play international games immediately in the very beginning, but have stayed in the close to the bottom at the International Rugby Board (IRB) rankings. As a new sport, there is little valid data from the player’s physical condition for the fine-tuned programs at the moment. This assignment will bring guidance for the general fitness plans for the players who are willing to reach to the national selection and thus raise the level of the selection.

There is a big difference between top and the bottom in IRB rankings. There are some studies from the professional level which we can use as reference for the assignment.

The professionalism started in rugby union in 1995 and has increased the amount of sport research in it. Still, we need to be careful not just copy professional trainings for other sports, but analyze and use everything what we can for our best interest. Finnish rugby needs that professional behavior to grow to the next level.

2 Conditioning in rugby

The main focus and philosophy behind the conditioning players should be injury prevention. When we are planning training session, we have to remember the safety. We need wide selection of fit players for a chance to field best possible line ups. Rugby player should be mobile in every joint without restrictions, strong muscles to move the player, fast nervous track to give right information for the muscles and cardiovascular system which then can support these functions for the whole rugby game event.

All the strength training should be guided from this angle. We need force to create greater power against other teams (or players) power, but also, muscle mass can prevent physical damage to the body from the impacts. There was counted 798 of (349 Light 5-6g, 328 light to moderate 6-6.5g, 55 moderate to heavy 6.5-7g, 38 heavy 7-8g, 24 very heavy 8-10g, 4 severe 10g+) impacts calculated for the back player and 1274 (563, 398, 143, 101, 56, 13) impacts for the forward player in the professional rugby game (Cunniffe, Proctor, Baker & Davies 2009).

In the next stage, we need to teach the muscles to work to prevent injuries. The muscle fibers inside the muscle are creating the movement only by “on-off” or “all or nothing”. This simple information relies on messages from our central nervous system (CNS). If we want to prevent injuries, we need to stress the CNS to deliver the message to the correct muscles to work as rapid as we can. There are actions we can control through our thoughts, but there is long way from the brains to the muscle in the real time game situations. We don't have time to think anymore, if our knee is twisting in the tackle. The information from the CNS should come from the shortest way to ignite these muscle actions needed in the contact situations. When information from the spine is fast and accurate, the muscles can create enough power to prevent the injury. Our bodies can learn these shortest and the most effective ways only by training these situations, with various methods in different game-like situations, but also in the gym. (Beachle & Earle 2008, 4-12.)

Rugby player needs be “fit” enough to play the whole game in a good professional level. In the beginning of the game our body works normally, but when game continues, we are getting tired

because of fatigue. Because this, we are starting to lose the playing skills, and reaction times will stretch too. This will lead lower success rates in different game situations and higher risk of injury. When we are “fit”, we have greater change to complete the whole 80 minutes of game without injury. (Luger & Pook 2004, 55-57.)

There is need to train anaerobic and aerobic endurance, lactic acid tolerance and pay attention that our techniques to train are efficient to be powerful, but also to save the energy throughout the whole game. Movements need to be explosive enough to make the motion easy. For example running, lifting opposite players and standing up from the tackle needs to be explosive enough to be successful. If the movement is not explosive, and players struggle to complete these movements and are slow doing these movements, it will be resulting in loss of energy. (Bomba & Haff 2009, 62-65.)

The most important area to train for rugby is the muscles which supports of the spine. This should be trained in every training session, but also in the gym. The muscles around the spine, neck, upper back and lower back need to be able to support the spine in surprising situations, but also deliver the power created in the lower body. Big muscle groups in the lower body are the most important for the creation of power. These two muscle areas should be trained with weights in the correct body positions to ensure the safe delivery of power in the game. There is a need to train these areas in all different dimensions of movement to ensure the mobility. These mobility trainings should be done with players own body weight. (Luger & Pook 2004. 55-57.)

All this is about motoric skills. How well can we make players to understand their own body movement, and to most effective use those body movements in game situations? Coaches should help players to find correct and safe body positions for the different situations in the game. The biggest concern is of course in the set pieces scrum and line out, but also in the contact situations in the open field game. The correct body positions are really important in the weight training, but the body should be trained to move on all the dimensions of movement and rotate which part need to relax and, and which should be stiff. (Stone , Stone & Sands 2007.)

When we want to learn to do something with our body, it needs training stimuli which causes super compensation. Continuing to do these repetitions and causing super compensation with right amount of food and recovery we can find development in those areas. All the repetitions don't have to be exactly the same, but close enough to meet the same or higher goal. When we have reached a recent goal, we can put the next goal further to be able to do more with our body. It is all the same in rugby than in all other physical activity. We just need to develop many abilities side by side and take care of our rest and nutrition. All this is about planning for the development needs of an individual player, and then analyze the feedback to plan further development. (Beachle & Earle 2008, 508-512.)

3 The game

Rugby Union game lasts two times 40 minutes with 10 minute interval. There is also a warm up for the game, which mostly is tenses and longer in duration in amateur level than professional. Warm ups can last from minimum half an hour to whole hour. After the game there is a cool down exercises of 10-15 min. The total amount of the game event for the player can be 130-165min. That really brings the focus to the endurance training, energy consumption, energy saving and recovery during the game, but also after the event. This can be easily forgotten when trainings are planned. How we can restore the energy to last all this to get the best result?

The game of rugby is competition between up to 15 man teams who are competing possession of the game ground and of the ball possession, and is identified as an invasion game. When the ball is in play, the ball carrier can use evasive movements to go forward to invade the opposite ground. Another way to invade the opposite side by carrying the ball is to use brutal force in the contact area to maintain going forward either individually or in small groups. Defending side can also use these situations to win ground from the opposite side by pushing them back in these situations. Team with ball possession can use different distance kicks to the opposite side and chase them with high speed to gain possession again. There is variety in different situations in the game, for example dodging, sprinting, running, where players handle the movement only with their own body weight. The game includes many contact situations, when participants fight either against one player from another team, or more players depending on the situation. (Greenwood 1997, 16-28.)

Variety in strength, stamina, speed and skill training stimulus should be in our training situations as in all another sports. There are big differences from tactics, social and physical attributes which will bring changes in the physical performance in the rugby game, but all can be improved with the proper training. The innate level of ability and the ability to respond to the training with an improvement in performance are the two key factors in the success on rugby as well (Gleeson & Maughan 2004, 2.).

There are certain different playing positions and roles in Rugby Union. Every position and role has special tasks in the rugby field. Other roles are standing more to be ready to get in to the action, when other ones are wrestling against opponents about possession of the ball at the same time. In the open game, the ways of carrying the ball varies in the behavior of players and decided tactics, but everyone has to be able to take part in evasive and contact game. Set pieces in the game will bring one great angle to the conditioning in rugby.

4 Resistance training

Players need to be strong like weight lifters and fast like sprinters in rugby. During the game they face the situations where resistance can be bigger than their body weight. Sometimes resistance in a game situation is double their weight or even more, but mostly the resistance is approximately the body weight. These are collisions in the open game, tackles, rucks and mauls but also set pieces for the forward players. This brings challenges to plan the strength training between individuals. When we know the development aims and demands of an individual player, then we can choose the correct methods to do it.

It is characteristic that rugby players are seeking maximum strength by using ways from body building to get muscles as big as possible. Big muscle can storage energy more than small but it also needs more energy to function well. The extra weigh which don't bring more power is quite useless. We can train body to weight 100kg or more with a decent fat percentage, and amounts of **absolute force** (isometric or exerted force to an external object) created is far to the levels professionals have. The biggest difference is in the power output and that gap is something that we should try to narrow. Other way to see force is **relative force**, the relation between players force and size (exerted force with body or muscle mass). When we are evaluating and planning exercise for the players, we should pay attention more to relative force. (Stone et al. 2007. 3, 56.)

The base of the strength is possible to get in the gym. In the beginning of the off-season, the players should have their goals set for the physical conditioning to choose training programs for the resistance training in the gym. Off-season and preseason (later transition phase and general preparation phase) is good time to work on basic flexibility, strength-endurance, strength-power and strength-speed as a platform. Training volume should be high in the beginning of the training season when intensity and technique is low, what closer the season comes volume degrades and technique and intensity rises (McArdle, Katch & Katch 2000, 409). In the preseason and game season all this work should change to be more rugby specific,

and at that time training is mostly maintenance of strength levels during the game season. Here are some methods for the rugby related methods to the gym training. (Stone et al. 2007. 4.)

5 Power

The weight training is not all about how much load athlete can move. More important for the rugby player is power, how fast they move different loads in different distances (power = load x velocity). It means that player's weight has importance, but also the velocity brings power.

Most important is the acceleration of movement until the end. We look this closer in the speed part of the assignment. Power is the big part of the gym training for the rugby. The greater the resistance is in power equation (picture 1.), more power is needed, and speed comes dominant when resistance is smaller. Both of the ways are important, but it differs in the need of individual and the role in the field. (Keränen 15.4.2015; Walsh 1990. 25-28.)

Picture 1. When Work done increases the bigger Power is (needed). Bigger Power is (needed) when time is smaller. W = load, resistance, distance. t = time used for a repetition or series of repetitions

$$P = \frac{W}{t}$$

P = Power

W = Work done

t = Time taken

6 Strength and Power training methods

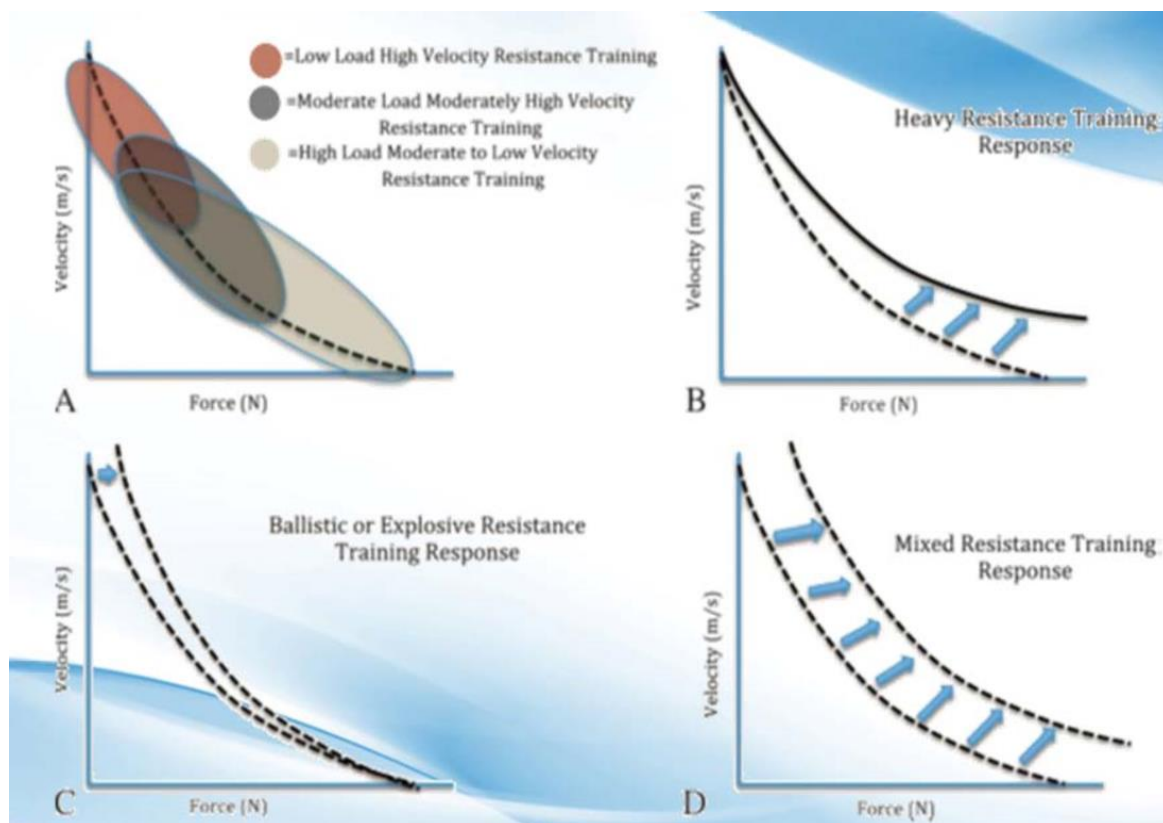
When joint angle is shortening it's called concentric contraction, when lengthening is eccentric and static is isometric. The most of the training should be concentrated to muscle contraction in cycles slow eccentric phase and fast concentric phase. Overloading methods (100-140% from 1 repetition maximum (RM) uses eccentric contraction for the muscle growth and it recruits greater number of muscle fibers. Then the training stimuli come through muscle fiber hypertrophy and neural development. Methods like this are good for the off-season training, but are not advised to do too often, because of the slow velocity of the movement, which is really important in rugby. It is more advised to control the eccentric contraction to get the muscle growth and make the concentric contraction as explosive as possible. Eccentric movements like Nordic hamstrings have found to be good avoiding hamstring problems (Keränen 15.4.2015). Same kind of results have been found with Romanian dead lift (IRB 2014).

Another important factor when choosing methods are different kind of muscle fibers. There are slow twitch fibers (type 1) and fast twitch fibers (type 2, where there are more varieties) to train. Using big (10-30) amount of repetitions and doing slowly we are concentrating to slow twitch fibers. Bodybuilders use these kinds of methods to have mainly hypertrophy stimuli when repetitions are greater, but it is not good for the rugby player for a long period. It is good to use these in the learning and recovering phase, or in small amount of 1RM development through muscle size. Fast twitch fiber is three times faster than slow one, and for the rugby, these muscle fibers are much more important. Hypertrophy stimuli for the fast twitch fibers come when you are working with medium amounts (5-10) of repetitions. Powerlifter methods to do series with small amount repetitions (1-3) of close to 100% load is more advised for 1RM development. The training stimuli is the same than in overloading methods. (Beachle & Earle 2008, 382-410).

Increasing power what players need in rugby is easier than it sounds. Power exercises like snatches and cleans should be performed first in the training session (Beachle & Earle 2008, 390-391). Power training has three different areas to train in velocity-force curve (*picture 2*).

There is **low weight high velocity** movements with small weights example pulling sledge, throwing light 2-5kg medicine ball and plyometric training. **Moderate velocity moderately high weight** training can be hang power cleans, sumo dead lift high pulls or just hang pulls if power snatch and clean are technically too challenging. Resistance should be from 70-90% of 1RM to get biggest power output. **High load moderate to low velocity** movements can be bench press, squats or deadlifts with almost maximum weights. All the movements should be simple to perform to get stimuli which increases power. Amount of repetitions should 2-4 in 5-8 sets. The best result will be if different velocities of power movements are mixed in same training (Keränen 15.4.2015).

Picture 2. Training stimuli areas velocity-force curve, responses of linear training and mixed training



(Keränen 15.4.2015)

6.1 Repetition method

Repetition method is the most basic method used in the gym training. In main movements 4 – 6 sets in series and 2-4 min recovery. The amount of repetition depends of the wanted

stimulus. Hypertrophy is made with 6 – 12 repetitions and combination in hypertrophy and neural development with 4-6. These sets are normally done until failure to make all repetitions in set. When used for the supportive movements athlete does 3-4 sets in series with 1-2min recovery and with 8-12 repetitions. (Beachle& Earle 2008, 406.)

6.2 Maximal effort method

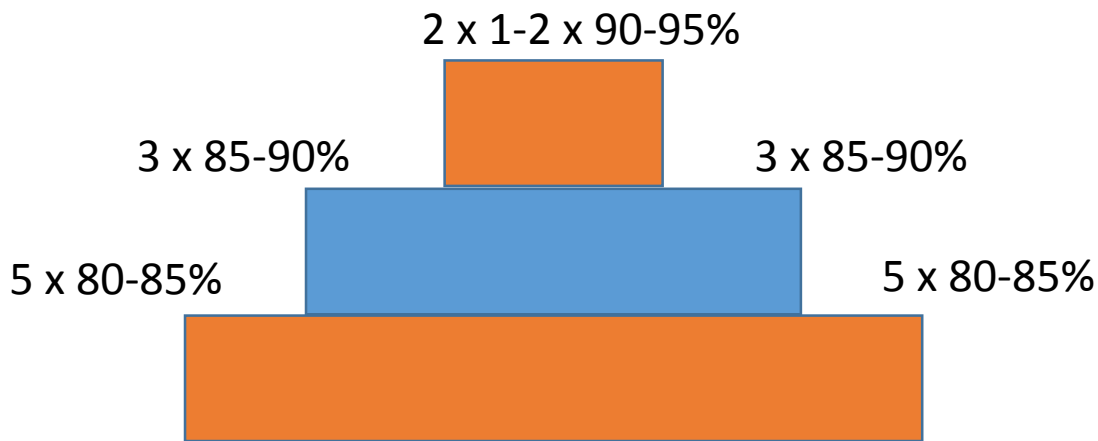
One of the basic methods for the Olympic weightlifters and powerlifters is maximal effort method. In it you do 1-5 repetitions close to 1RM weights in set and have 3-5 min recovery, and have 4-6 sets in series. Some sets like for example 1-2 can be “warm up” sets to get ready for the maximum efforts. This type of training is NOT to be done until failure to finish the set. Maximum effort method increases power mostly through nervous system development. (Beachle & Earle 2008, 400, 406.)

6.3 Pyramid methods

There are different kinds of pyramid methods, because “pyramid” is just the platform for the series, the shape of training where load goes from low to high and comes in the same shape. Pyramid can take different kind of shape, and depends of the wanted stimulus. It can be made only to the top of the pyramid but it´s also made with drop sets which increase the fatigue and complete load. Series normally includes 4-8 sets 2-4min recovery. Pyramid method is normally used with movements that affects in big muscle groups as dead lift, squats, cleans and bench press. Can be used to power training if amount of repetitions in set are small 2-4 and athlete don´t lose the energy in earlier sets (Keränen 15.4.2015).

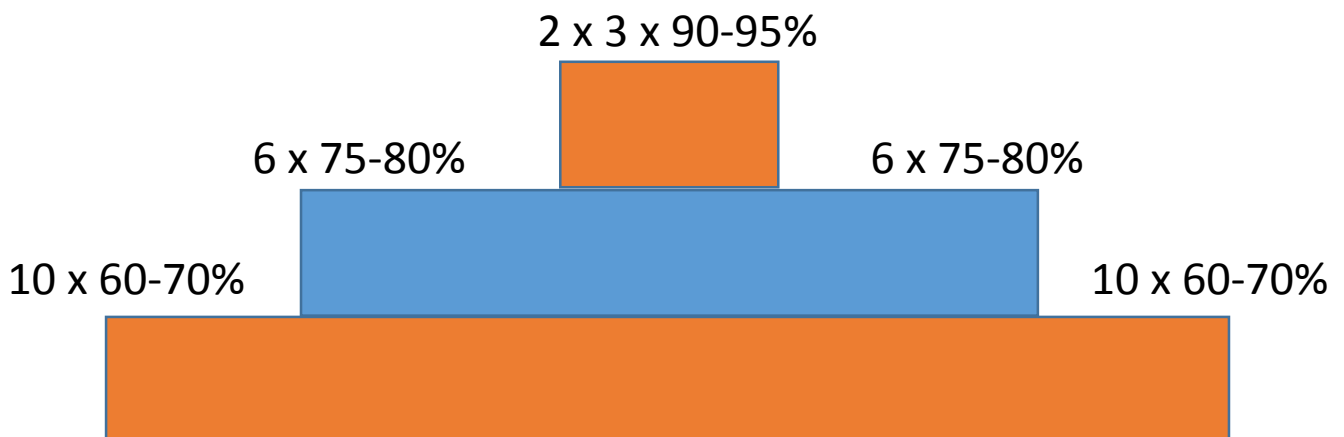
Narrow pyramid is stressing the same stimulus. Example below: Neural development and smaller amounts of hypertrophy with smaller weights and bigger amount of repetitions.

5 x 80-85% 1RM, 3 x 85-90%, 2 x 1-2 x 90-95%, 3 x 86-91, 5 x 80-85%



Wide pyramid is stressing wider range of stimulus. As in example below: Hypertrophy and neural development. Good way to produce platform strength for the further development in power training.

10 x 60-70% 1RM, 6 x 75-80%, 3 x 90-95%, 3 x 90 - 95%, 6 x 75-80%, 10 x 60-70%



6.4 Super sets methods

One set is combination of two or more different movements without rest in between. Method is normally used as in supportive movements. 3-4 sets in each series from each movement and 1-2 min recovery between sets. (Beachle & Earle 2008, 392.)

6.4.1 Antagonist super set

Antagonist muscles moves joint to the opposite directions than the primary muscles. In the example super set bicep curl (*picture 3*), bicep contracts elbow's hinge joint to the flexion.

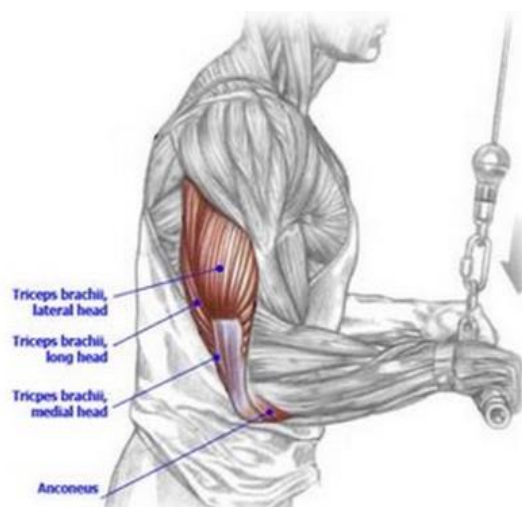
Triceps are antagonist muscles to the biceps and in example triceps pushdown (*picture 4.*) are contracting joint back to the extension. This brings both extension and flexion training stimuli for elbows hinge joint. (Beachle & Earle 2008, 392.)

Picture 3. Biceps curl



(creatudietaideal.com)

Picture 4. Triceps pushdown

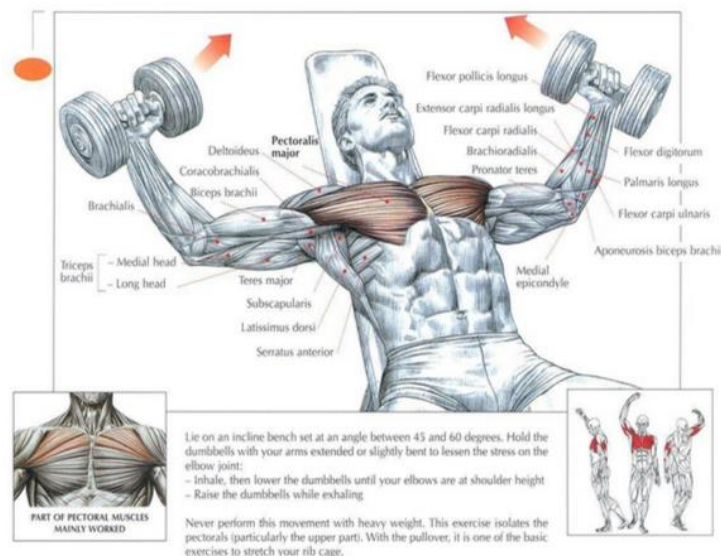


(creatudietaideal.com)

6.4.2 Pre-exhaust super set (Compound set)

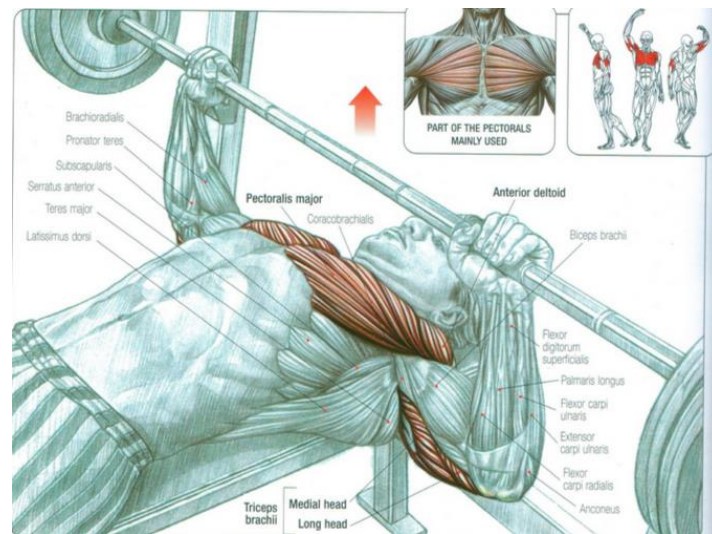
This set is made with combination of two different movements for the same muscle group without rest in between, and with little different parts of the muscle and/or different agonist muscles. In the example Incline dumbbell flies (*picture 5.*) and Chest press (*picture 6.*) movements leads concentrated stimuli to the different parts in the pectoralis major. This is effective method for increasing muscle size. (Beachle & Earle 2008, 392.)

Picture 5. Incline dumbbell flies



(peakfatlossandfitness.com.)

Picture 6. Chest press (Bench press)



(axonblogg.se.)

6.4.3 Giant super set

This set is combination of three different movements without rest between. When combining more movements to one super set general fatigue rises and can lead less efficient and affective training stimuli for the wanted muscles.

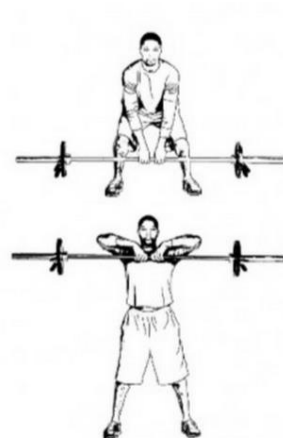
6.5 Circuit training method

Circuit training can be combination of two or more movements and affect general conditioning and cardiovascular endurance. It can also be mixture of usual weight training movements and cardio training together. Selected movements can be targeted to certain muscles or certain part of the body. Rugby conditioning should mostly use all big muscle groups and movements which are as functional as it is possible. Imagination is the limit and imagination in making the trainings with this method is really appreciated in team training. (Delavier & Dundill 2011. 238-240.)

6.6 Dynamic training method

Normally made with 30-60% from maximum load and concentric contraction should be as explosive as it can. It is done with 1-6 repetitions with 3-5 min recovery, or when athlete is ready to make 100% effort. Most common movements are the olympic lifts, but the technique is challenging for many who want to get wanted training stimuli. Easier movements could be more beneficial for many of the trainers, for example sumo deadlift high pulls or hang cleans (*picture 7.*) instead of power cleans (IRB 2014; Keränen 15.4.2015).

Picture 7. Sumo deadlift high pull



Dynamic training method can include **plyometric trainings** (*plyometric method. chapter 6.9*) with dynamic effort. In the dynamic training athletes can use rubber bands and extra weight chains, and those give extra resistance in the end of the movement. This type of training is used to gain explosiveness and speed.

6.7 Negatives method

This overloading method can be used like maximum training method, with big weights, 1-3 repetitions and 3-5min recovery. The difference is that athlete does only the eccentric resistance and assistant (spotter, another hand, machine) will do most of the concentric work. Movement should always end in the negative. This eccentric phase should last 4-6s. This can also be done in the end of the set instead of “forced” repetition. This method should not be used in regular basis, but it can help over the plateau in strength development. (Delavier & Gundill 2011, 46-47.)

6.8 Isometric training

Isometric method is close to *negatives method*, a battle against opponent which is not going to move an inch. The problem is that in one effort athlete use only one angle of the whole range of motion (ROM). That can also be beneficial after some injury and when athlete can't use the whole ROM. There should be 4-5 joint angles through the ROM in the training to improve muscle strength (McArdle et al. 2000. 403). The possible decreases in muscle elasticity and loss of speed of movement can be avoided with stretching and relaxation. The huge benefit in isometric method is that it will recruit huge amounts of motor units which is really difficult using other methods. Isometric work should not last more than 5-10s in this and other methods like negatives method. The CNS fatigue is huge even when athlete does not feel it like in other muscular training. Isometric training can be used to defeat plateau in development. (Read 2013.)

We can find specific body positions like **Scrum** in rugby where this method is affective. The angle of hip and knee should be close to 90 degrees and if the scrum is not going forward, then it should also not take a single inch back (Greenwood 1997. 176). Nowadays the training would need to be from 90 to 110 degrees. Isometric training will be good method to train for the strong correct body positions without special equipment.

6.9 Plyometric method

Plyometric method consists of different drills and exercises where muscles, ligaments and tendons rapidly stretch in eccentric movement and then rapidly concentric contraction occurs. Quicker the eccentric phase is, the quicker the concentric phase is. Method uses elastic muscles as really strong string or rubber band which collects the elastic energy when it stretches and gives explosive start for the concentric contraction. Normally plyometric trainings are different jumps. (Beachle & Earle 2008, 422-425.)

These trainings should start from the basics every time as an example running coordination or stepping ladders making sure that body is 100% ready for it. If athlete has any problem in knees

or ankles, these should not be done without professional assessment and guidance. The body positions needs to be corrected first for the jumps. In the beginning there should be jumps with both feet for some time and different landings before attempting jumps with only one foot or as a continuous jumps exercise. When physical conditions are ensured there are possibilities to train box jumps, hurdles, depth jump etc.

Rugby players are heavy and there is a special need to find good surface to do plyometric training. Also, before the beginning of the actual training you need to ensure the full ROM in the warm up to avoid injuries. Plyometric training is about the quality not quantity, so the focus need to be 100%. Ground contact should be as short as possible. Knees, hip and heels should go up to maximize knee drive, and reduce the arc and rate of the swing leg. Landing should be “quiet” on the balls of the feet and toe up to lock the ankle to support, and have body posture in the upright position.

Relaxation is important part of training as well as correct breathing technique. The face and the neck should be relaxed in optimal postural position. Inhale during landing phase, then hold the breath during stretching phase and exhale after shortening phase is complete. Average recovery between sets is 2min but in high intensive shocking exercise it can be up to 3 min. Lighter exercises can have recovery time from 30 to 60s. Once a week is a good amount of stimuli from plyometric training because there are other loads for the nervous system in rugby training (Walsh 1990. 34-44; Farentinos & Radcliffe 1999. 28-29).

	Off season	Pre-season	Game season
1 st year No. of contacts/session	60	100	50
2 nd year No. of contacts/session	100	150	70
*Player should be able to back squat 150% from own body weight **Double leg jump is one foot contact and triple jump is counted two foot contacts			

(Walsh 1990. 34-44.)

6.10 Contrast training

The athlete completes a set of heavy loaded strength type exercise following by a lighter more explosive exercise. Example 6 sets of 80% 1RM load dead lifts followed by 4 sets of hurdle hops. This is affective to develop explosiveness and also recommendable for beginners. (IRB 2014.)

6.11 Complex training

The athlete completes a series of sets using a heavy resistance and then completes a series of explosive lighter loaded movements. Example back squat 80% followed by box jumps with 3min or more (up to 10min) rest between movements. This have found to be effective in power development. (IRB 2014; Keränen 15.4.2015.)

7 Energy expenditure

Players play in different roles and the physical activity might be different, but the average energy expenditures are around to 5000kj during the game and average 60kj/min, heart rates at approximately 160-170 beats/min. Sprinting, tackling, kicking, passing, and set pieces relies on anaerobic energy supply. “The development of fatigue during a game seems to be related to depletion of the muscle glycogen store.” (Gleeson & Maughan 2004).

All these actions from rapid muscle contraction need energy that is supplied from the breakdown of **Adenosine Triphosphate (ATP)**. All these actions that are repeated during the match, the player needs all three energy systems to resynthesize ATP for the whole game, **phosphagen -, anaerobic(lactic)- and aerobic** system all at the same time, but to be used in this order. When for example, when sprinting or 1 vs 1 struggle that lasts only seconds, the substantial fuel is **phosphocreatine (PCr)** after ATP stores are empty. When the working time stretches over 1 min or the recovery is not complete, between short actions the body uses **anaerobic system** to satisfy the need of the muscle movement “**without oxygen**”. When body starts to need oxygen to break down the carbohydrate to the energy, the lactate start to appear and anaerobic contribution start to decrease. **Aerobic** contribution stays the same or possibly increases a little, which means that the relative aerobic metabolism increases during the match. When there is again enough oxygen (lower intensity or other recovery) for the activity, body circulates lactates back to energy. Aerobic system primarily uses carbohydrate and fat as a fuel (Bonci 2009).

Energy demands in rugby are anaerobic- and aerobic and the main fuel sources are carbohydrates and fats. In training demands we should train athlete’s body to work in these frames. Those players who can burn fat as energy more efficiently are saving the glucose for the end of the game and can be more alert for the sprint needed. The bases of the endurance training are to be done in the preparation and development phases, also athletes should vary the work loads and intensities in different methods. Endurance training should be started with moderate intensity duration of one hour or more in general preparation phase. In specific preparation phase high intensity anaerobic training with shorter duration should be trained

instead. When the pre-competition and competition phase comes closer, rugby players should stay close of the work rates of the rugby game front five 1:4 and others 1:6. The mean heart rate from the forward player was measured at 173 beats/min and from the back player 169 beats/min, when those were measured from professional rugby players in the actual rugby game (Cunniffe et al. 2009; Hawley et al. 1997).

8 Endurance

Endurance is commonly divided in muscular- and aerobic endurance (cardiovascular endurance). **Muscular endurance** we can see in different wrestling situations like scrums and mauls which lasts more than 10 seconds. Muscular endurance development is mostly connected to resistance- (Chapter 4.) and to anaerobic training. **Aerobic endurance** is combination of cardiovascular- and respiratory systems capability to maintain oxygen delivery during prolonged physical activity and ability to process energy aerobically in the muscles. **Anaerobic endurance** is the opposite from aerobic endurance, short but intensive bursts using ATP-PCr systems and anaerobic breakdown of glycogen in the muscle. (Kelley, Wilmore & Costill 247-277.)

When we look at the endurance training we should come back to the analyses about the game event, how it is planned, and what it includes? If we agree that one individual player starts his warm up 45min before the game, and after that he plays both halves 80min, that is already 135min of physical activity, and after that there is a cool down 15min to start recovering. The professional rugby games work rate 1:5.5-6 with an average heart rate (HR) 174 beats/min (Cunniffe et al. 2009). The game time includes active periods from 5 seconds to 63 normally with average 42 second resting periods (Luger & Pook 2004, 6). In high level active periods the game time can rise sometimes over minute. This kind of activity needs good energy use from the body to cover the whole game day and get it back to recover.

Training endurance in sports and especially for rugby is a challenging task and need more research from longer periods. The best ways to develop endurance in long term is unclear, but there is something where we can rely on (Larsen 2010). The big discussion in science is the effects between long duration (± 60 min) training with same pace and short maximal intermittent training. Tabata et al. (1996) found that short (20s) high intensity training bouts repeated many times with short (10s) rest periods increase both aerobic and anaerobic endurance significantly and better than long same pace training. This type of training stimulates maximal oxygen uptake and accumulates oxygen deficit, which are really important in rugby. When high intensity training bouts are longer (30s) and also rest periods (2-3min) the oxygen debt has time to recover and maximal oxygen uptake don't raise as high then in shorter rest.

Longer rest can replenish PCr stores, what is needed again high intensity anaerobic work. If the work bout produces too much lactate to the muscles, the resynthesize of lactate to glycogen is needed and the PCr restoration is delayed. That can cause that 2 min or 10s rest effect is the same. (Tabata et al. 1997.)

Is there no use for long moderate or low pace jogging and bicycling in aerobic endurance development anymore? It is proved that also short high intensity (HIT) training develops aerobic endurance (VO₂ max) (Tabata et al. 1996)? Kenley et al. (2012) have suggested that moderate pace aerobic endurance training should include every athletes program to avoid leg problems and survive with less competition fatigue. 25-30min continuous aerobic training is shown to reduce lactate production in high intensity tests than high intensity training (Tanisho & Hirakawa 2009). High intensity training can be ~75% less time consuming to get same results in aerobic endurance development than low pace trainers (Kenley et al. 2012, 264). This can come handy, when there is no other training stimuli for the fast-twitch (type-II) muscle fibers. Light endurance training which uses slow-twitch fibers (type-I) can work along with power and anaerobic development as using different muscle fibers (Kenley 2012, 260). When rugby players train more the need of the recovering low pace training rises also after hard trainings and games.

Rugby players should ensure the base of aerobic fitness and work capacity with low and moderate pace long duration exercises in the beginning of the training season. This is usually done with hard strength training season and is exhausting, and it is important to change to high intensity endurance training to stress anaerobic and aerobic endurance together. “More demanding the training, the greater the fitness benefits”. (Tabata et al. 1996.) Anaerobic and power development should be not be mixed with high intensity endurance training, because fast type-II fibers need ATP-PCr system to activate (Kenley et al. 2012, 260, 272).

9 The methods of endurance training

Central nervous system, athletic will power, aerobic capacity, anaerobic capacity and speed reserve are the factors which affects in the endurance training (Stone M.H., Stone M. & Sands 2007. 84). The very basic demands of endurance training in other sports are really similar to the rugby game so that we can agree as a rugby specific training. Also, demands of lactic acid threshold and lactic acid circulation are big part of the endurance training in rugby. We can always try to input more game related decision making situations in it, and introduce the rugby ball to be even more specific most of the times. This is facility and time consuming issue to manage. We just need to be aware that the intensities stay correct when we aim at progress in different types of endurance. (Luger & Pook 2004, 183-189.)

9.1 Increasing aerobic endurance

There are several ways to improve aerobic endurance. The most common way is **uniform method**, the long going exercise with 60% from maximum velocity. Even shorter aerobic training has been shown to reduce muscle girth, maximum strength and speed- and power related performance (Stone M.H., Stone M. & Sands 2007. 84-85). If there is no other special need for this kind of low pace session, like recovery from the game, recovering to other training, or in the learning phase, endurance training for rugby players should be done with other ways. (Luger & Pook 2004, 183-189.)

To increase the aerobic endurance one set needs to be 3-10 min long and the intervals between sets with maximum 3-4 min rest. New set should start when heart rate (HR) is around 120 beats/min. The velocity in sets should be around 60% from maximal velocity and HR 130-150 beats/min.

9.1.1 Alternate method

This method will improve cardiorespiratory and CNS capacity. Single training can take 90min or less and can be divided in smaller proportions (example 20min x 3) and has active recovery between the sets. During the set HR should peak until 180 beats/min and then decrease velocity to bring HR down to 140 beats/min to recuperate. Changed velocity will last whole set. (Bomba 2009, 344-360).

9.1.2 Fart leg/Speed play

This method is based mostly on athletes feeling. The athlete will sprint the length what he desires and then slows the velocity to walking and sprints again when feels for it. Another way is to measure the start of the new sprint from HR or distance. For example, when HR comes down to 140 it is time to sprint again, or measure certain distances before the session which will be sprinted and which will be walked. (Beachle & Earle 2008, 500)

9.1.3 Interval training

This well-known method has many ways to cooperate with it. There is a possibility to have different lengths of work and intervals between, but also different ways for the recovery during interval. It is important to follow the heart rates to stay in the aerobic level (Bomba 2009, 344-360).

Example training for off season: Rowing or jogging 4 x 10min in HR 140-150 beats per minute. Have 2-3min rest between the sessions, and let HR drop below 120 beats.

9.2 Increasing anaerobic endurance

The improvement of anaerobic endurance needs high intensities from sub maximal to maximal velocities. Working in the areas from 90-95% maximum is mentally demanding. The sets can last 5-120s and the rest lasts 2-10 min to replenish the oxygen debt. If there are several series

including many sets, there should be one longer interval of 6-10min so that accumulated lactic acid can oxidize. The aim is to enhance the rate of anaerobic glycolysis and increase the anaerobic capacity. (Luger & Pook 2004, 183-189.)

9.2.1 Interval training/model training

Interval training is the same as earlier described aerobic methods, but having shorter duration and intensity with HR going over 170 beats/min.

Model training is a specific interval training to follow the game or race event. It is mixture of different kind of work load, velocity, and rest. (Beachle & Earle 2008, 475.)

9.2.2 Lactate acid (LA) tolerance training

This is the most important training for all the rugby players to be an effective player. Athletes who can adapt to this training have their bodies handle lactate clearance better and they can exercise at higher levels of intensity and output. This is the only “no pain, no gain” physical training which players should do. There are REAL positive effects and increasing aspects both physically and psychologically. Athletes who adapt and learn to tolerate increases of LA can work more intensively and produce more LA, because it is then not inhibiting the work. This way, toward the end of the event, player can produce more energy anaerobically (Bomba 2009. 258). When we train our LA system to release energy to resynthesize ATP well for the anaerobic glycolysis, we can be powerful even when peripheral fatigue is huge.

In this method work periods less than minute needs 4-8 (2 x 2-4) repetitions. Longer 2-3 min (4-6) periods can be used, if athlete is able to keep HR close to the maximum for the whole repetition. Normally the maximum limit of LA tolerance is reached in 40-50s. Rest should be 10-15 times bigger than the time of work so that LA leaves from the working muscle. There is a chance to do overlapping muscle groups, but the intensity needs to stay close to maximum to have right training stimuli. It is advised not to do these kinds of trainings more than 1-2 times per week (Bomba 2009. 258).

9.2.3 Phosphate system training

The aim of this training is to increase the quantity of ATP-creatine phosphate (CP) stored in the muscle and increase the activity of enzymes releasing energy through the ATP-CP reaction. Work periods that are needed are only 4-15 seconds long and recovery range is 4-25 times bigger than work period. Long recovery is needed to restore CP in the system. If set last too long or recovery is not long enough, LA will be produced, and training stimuli is unwanted (Bomba 2009. 260).

10 Running speed, agility & quickness (SAQ)

SAQ training may be the biggest part of injury prevention. SAQ training should be implemented to the team training whole year around. There are too many injuries that happens without contact in turns, changes etc. in rugby as well as in other sports. Agility training is really good for the warm ups to open the range of motions, and wake up the body for the further training whatever it is. In her floorball study (Pasanen, 2009) found that 20-30 min SAQ training 1-3 times a week as a warm up reduced 66% injuries in training group than in control group in 6 months period. Nevertheless, it is wise to perfect the basics before going too creative, because too sloppy SAQ training will do more harm by teaching wrong movement patterns (Brown & Ferrigno 2005.224).

10.1 Agility

Agility is an expression of an athlete's coordinative abilities, which are the basis of acceleration, deceleration, maximum velocity, and multidirectional skills (Beachle & Earle 2008, 470).

Planning the agility training needs just imagination, but it is good if you have the same cones, ladders, hurdles and sticks to help the creativity. Agility trainings can be done in few steps area using only simple equipment to the complex agility tracks. It is important to stimulate the really simplest coordinative skills as running, jumping, throwing, body position, moving in different ways and in different directions. After everything runs smoothly, we can complicate the training again with more game related situations. Normally in agility training, the speed or intensity is not essential, but to be able to concentrate 100% will determine the success in the activity. (Beachle & Earle 2008, 469-474.)

10.2 Quickness

Almost all agility training made by feet could be transferred to the quickness training by adding "Do it as fast as you can now!" When the intensity of the movement rises, you have quickness training stimuli. Again, you train coordinative skills, but it is more challenging for players to do it quicker. Using agility and quickness trainings as the warm up for the training these should be

demanding, and more, if it is the topic of the session. Full concentration is needed to get sharp action and to get correct stimulus. Different kind of decision making in situations through visual stimuli will be beneficial in the training (Baechle & Earle 2008, 470, 472).

10.3 Running speed

Running speed is the most essential ability when scoring points by carrying the ball in rugby. When talking about training running speed we need to look stride length and rate but also reaction time, acceleration and starting ability. These are mostly neuromuscular abilities and cannot be trained if athlete is not fully recovered from previous workouts. It is wise to plan speed development training to the beginning of the training session. The best development for the CNS occurs when athletes are “fresh” and explosive (Brown & Ferrigno 2005. 17-22).

We train a lot of strength of the leg which push us away from the ground, but we need to look at the ROM as well. If we can stretch the stride length by 15cm we are around 0,1s faster in 10m depending of the stride rate. This can cause the loss of frequency, but working together with stride rate the results are good. Especially for the back players this should be highlighted that even the stride rate is the most important for the rugby players. Higher the frequency, higher is the possibility to produce locomotive energy and direction change. (Brown & Ferrigno 2005. 17-22).

The explosive start, acceleration, and deceleration are really important when scoring the try. In the rugby game, the major amount of intense accelerations does not start from standing situations (Cunniffe et al. 2009). This could be recognized easily in speed training. Also they proved that the most of the sprint distances were between 10-20m during the game, so short explosive acceleration should be the most common way to train speed for rugby. In this, sprints body position hardly never opens like in the stride of sprinters, but this should be also trained in the sake of correct running technique. Still, 6% of the game is sprinting and 10% cruising, 14% striding and 5% high intensity running. The benefit of correct technique will come back in energy saving. (Cunniffe et al. 2009). Training deceleration during speed training is really important for the rugby players. Deceleration occurs in changes of speed and direction when

players are various situations like dodging, stepping with the ball and support running. (Beachle & Earle 2008, 470-473.)

10.4 Running speed training methods

The methods vary in speed development as in training other abilities. Moving on foot is common but most important way in rugby conditioning with other power exercises. The base of the speed training for the rugby is 100% effort to get power, but the coordination and anaerobic endurance are important stimuli also. Work and recovery rate should be at least 1:10 between sets, and between series to have full recovery of 6-10 min. Two minutes is a short recovery and ATP and PCr stores are not full. Ten minutes means full rest. There can be mixture of different kind of methods in one session, and then loads should increase between sets and series from small to maximum. Different effects to ignite the movement brings needed game situation to these trainings. (Bompa & Haff 2009, 324-325.)

10.4.1 Repetition method

Athlete will work out selected distance depending from the role on the field and number of repetitions in one set. For example, do 4-6 repetitions of 40m and recovery time between 2-3 min. There can be multiple sets in different distances. This kind of training improves coordination and sprinting power (Carr 1991.19-20).

10.4.2 Running coordination

These slow pace coordination trainings have good nervous training stimuli itself when the movements are made concerning them to be sharp and accurate. The common drills are shuffling, carioca, high knees, high heels, backward run, one leg running, galloping, quick step, straight leg running and many others. Also, mixing these to complicate drills, challenges the CNS very well. For the warm up, there can be walking back recovery, but without feeling lactic acids, and not cutting the edge from the actual training. Higher intensity training can have recovery from 30-60s. (Farentinos & Radcliffe 1999. 28-29).

10.4.3 Contrast acceleration method

Contrast acceleration method teaches quick transitions in speed and enhances stride frequency of acceleration (Brown & Ferrigno 2005,59-60). Assistant uses bullet belt, towel, rope or hands to resist the stride from behind. Athlete need to pump with the legs and hands explosively. It is possible to let go after five pumps to avoid the lactic acid creation after it, but this depends of the aim of the training.

10.4.4 Assisted acceleration and speed

This exercise increases acceleration when done in shorter distances; longer distances increase top speed and stride frequency. Athlete can be helped by towing with the rubber band when running in 3-7 degree declination (Beachle & Earle 2008, 473). It is suggested to train on the grass to avoid injury if athlete falls.

10.4.5 Resisted acceleration and speed

Resisted acceleration can be trained in stairs which improves starting power and stride length. Resistance can come from the weights or from the assistant on the flat acceleration to aim elastic strength for the start from zero speed. This acceleration training should be between 4-8 s to get best power input to the movement. Resisted speed training can be made in sand, uphill and with equipment like sledge or parachute. When using equipment the resistance should not be $\geq 10\%$ ($\sim 1\text{m/s}$) (Beachle & Earle 2008, 473). This type of training enhances running strength and power and also increases stride length. To improve speed, the inclination can be only in 1-3 degree angle. Sledge or parachute can be released to include “over speed” feeling like assisted speed method.

11 Stretching

As it is said, the rugby player should be mobile and strong to prevent injuries. Also with good range of motion (ROM) athletes can produce more Power. Good mobility means that joints can move in their ROM without restrictions and using appropriate muscles to it. There are many ways to develop mobility. All dynamic movement has possibility to improve mobility. Stretching the length of muscles and ligaments has a big part in it. There are variety in methods and times when different methods should be used. Different stretching methods works better for some of the athletes than to other ones. It is wise to try different methods to find the best ones for different situations. (Beachle & Earle 2008, 296-324.)

In the beginning of the training it is good to open the muscles and ROM by stretching. The length of stretches should be 2-10s before training and after the warm up. After training, the muscles should be stretched to the complete length to let nutrients inside the muscles and ensure the beginning of the recovery. These stretches should be 10-30s. Over 30s (-120s) stretches should be used in the separated mobility training or combined after easy aerobic training. (Beachle & Earle 2008, 296-324.)

11.1 Static stretching

Traditional static stretches should be made after all speed and power movements are completed during the cool down (Brown & Ferrigno 2005.224). Static stretches that lasts too long can have a negative effect for the power production in the beginning of the training. Long static stretches are base for maintaining the mobility and expanding it. Normall static stretches are slow and lasts 30 seconds or more. (Beachle & Earle 2008, 300.)

11.2 Ballistic stretching

Ballistic stretching is a bouncing type of movement. Athlete don't stay in the end of the stretch, but just activates the muscle and bounces back. Normally used as a pre exercise warm up.

Danger is to cause injure or damage more already injured tissues especially for those athletes who have back or hamstring problems. (Beachle & Earle 2008, 300.)

11.3 Dynamic stretching

Dynamic stretching means opening the ROM with movements which will stretch the muscle fibers and ligaments. This is the opposite way than static stretching, and good method to combine with other exercises in the warm up. These movements should be done with slow and concentrated motion to avoid injury. After the intensive training, when fatigue occur, the dynamic stretches should be avoided. There is a chance that the nerve receptors don't give clear signal for the muscle to contract when fatigue is too high, and rapture in tissue may occur. (Beachle & Earle 2008, 300-301.)

11.4 Proprioceptive Neuromuscular Facilitation Stretch (PNF)

PNF stretching is usually made with partner or equipment (towel, rubber band etc). It involves passive and active movements (concentric and isometric). There is three types of PNF stretches. (Beachle & Earle 2008, 300-306.)

Hold-Relax includes passive pre stretch in the point of mild discomfort of 10 seconds. Then athlete resists partner's slow pressure to the direction of stretch so (concentric), that isometric muscle action occurs (static) for 6 seconds. Then athlete relax and 30 second passive stretch is used. The last stretch should be with increased ROM to make sure inhibit movement.

Contract-Relax starts the same then Hold-Relax with the pre stretch of 10 seconds. Then partner release the pressure slowly that whole ROM occurs. Then again 30 second passive stretch and increased ROM and inhibit movement.

Hold-Relax With Agonist Contraction is identical with hold-relax in first two phases. Third phase is to help partner's pressure to the same direction with agonist muscle. ROM in the last phase should be greater.

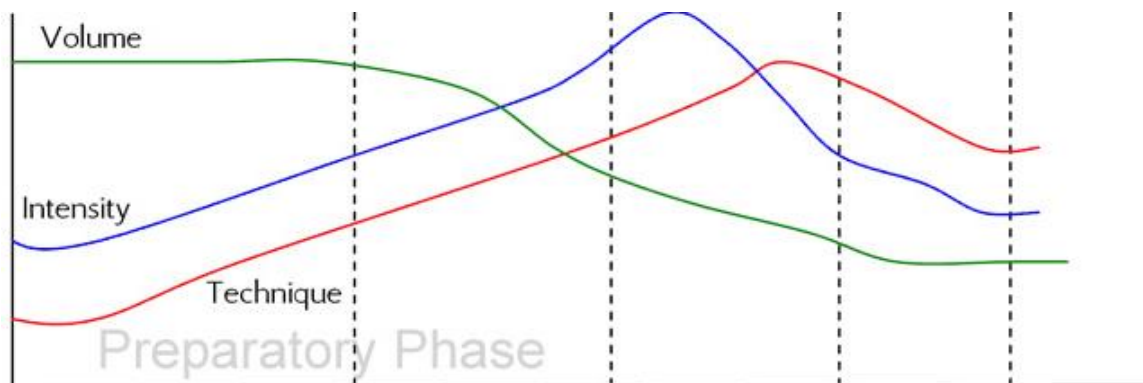
12 Planning the training for Finnish rugby season

The annual year plan includes different phases to describe to activity in team training. It is divided in three phases; transition, preparation and competition phases. These include smaller mesocycles especially for the individual conditioning needs. Mesocycles can last 2-7 weeks depending of the time of the season and density of the cycle. The game season is short in Finland and that make Transition and general preparation phases longer than normal seasonal rugby periodization. These long phases should be divided to smaller phases as an example **transition phase** is divided to **respiratory phase** and **pre preparation phase**. Actual preparation phase can be divided to **general preparation** and **specific preparation**.

Microcycles are the smallest form of the training cycles and contains training plan for 3-7 days. There are different microcycles throughout the year and they vary depending of the training demand and recovery needs. It is important to have a rough annual plan for the conditioning where you have a robust idea of the training season. Normally the loads are bigger in the beginning of the season and gets smaller closer to the game season. This causes a lot of fatigue mentally and physically. Fatigue should be monitored from the heart rates and workload tables to avoid overtraining. Intensity increases as the game season comes closer. The season structure in Finland is little different from the other rugby nations. During the winter there is a lot of time for the preparation and game season is quite short. Game season has found its place to be between from the middle of May to the end of September. (Bomba & Haff 2009, 125- 148.)

The preparation should start with short adjusting period after in transition phase to be ready for the high volumes in preparatory phase (general training). Intensity and technique should rise towards season until comes the games starts. Volumes need to drop for the season to release the fatigue from the training season. (*Picture 7*)

Picture 8. Monocycle=Annual plan.



GENERAL PREPARATION, SPECIFIC, GAME AND TRANSITION PHASE

(professionalsoccercoaching.com.)

12.1 Transition phase

Season should start immediately after **the game season** with **respiratory phase** for 4-6 weeks. The respiratory phase should give a possibility for the body to have full recovery. This means that all the small bruises and micro raptures have time to recover totally. This phase usually includes at least one or two international games and it means shorter rest period for the players from the national selection. It have been studied that muscle mass start to decrease after 10 days of full rest and cardio respiratory. Still it is important to have at least 2 weeks recovery without any activity which causes impact or stress for tissues. It is mentally important to forget rugby for the short period but maintain active lifestyle for the **active recovery**. Transition phase includes 1st part of the **general preparation** (pre preparation) for 5-7 weeks. Then it is the best time to lose weight, get muscle mass, and adjust the **body composition** if needed. This is the time to build the platform for the actual training season. The team training is not really challenging tactically, but going through the individual **basic skills** for the future. The **endurance** training for the forwards is essential. (Bomba & Haff 2009, 125- 148, 156-166.)

12.2 Preparatory phase

Preparatory phase is divided in **general preparation** for 7-10 weeks and **specific preparation** for another 7-10 weeks. General preparation phase means increase of **speed** and **power** training for the individual players, but could be included in the team training as well. The team training continues almost the same, but **small unit skill** and **game sense** exercises are implemented in the training. **Specific preparation** means specific training for the different roles and positions in the field. Still, we don't forget the individual needs, but forwards should pay attention to their scrumming abilities in the gym as well. Backs should be concentrating in their evasive skills as a specific power and speed training. Team training in specific preparation phase is all about rugby basic skills, but mainly team skills. (Bomba & Haff 2009, 125-150.)

12.3 Competition phase

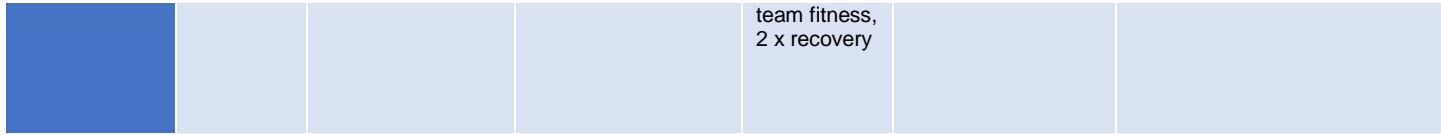
Before the actual competition phase there is a short **pre competition phase**. Exercises in the training are all about rugby specific and are looking to put team skills, tactics and the whole team movement in place. There should be some preparation games to analyze the team movements and bring it back to the training before the actual season. Individual conditioning should be close to maximum in power output. Main **competition phase** is mostly maintaining the fitness and strength levels, but peaking should happen before the most important games in short **peaking cycle (taper cycle)**. In the middle of the summer there is a break in games for 2-3 weekends when there is a chance for the increased conditioning period if needed. Team training is maintaining skills and adjusting the team skills. (Bomba & Haff 2009, 125- 148, 151-157.)

Annual training plan JRC 2014-15

	Transition		Prep.		Compet.		Transition
<i>Phase Time</i>	Transition /Respiratory phase	Transition/ General prep.	General prep.	Specific prep.	Pre compet.	Main compet.	Transition /Respiratory phase
	5 weeks (40-44)	6 weeks (45-51)	10 weeks (51-8)	9 weeks (9-17)	4weeks		4 weeks (41-44) 28.9.15

Type of training	4.10.14	8.11.14	20.12.15	28.2.15	25.4.15 (18-21)	19weeks (22-40)	
TACTICAL & TECHNICAL	Rest, Other sports then rugby Includes 3 week period when no sports at all Optional skill clinics	Other sports then rugby General skills, General fitness Positional skills Optional Skill clinics	General skills, General fitness Positional skills Small unit skills Game sense	Team skills Small unit skills Positional skills Game sense General fitness	Team skills Small unit skills Positional skills Game sense Training based on game analyses	Game sense Training based on game analyses 3 week increased fitness training in the summer break	Rest Other sports then rugby Includes 3 week period when no rugby at all. Max. walking and easy cycling
	Indoor turf, killeri 1/week Indoor court, hippos 1/week All optional and for the beginners course	Indoor turf, killeri 1/week Indoor court, hippos 1/week Optional wrestling 1/week Training camp	Indoor turf, killeri 1/week Indoor court, hippos 1/week Optional wrestling 1/week Beginners course	Indoor turf, killeri 1/week Indoor court, hippos 1/week Optional wrestling 1/week Training camp	Indoor turf, killeri 1/week Outside turf, Vehka 1/week Indoor court, hippos 1/week 2-3 Training games Training camp	Outdoor grass, Huhta 2/week Games	Indoor turf, killeri 1/week Indoor court, hippos 1/week All optional and for the beginners course

Phase Time	Transition phase	Anatomical adaptation phase	Maximum strength phase	Conversion phase	Maintenance phase	Transition phase
	5 weeks (40-44)	8 weeks (44-1)	14weeks (2-15)	5 weeks (16-20)	20weeks (21-40)	4 weeks (41-44)
Type of training	4.10.14	8.11.14	12.1.15	30.3.15	4.5.15	28.9.15
Resistance training TEAM	Rest & recovery	SAQ, Endurance, Fitness, (Power prep.)	SAQ, Fitness, Power (Speed and plyometric)	SAQ, Specific Fitness, Specific Power	SAQ, Specific fitness, Specific power	Rest & recovery
Resistance training INDIVIDUAL	Rest & recovery	Strength, endurance, (Power)	Power (Speed & MxS), strength, Fitness	SAQ, Specific Fitness, Specific Power	SAQ, Specific fitness, Specific power	Rest & recovery Easy gym training
Fitness TEAM	Recovery	Work ´n rest rate 5:1 – 2:1 Aerobic training	Work ´n rest rate 4:1 – 2:1 Aerobic & anaerobic training	Work ´n rest rate 2:1, 1:1, 1:2 Specific anaerobic & aerobic training	Specific fitness	recovery
Frequency of training/week	2-3	2 x team training, 2-3 x resistance training, 1 x team fitness, 2 x recovery	2 x team training, 2-3 x resistance training, 1 x team fitness, 2 x recovery	2 x team training, 2 x resistance training, 1 x	2 x team training, 1-2 x resistance training, 2 x recovery	2-4



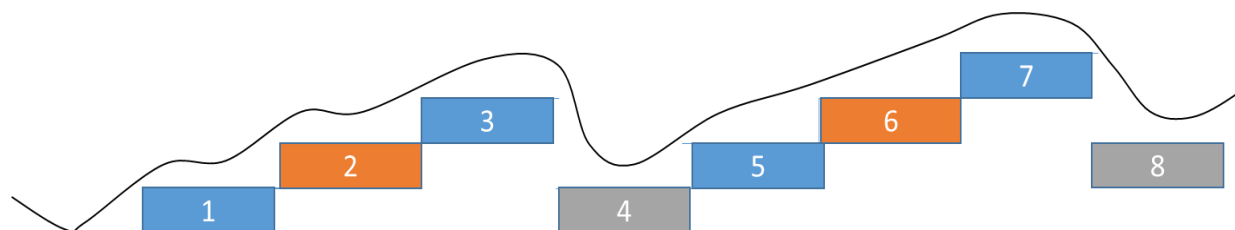
Jyväskylä Rugby Club men´s team training plan 2015 by Henri Tyrväinen

13 Planning training for recovery

The most important demand for the development is recovery from the earlier training stimuli. We can train too much or vary the training too little if we don't plan ahead. When we have the **annual plan** we know the main stimuli in our training for each **macrocycle** (picture 9). Then we choose the methods to develop wanted physical attributes in the macrocycle. With that we avoid trying to develop everything at same time. Macrocycles breaks down to the microcycles which should be planned ahead, but should be flexible for the individual needs. Athlete should have a training plan for at least one **microcycle** (Picture 10 and 11) ahead. (Bomba & Haff 2009, 97-105.)

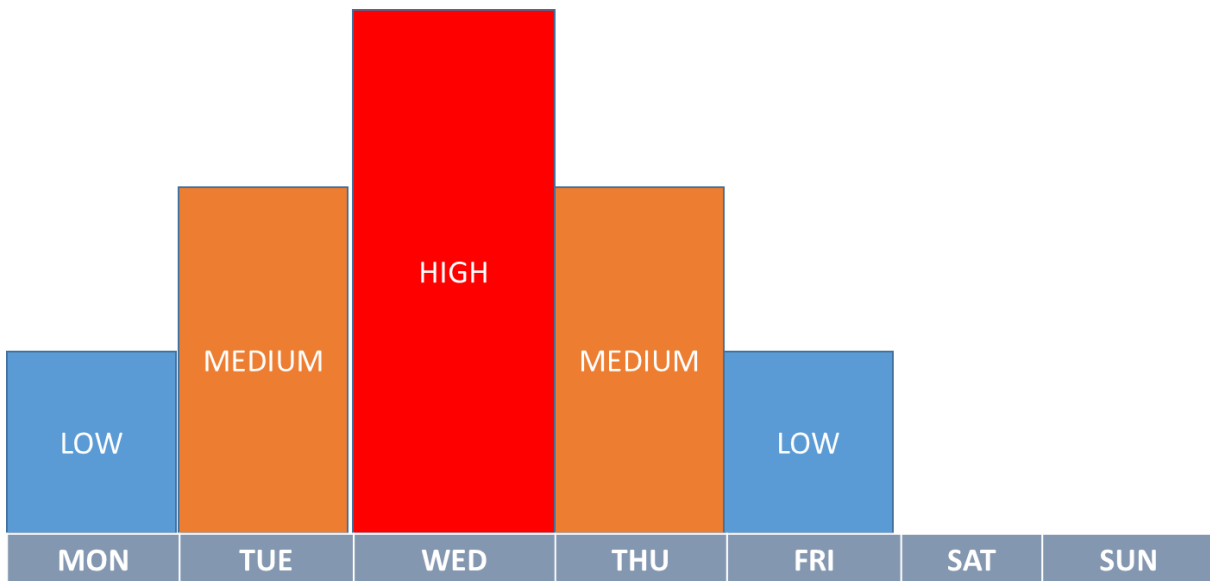
When planning the microcycle there should be different types of training overlapping in stimuli and recovering times. This is essential way to get enough training to develop different physical abilities at the same time. It is advised that in hard strength training the recovery is at 2-7 days but plyometric training use same eccentric movement. When these kind of trainings are planned in same microcycle the loads should not be 100%. The maximum nervous stimuli in speed training, power-velocity or 1RM training are hard to assume because it is related to recovery inside the muscles and nerves. For the minimum recovery for this kind of 100% training is 72h. Speed endurance training recovery is again really individual, but 1-2 times the recovery time is recommendable. Tactical and technical training brings peripheral tiredness with all the other training. With a good night sleep tiredness will be recovered. (Bomba & Haff 2009, 97-105.)

Picture 9. Example of eight week step loading macrocycle in preseason. Load rises every week until fourth is easier week. Fifth week starts from the same level as second. Curve shows undulating load.

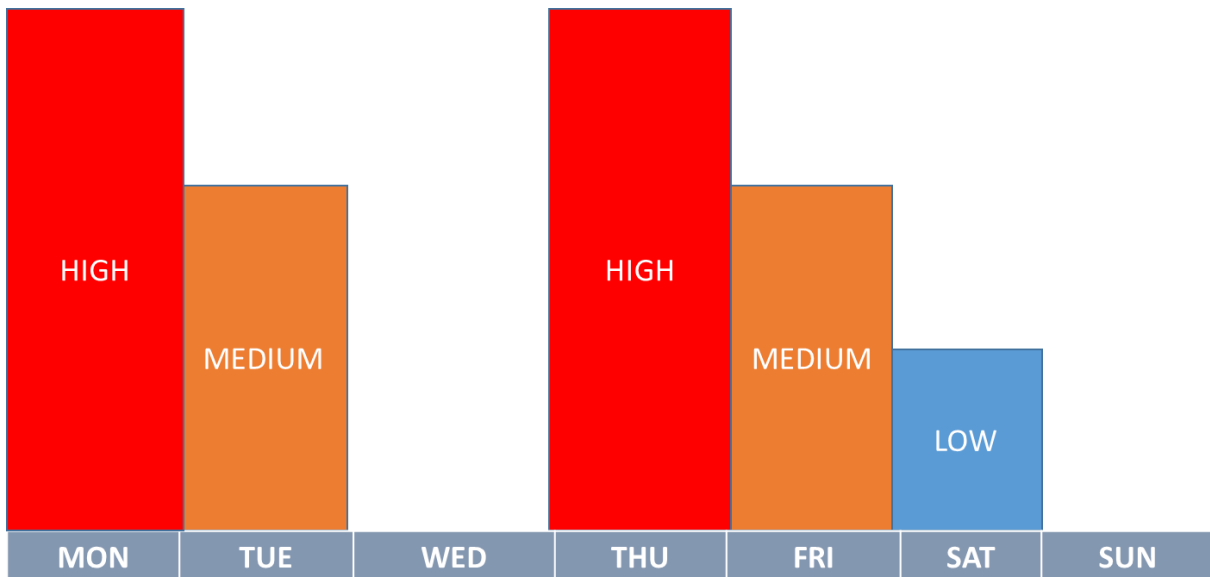


(elite-athletic-performance.com/russian-strength-training.html.)

Picture 10. Example of five day resistance and team training microcycle where the highest load is the middle.



Picture 11. Example of five day resistance and team training microcycle where is two high load trainings.



14 Summary

In this work I have represented methods to use for rugby conditioning. I wanted to bring the ideas forward which are really effective and needed for the physical conditioning for the demands of rugby game. The correct techniques for the phosphate system training and lactic acid tolerance training are needed to get our players fit for the game. Also, strength and power training has to vary for different roles and positions to get one step forward and to get better results.

The main message is that we need to take more professional ways to get our players to better shape in Finland. There is plenty of knowledge for us to use, but we need to collect better information about our players. We have possibility to understand our athlete's individual needs better, when we are monitoring them in longer periods. This needs a hard look to find the best ways to collect the information to our use and to put better conditioning plans in to action.

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Appendix 5. Warriors Rucby Club (Helsinki) fitness test results 2015

Warriors fitness club				Season 2015		November 2014							25.11.2014	
Fitness tests														
				Endurance		Speed		Agility	Strength					
				Bleep test (level)	7minute test (resu)	20m sprint (s)	20m speed (s)	T-run (s)	Deadlift max (kg)	Own weight bench press (1min max reps)	Own weight front squat (1min max reps)	Pullups max (reps)	Max overhead press (k)	
Last name	First name	Position(s)	Weight (kg)											
#	Hyvärinen	Petteri	Back											
#	Kokkonen	Jani	Back											
#	Kopakkala	Olli	Back	85										
#	Mohell	Tino	Back	80					140	65kg	(back squat)	4	4	45
#	Nieminen	Teemu	Back	95										
#	Niiranen	Oskari	Back	77										
#	Saarnia	Rasmus	Back	87							4	13	6	
#	Sarkkinen	Nicholas	Back											
#	Sarkkinen	Chris	Back	75					145	10	13	15	60	
#	Tervo	Hemppe	Back											
#	Cozzi	Johnathan	Back row											
#	Eskola	Kosti	Back row	114					210		3	8		
#	Mikkola	Juuso	Back row	85					170	11		16	55	
#	Moilanen	Aleksi	Back row											
#	Patola	Tuomas	Back row	100					170	95kg		1	3	55
#	Talasmäki	Eero	Back row											
#	Vilen	Jaakko	Back row											
#	Virrankoski	Petri	Back row											
#	Finell	Thomas	Centre	88					170	11	10	10	70	
#	Hyytiäinen	Matias	Centre	97					160	7	3	3	70	
#	Lammi	Antti	Centre	92					180		11	19	80	
#	Meriläinen	Jussi	Centre											
#	Pekkola	Erik	Centre											
#	Vento	Isak	Centre	77										
#	Kiias	Sami	Flank	90					150		8			
#	Almenoksa	Aleksi	Flank/Wing	88										
#	Atkins	Duane	Flyhalf											
#	Sariola	Lasse	Flyhalf	80										
#	Karnau	Kevin	Forward	97					200	10	8	13	80	
#	Gröndahl	Mikko	Front row											
#	Hakkarainen	Harri	Front row											
#	Uotila	Iiro	Front row											
#	Siren	Juuso	Fullback											
#	Valtia	Valteri	Fullback	75					180	15	13	13	65	
5	Pappila	Antti	Hooker	95					80kg			2	60	
6	Vikström	Patrick	Hooker											
8	Andersson	Henrik	Lock											
7	Keskinen	Jussi	Lock											
#	Lännpää	Antti	Lock											
#	Reynish	Stuart	Lock											
9	Simpanen	Lasse	Lock											
2	Kivinen	Lassi	Prop	109							1	2	65	
1	Rainvuori	Juha	Prop											
4	Ryynänen	Riku	Prop											
3	Uosukainen	Jussi	Prop											
#	Parisi	Andrei	Scrumhalf											
#	Wetterstöm	Jim	Scrumhalf											
#	Espinosa	Leonardo	Wing											
#	Hillo	Jaakko	Wing											
#	Hölttä	Janne	Wing											
#	Jokelainen	Jukka	Wing											
#	Jordan	Matthew	Wing											
#	Tanaka	Atsushi	Wing											
#	von Veh	Jochum	Wing											
#	Korhonen	Kasper		84										
#	Marjala	Antti		95					220	12	8	7	85	

Appendix 6. Warriors Rugby Club (Helsinki) fitness test results 2014

Warriors fitness club				Season 2014		9.3.2014					28.11.2013				
Fitness tests						Endurance		Speed		Agility	Strength				
Last name	First name	Position	Weight	Bleep test	7minute	20m spr	20m spe	T-run (s)	Deadlift max	Own weight	Own weight	Pullups	Max		
#	Almenoksa	Aleksi	Flank/Wing	88			2,93		230	10	30	15	70	#REF!	
8	Andersson	Henrik	Lock		10,2									#REF!	
#	Atkins	Duane	Flyhalf											#REF!	
#	Cozzi	Johnathan	Back row											#REF!	
#	Eskola	Kosti	Back row	118	10,4		3,39	3,28						#REF!	
#	Espinosa	Leonardo	Wing											#REF!	
#	Finell	Thomas	Centre		6			3,18						#REF!	
	Gröndahl	Mikko						3,35						#REF!	
#	Hakkarainen	Harri	Front row		5,8									#REF!	
#	Hillo	Jaakko	Wing											#REF!	
#	Hölttä	Janne	Wing											#REF!	
#	Hyvärinen	Petteri	Back	78			3,21		140	9	22	13	60	#REF!	
#	Hyytiäinen	Matias	Centre	93						8		6	70	#REF!	
#	Jordan	Matthew	Wing				3,07							#REF!	
7	Keskinen	Jussi	Lock											#REF!	
#	Kiias	Samu	Flank	85	9,1			3,08	160					#REF!	
#	Kokkonen	Jani	Back		10,3		3,16	3,11						#REF!	
#	Kopakkala	Olli	Back	85					120	75	15	3	45	#REF!	
2	Kostamo	Lassi	Prop	105				3,53	150	4		2	65	#REF!	
#	Lammi	Antti	Centre	90	10		3,02	3,04	190	19	20	16	75	#REF!	
#	Länneppää	Antti	Lock		11,1			3,04						#REF!	
#	Meriläinen	Jussi	Centre											#REF!	
#	Mikkola	Juuso	Back row	80	10,3		3,15		160	14	23	19	50	#REF!	
#	Moiilanen	Aleksi	Back row					3,54						#REF!	
#	Nieminen	Teemu	Back	95			3,18							#REF!	
#	Niiranen	Oskari	Back	77	8,3		3,1		170	16	27	18	65	#REF!	
5	Pappila	Antti	Hooker	92					150	80kg		2	60	#REF!	
#	Parisi	Andrei	Scrumhalf		7,5			3,43						#REF!	
#	Patola	Tuomas	Lock		10,7			3,01						#REF!	
#	Pekkola	Erik	Centre											#REF!	
1	Rainvuori	Juha	Prop		6,1			3,28						#REF!	
#	Reynish	Stuart	Lock											#REF!	
4	Ryynänen	Riku	Prop											#REF!	
#	Saarnia	Rasmus	Back		10,2									#REF!	
#	Sariola	Lasse	Flyhalf	80	9		3,05			15	32		70	#REF!	
#	Sarkkinen	Chris	Back	72,5					145	15	23	17	55	#REF!	
#	Sarkkinen	Nicholas	Back		11,6			3,11	160	11	26	17	50	#REF!	
9	Simpanen	Lasse	Lock											#REF!	
#	Siren	Juuso	Fullback					3,21							
#	Talasmäki	Eero	Back row												
#	Tanaka	Atsushi	Wing												
#	Tervo	Hemppa	Back				3,16								
3	Uosukainen	Jussi	Prop												
#	Uotila	Iiro	Front row					3,49							
#	Valtia	Valteri	Back row												
#	Vento	Isak	Centre	77			3,22		140	9	13	9	55		
6	Vikström	Patrick	Hooker												
#	Vilén	Jaakko	Back row												
	Virrankoski	Petri													
#	von Veh	Jochum	Wing		4,0*			3,3							
#	Wetterström	Jim	Scrumhalf				3,28	3,19							

Appendix 7. Jyväskylä Rugby Club fitness test results 2014

Jyväskylä Rugby Club 2014												
May												
Weight	10m sprint		30m	10m	30m	10m	30m	Horizontal jumps		Bleep test	HR	
	1st	2nd	3rd	Best form 3 jumps		Average	Peak					
Urho Ylinampa	.174	.4.16	.171	.4.11	.167	.4.06	2.8m	11'5	195/min			
Karl Filtress	.183	.4.44	.182	.4.40	.178	.4.34	2.6m	10'3	183/min	ill		
Ilari Kampman	.183	.4.35	.180	.4.28	.181	.4.29	2.6m	12'1	197/min			
Radu Pralea	.188	.4.44	.182	.4.24	.178	.4.21	2.8m	8'10	195/min			
Tomi Moilanen	.191	.4.58	.190	.4.54	.190	.4.48	2.4m	10'9	191/min			
Streght tests february												
Weight	Height	Clean 1RM	Deadlift 1RM	Shoulder press 1RM	Back squat 1min max repetition	Military pench press 1min maximum, own weight						
							own body weight	own weight				
Teemu Elomaa	185	97,5	110	180	xxxxxxx	18	4					
Mikael												
Fakhimzadeh	89	180	xxxxxxx	xxxxxxx	75	xxxxxxx	14					
mikko jussila	89	185	85	70	70	14	13					
Ilari Kampman	101,5	184	100	220	75	21	16					
Aaro Katainen	103	191	110	220	80	25	9					
Mauno Konttila	107,5	184	105	230	80	28	5					
Tuomo Leinonen	99	181	80	155	55	8	0					
Tomi Moilanen	93	185	80	150	60	10	0					
Pertti Salmijärvi	78	182	75	140	50	2	0					
Ville Tirkkonen	90	184,5	100	165	70	17	10					
hene tyrväinen	100	178	xxxxxxx	xxxxxxx	80	xxxxxxx	2					
Janne Heinänen	113,5	178	82,5	200	77,5	11	4					

Appendix 8. Jyväskylä Rugby Club fitness test results 2015

Jyväskylä Rugby Club 2014													
Fitness test 20.3.													
	Weight	10m sprint	30m	10m	30m	10m	30m	Horizontal jumps			Bleep test	HR	
		1st		2nd		3rd		Best form 3 jumps				Average	Peak
Urho Ylinampa		.174	4.16	.171	4.11	.167	4.06	2.8m			115		195/min
Karl Filtness		.183	4.44	.182	4.40	.178	4.34	2.6m			103		183/min
Ilari Kampman		.183	4.35	.180	4.28	.181	4.29	2.6m			121		197/min
Radu Pralea		.188	4.44	.182	4.24	.178	4.21	2.8m			8'10		195/min
Tomi Moilanen		.191	4.58	.190	4.54	.190	4.48	2.4m			109		191/min
Streght tests 11.2.													
	Weight	Height	Clean 1RM	Deadlift 1RM	Shoulder press 1RM	Back squat 1min max repetition , own body weight	Military pench press 1min maximum , own weight						
Teemu Elomaa	185	97,5	110	180	xxxxxxx	18	4						
Mikael Fakhimzadeh	89	180	xxxxxxx	xxxxxxx	75	xxxxxxx	14						
mikko jussila	89	185	85	70	70	14	13						
Ilari Kampman	101,5	184	100	220	75	21	16						
Aaro Katainen	103	191	110	220	80	25	9						
Mauno Konttila	107,5	184	105	230	80	28	5						
Tuomo Leinonen	99	181	80	155	55	8	0						
Tomi Moilanen	93	185	80	150	60	10	0						
Pertti Salmijärvi	78	182	75	140	50	2	0						
Ville Tirkkonen	90	184,5	100	165	70	17	10						
hene tyrvainen	100	178	xxxxxxx	xxxxxxx	80	xxxxxxx	2						
Janne Heinänen	113,5	178	82,5	200	77,5	11	4						