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Technical and tactical game analysis of elite female beach volleyball

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Mikko Häyrinen[1] & Kostas Tampouratzis[2]

[1] KIHU – Research Institute for Olympic Sports
[2] Finnish Volleyball Association

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CONTENTS

ABSTRACT

The purpose of this study was to make an update on the technical and tactical game analysis of top-level female beach volleyball to set a reliable view of game. Another goal was to analyse different technical skills as possible determinants on winning in international top-level female beach volleyball.

A temporal analysis concerning the duration of the rallies, breaks and sets was made. For the technical and tactical analysis 1174 rallies from 31 sets and 16 different matches played in World Tour 2010 and 2011 and European Championships 2011 between world top female beach volleyball teams were analysed. All ball contacts were analysed using a coding system developed for this study using Data Volley 3.4.8 -match analysis software.

The rally duration in female elite beach volleyball was 6.9 seconds, the real playing time in one set 4 min 26 s, the duration of a set 18 min 10 s and the duration of a break 24 s. 61 % of the points were scored by attacking, 24 % from the opponent's errors, 9 % by serving and 5 % by blocking. 39 % of the points were scored in break point situation and 61 % in side out situation. The start of the set proved to be very important, because 87 % of the sets were won by the teams which were ahead at the technical time-out.

Attacking was the most used skill followed closely by setting and serving. Blocking was the least used skill; still a lot of blocking attempts without ball contact were made. The attacks were divided equally to spikes and shots whereas majority of the attacks were executed in side out situation. Jump float serve was the most used serving technique and so the most used reception type was jump float receiving.

Jump float and float serves were found to be as effective and jump serve the least effective serve technique. Especially the error percentage in jump serving was high. The efficiency of spikes in side out attack situations was little lower than shots. In counter attack situations the efficiency of shots was higher. The success percentage in side out attack situation was higher than in counter attack situation and error percentage little higher, respectively. More block touches were achieved after opponent's spike attacks when compared to shot attacks and also more kill blocks were similarly achieved after spike attacks. The digs were performed almost as often after opponent's spike and shot attacks, but the players were more successful in defending opponent's shot attacks than spike attacks.

The set winners were clearly better in side out attacking and blocking and also in counter attacking, receiving and serving. In side out attacking the winners and losers were especially differentiated by succeeding in spiking. In blocking the winners were clearly better in blocking against spikes.

In conclusion it can be said that the loading of a female beach volleyball match has decreased slightly. The results suggest that attacking and blocking were the most decisive skills concerning winning a set in top-level female beach volleyball. Especially the side out attacking considered being a very important skill.

Key words: beach volleyball, match analysis, female, winning

1 INTRODUCTION

Beach volleyball is a rather young international top-level sport. It has been included to the program of the Olympic Games since 1996. Since then the sport has grown quite rapidly and it has become one of the most popular events in the Olympic Games. (FIVB 2012.)

There is not so much published research concerning beach volleyball if compared to the more traditional sports like volleyball, basketball or football. During the last decade the number of published studies has increased quite rapidly. Some studies have been published concerning the effects of the rule changes to the game (e.g. Giatsis & Tzetzis 2003; Giatsis & Zetou 2003; Giatsis et al. 2005; Ronglan & Grydeland 2006; Giatsis et al. 2011; Tili & Giatsis 2011). Also the physiological requirements of beach volleyball have been studied (e.g. Pérez-Turpin et al. 2009; Magalhães et al 2011) as well as the biomechanics of jumping in the beach volleyball environment (a.k.a. sand) (e.g. Giatsis et al. 2004; Tilp et al. 2008). Perceptual skills have as well been studied lately (e.g. Kredel et al. 2011; Canal-Bruland et al. 2011). Moreover injuries related to beach volleyball have also been studied (e.g. Bahr & Reeser 2003; Pfirrmann et al. 2008; Lajtai et al. 2009).

Match analysis has been used to analyse the top-level matches in both men and women separately (e.g. Kröger 2006; Tilp et al. 2006; Giatsis & Zahariadis 2008; Koch & Tilp 2009a). Also the differences between genders have been analysed (e.g. Laios 2008; Koch & Tilp 2009b) as well as between the winning and losing teams (e.g. Giatsis & Tzetzis 2003; Michalopoulou et al. 2005). Serve is a skill which has been analysed more carefully than other skills (e.g. López-Martinez & Palao 2009; Buscá et al. 2012).

Some of these match analysis studies have concerned women's beach volleyball, but the latest ones concerning women's matches have analysed matches from 2008. So there was a need to make an update on the technical and tactical game analysis of top-level female beach volleyball to set a reliable view of game and also to analyse different technical skills as possible determinants on winning in international top-level female beach volleyball.

2 METHODS

For this study women's beach volleyball matches played in World Tour 2010 and 2011 and European Championships 2011 were analysed. The analyses were made using Data Volley 3.4.8 -match analysis software (Data Project, Bologna, Italy). The teams that played on these matches were placed 3–38 on the World Tour ranking 31.12.2011.

For the time analysis 18 sets to 21 points and 2 sets to 15 points from 9 different matches were analysed. The duration of the rallies, sets and matches were analysed. The proportions of the rallies that lasted less than 10 seconds, rallies that lasted 10–20 seconds and rallies that lasted more than 20 seconds were calculated. The duration of the sets to 21 points was divides to two parts: 1) from the start of the set to the start of the technical time-out and 2) from the end of the technical time-out to the end of the set. Also the durations of the breaks between rallies and sets were analyzed. The breaks between rallies were divided more precisely to normal breaks, changes of sides, time-outs and technical time-outs. The proportions of the breaks that lasted less than 20 seconds, breaks that lasted 20–30 seconds and breaks that lasted more than 30 seconds were calculated. The accuracy of the time analysis was 1.0 s.

For the technical analysis 1174 rallies from 31 sets and 16 different matches were analysed. Serves (n=1174) and receptions (n=1023) were analysed using a 6-level scale, attacks (n=1370) using a 5-level scale, blocks (n=242) using 4-level scale, digs (n=544) and sets (n=1238) using 3-level scale. The serving type was defined as jump serve, jump float serve or float serve and reception type as jump serve reception, jump float reception or float reception. Attacks were divided to side out attacks and counter attacks and further to spikes (attack executed with maximum power) and shots (attack executed relatively softly to place the ball into empty areas of the court). Blocks were divided to blocks against opponent's spikes and shots. Digs were divided to digs from opponent's spikes and shots and to digs after dropping. (Table 1.)

Table 1. The criteria of the performance level of serve, reception, attack, dig, block and set.

Serve: jump serve, jump float serve or float serve	
#	straight point, ace
/	good serve: reception goes straight back to the serving team or the receiving team has no change to attack
+	good serve, - reception for the opponent
!	quite good serve, ! reception for the opponent
-	easy serve, # or + reception for the opponent
=	serve error
Reception: jump serve reception, jump float reception or float reception	
#	perfect reception, finger set possible
+	good reception, close to perfect reception, but not ideal position
!	quite good reception, 1.5–4 meters from the net, but with good ball curve
-	weak reception, can still be set for the attacker
/	reception goes straight back to the serving team or the receiving team has no change to attack
=	reception error
Attack: spike or shot in side out or counter attack situation	
#	point, the attack goes to opponent's court or the ball is unplayable after block or the opponent makes an error in blocking
+	good attack, opponent's block or dig is weak
-	easy attack, opponent's block or dig is good
/	blocked attack
=	error, attacker touch the net or the attack is unsuccessful
Block: blocking spikes or shots	
#	point, kill block
+	good attenuation of block, the ball is easy for own defence or difficult for opponent's side
-	weak attenuation of block, the ball comes difficult to own defence or easy for opponent's side
=	error, net foul
Dig: defending spikes, shots or using dropping away from the net	
#	perfect dig, the defending team can attack after the dig
-	weak dig, attacking is not possible after the dig or the ball goes straight back to the opponent after the dig
=	error, the ball is unplayable after the dig
Set	
+	good set
-	bad set, the attacker can't attack or has big difficulties to attack
=	technical error in setting or a set that ends the rally

The success and error percentages in different skills were calculated according to table 2. Also the number of kill blocks and the number of opponent's errors were analysed.

Table 2. The percentage of success (+%) and errors (-%) in skills. The criteria of the performance level of serve, reception, attack, dig, block and set.

Skill	*+%*	*-%*
Serve	percentage of aces and good serves (#, / and +)	percentage of serving errors (=)
Reception	percentage of perfect and good receptions (#,+ and !)	percentage of reception errors (=)
Attack	percentage of attack points of all attacks (#)	percentage of attacking errors (/ and =)
Dig	percentage of perfect and good digs (# and +)	percentage of digging errors (=)
Block	percentage of kill and good blocks (# and +)	percentage of block errors (=)
Set	percentage of good sets (+)	percentage of setting errors (=)

The winning percentage of scoring in own (break point situation) and opponent's (side out situation) serving turn was calculated. The sets were divided to four parts depending on the points (0–7, 8–11, 12–18 and over 19 points) of the leading team to analyse the progression of the sets more detail. The ways of scoring (serve, side out attack, counter attack, block, and opponent's errors) were also determined. Also the ways of making error points (serve, reception, set, side out attack and counter attack) were determined.

The winning of a set was analysed depending on the score at the time of technical time-out. The 10 sets that ended with two point differences were defined as close sets and the skill executions performed after 17 points in 21 point sets and 12 points in 15 point sets were analysed separately and compared to the overall skill executions.

To analyse serving and receiving areas the court was divided to three parts which width was equal. To analyse attack distribution the net was divided to five areas. (Figure 1.) The attacks from the second touch were analysed separately. Attack distribution and success from different areas were analysed for side out and counter attacks separately.

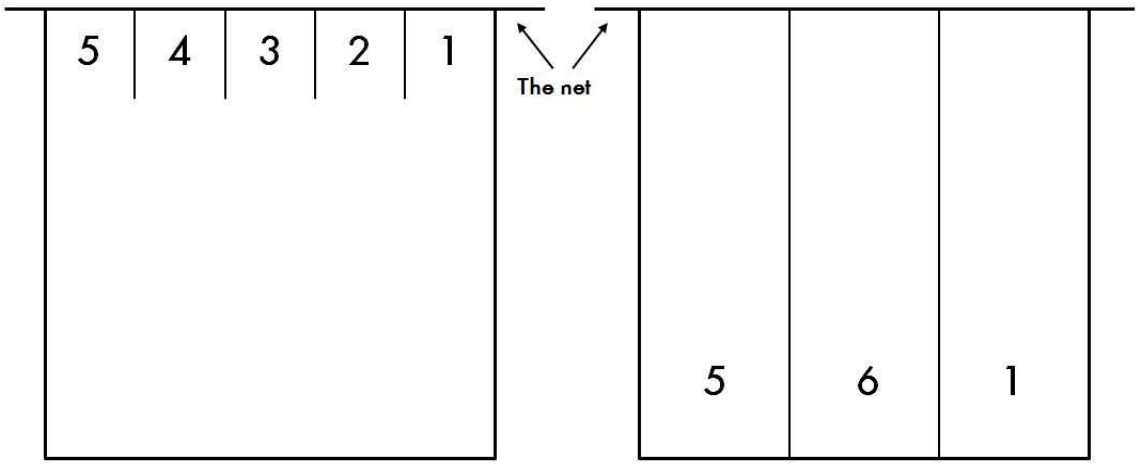

Figure 1. The distribution of the court to areas where the attacks were performed (on the left) and to areas where the serves and receptions were executed and the attacks directed (on the right).

The statistical analysis of the matches was made by PASW Statistics 18 (IBM SPSS, USA) and Microsoft Office Excel 2007 software (Microsoft Corporation, USA). The numbers of skill executions were compared by χ^2-test. The normality of the success in each technical variable used for statistical analysis was tested using Shapiro-Wilk test and then either t-test for paired samples or Wilcoxon signed-rank test was used to compare different techniques and situations and the winning and losing teams of a set. The level of statistical significance was determined as $p<0.05$.

3 RESULTS

3.1 Structure of the match

The average number of rallies in a set was 37.8±3.6. The average duration of a rally was 6.9±4.2 s and the maximum duration 27 s. So the net playing time in one set was 4 min 26 s ± 46 s. (Table 3.) The proportion of the rallies that lasted less than 10 seconds was 80 % and the proportion of the rallies that lasted 10–20 seconds was 19 % and finally the proportion of the rallies that last over 20 seconds was 1 % (table 4).

The average duration of a set to 21 points was 18 min 10 s ± 2 min 16 s and a set to 15 points 14 min 24 s ± 49 s. The sets to 21 points were divided to two parts according to the technical time-out and the duration of the first part of the set was on average 9 min 25 s ± 52 s and the second part 8 min 12 s ± 3 min 15 s. The matches that ended in two sets lasted on average 39 min 42 s ± 3 min 55 s and the duration of the matches that lasted three sets was 53 min 41 s ± 3 min 48 s. (Table 3 and 5.)

The average duration of the breaks (no longer breaks e.g. time-outs, technical time-outs, set breaks and changes of sides) between rallies was 18.7±7.2 s. When all the breaks were considered the average duration was 24.0±18.1 s. The duration of the changes of sides was little bit longer than the average of all breaks (25.2±3.7 s). The normal and technical time-out had quite similar length 79.0±6.6 s and 79.4±8.5 s, respectively. The duration of set breaks was 100.2±8.6 s. 59 % of the all breaks lasted less than 20 seconds and 11 % more than 30 seconds (Table 6 and 7.) The work-rest ratio for these matches was 1:3.5 aka 29 %.

Table 3. The durations of the rallies, sets and matches.

	Rallies	Net playing time in a set	Sets to 21 points	Sets to 15 points	Matches 2 set	Matches 3 set
Average	6.9 s	4 min 26 s	18 min 10 s	14 min 24 s	39 min 42 s	53 min 41 s
SD	4.2 s	46 s	2 min 16 s	49 s	3 min 55 s	3 min 48 s
Total amount	765	18	18	2	7	2
Max	27 s	6 min 20 s	24 min 23 s	14 min 59 s	45 min 22 s	56 min 22 s
Min	1 s	3 min 26 s	15 min 15 s	13 min 50 s	35 min 12 s	50 min 59 s

Table 4. The amount and proportions of rallies with different durations.

	< 10 s	10–20 s	> 20 s
Amount	611	144	10
Proportion	79.9 %	18.8 %	1.3 %

Table 5. The durations of the two parts of the sets.

	From the start of the set to the start of the technical time-out	From the end of the technical time-out to the end of the set
Average	9 min 25 s	8 min 12 s
SD	52 s	3 min 15 s
Total amount	18	18
Max	11 min 15 s	17 min 10 s
Min	7 min 35 s	4 min 42 s

Table 6. The durations of the breaks between rallies and sets and the durations of time-outs, technical time-outs and changes of sides.

	All breaks between rallies	Breaks between rallies without longer breaks	Changes of sides	Time-outs	Technical time-outs	Set breaks
Average	24.0 s	18.7 s	25.2 s	79.0 s	79.4 s	100.2 s
SD	18.1 s	7.2 s	3.7 s	6.6 s	8.5 s	8.6 s
Total amount	755	627	82	23	18	11
Max	112 s	82 s	34 s	92 s	98 s	112 s
Min	8 s	8 s	18 s	64 s	65 s	88 s

Table 7. The amount and proportions of all breaks and the breaks without longer breaks (time-outs, set breaks and changes of sides) with different durations.

	< 20 s	20–30 s	> 30 s
All breaks			
Amount	448	221	86
Proportion	59.3 %	29.3%	11.4 %
Breaks without longer breaks			
Amount	446	157	24
Proportion	79.9 %	25.0%	3.8 %

3.2 Winning rallies and sets

A team scored on average 18.9±3.6 points per set. From these points 1.7±1.4 were serve aces, 7.7±2.5 were made by side out attacking, 3.9±2.0 counter attacking, 1.0±1.0 by blocking and 4.6±1.8 came from opponent's errors. The opponent's errors were divided to serve (2.2±1.5), side out attack (1.4±1.0), counter attack (0.8±0.9) and setting (0.2±0.4) errors. Figure 2 presents the proportions of the different ways of scoring points and suffering error points.

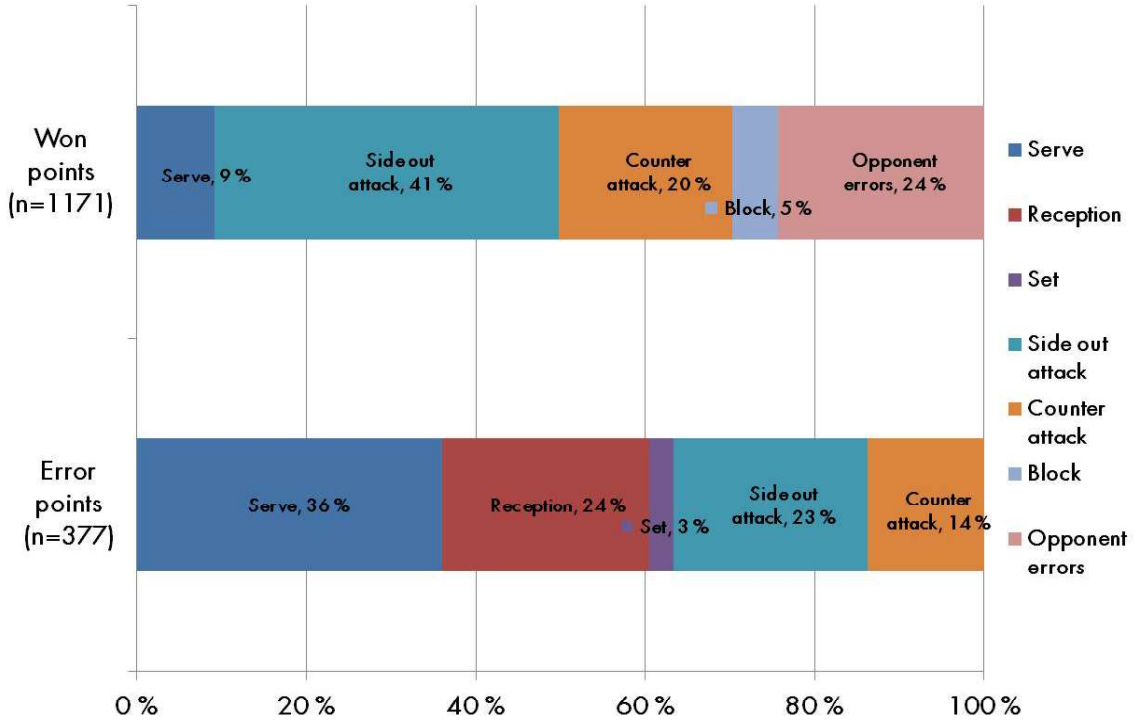

Figure 2. The proportions of the different ways of scoring points and losing points by errors.

61 % of the points were scored in side out situation (opponent's serve) and 39 % in break point situation (own serve). In the different phases of sets the winning percentage in side out situation was above average in the middle of the set (the leading team had 8–18 points) and in break point situation only in the start of the set (0–7 points) (figure 3).

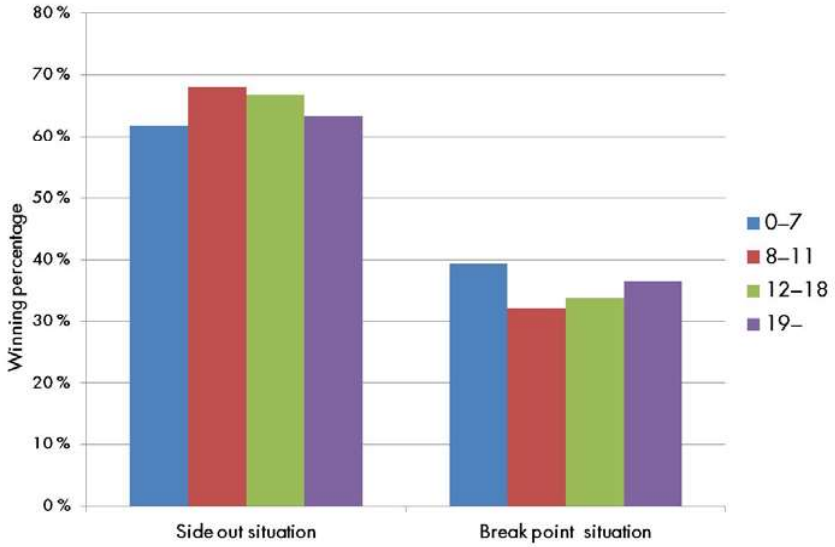

Figure 3. The winning percentages of rallies in side out and break point situations in different phases of sets.

The winning percentage of a set was 87 % when the team was ahead at the technical time-out and only 13 % when the team was down at the technical time-out. If a team was ahead with 3 or more points the winning percentage was 100 % (Table 8). The final difference in the points was 2 in 7 sets (23 %), 3–4, 5–6 and more than 7 in 8 sets (26 %).

Table 8. Winning and losing of a set with different point differences at the technical time-out.

Point difference at the technical time-out	Amount of won sets	Amount of loosed sets	Winning percentage
-5 or more	0	10	**0 %**
-3	0	9	**0 %**
-1	4	8	**33 %**
+1	8	5	**67 %**
+3	9	0	**100 %**
+5 or more	10	0	**100 %**

3.3 Amount and proportion of different skill execution

In total one team performed 90.0±15.0 skill executions in one set. The most used techniques were attacking (22.1±4.6), setting (19.7±4.7) and serving (18.9±3.4). Also quite many receptions were executed (16.5±3.4). Digging (8.8±3.3) and blocking (3.9±2.1) skills were used less. (Figure 4.)

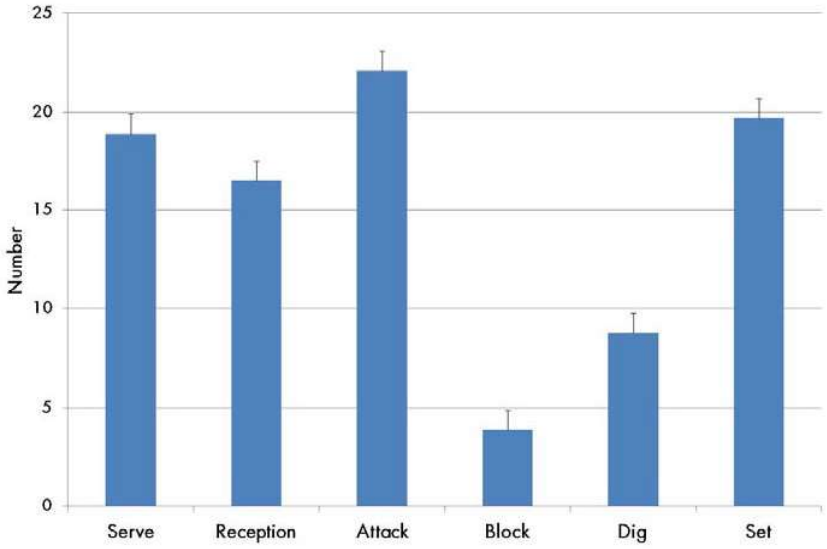

Figure 4. The amount of different skill executions in one set by one team.

Jump float was the most used serve technique followed by float and jump serves and as a consequence the reception of jump float serve was most common followed by the reception of float and jump serves (figure 5). 65 % of the attacks were side out attacks and 35 % counter attacks. 51 % of all attacks were performed using shot technique and 49 % using spike technique. In side out attack situation about 50 % of the attacks were executed using both spike and shot technique and in counter attack situation shots were used slightly more (54 %) than spikes (46 %). (Figure 6.) More block contacts were made after opponent's spike attacks than after shot attacks contrary to dig contacts (figure 7).

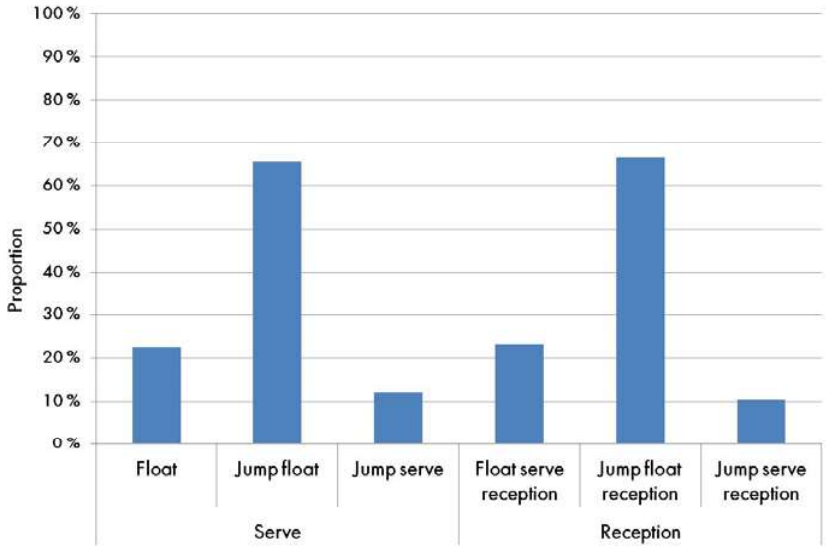

Figure 5. The proportions of different serve (n=1174) and reception (n=1023) techniques.

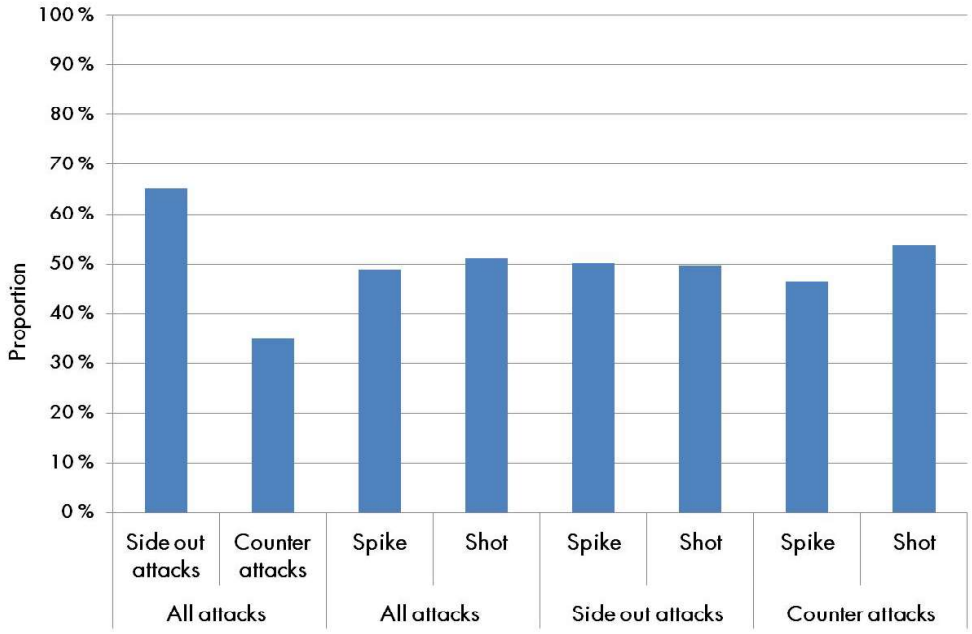

Figure 6. The proportions of attacking situations (n=1174) and used techniques in different situations.

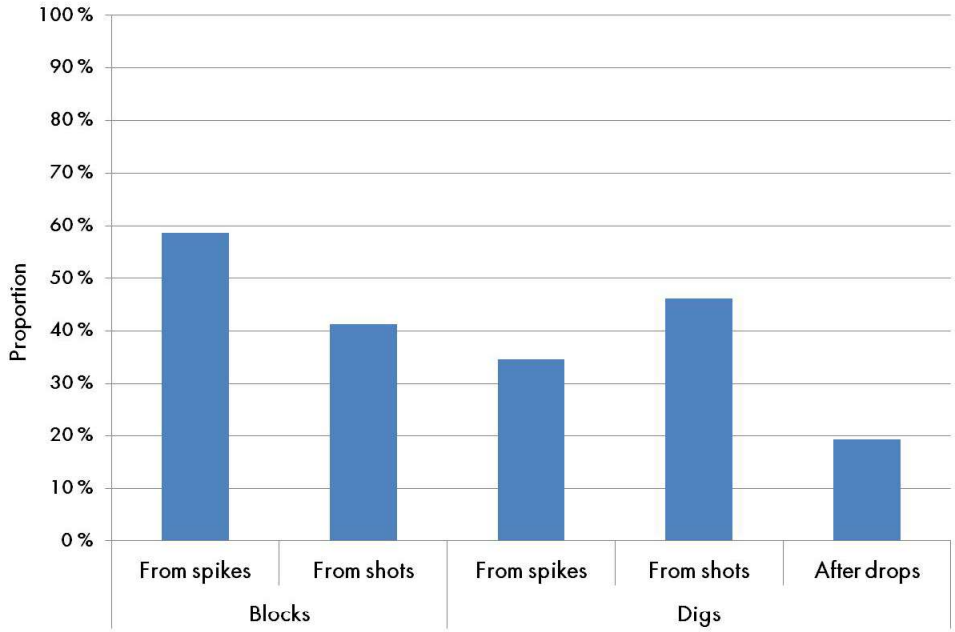

Figure 7. The proportions of different blocking (n=242) and digging (n=544) situations.

3.4 Distribution and success in different skill executions with different techniques

The two highest overall success percentages were found in setting (99 %) and receiving (71 %) and the two lowest in serving (27 %) and blocking (43 %). On the other hand the two highest error percentages were found in blocking (39 %) and digging (23 %) and the two lowest in setting (1 %) and receiving (9 %). (Figure 8.)

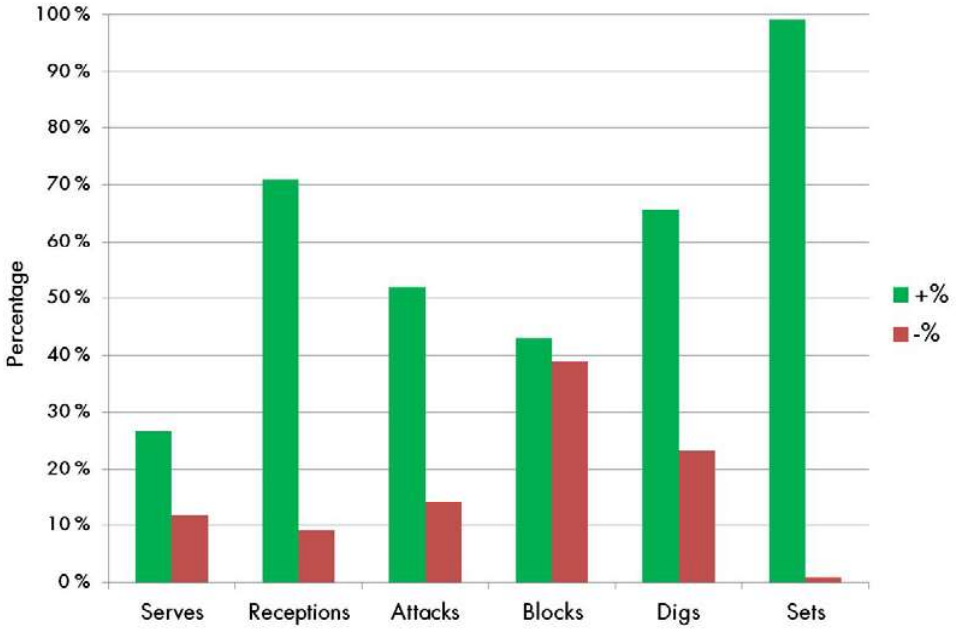

Figure 8. The overall success and error percentages of different skill executions.

3.4.1 Serve and reception

Overall 41 % of the serves were executed from area 6, 35 % from area 5 and 23 % from area 1. From all serves 42 % were directed to area 6, 34 % to area 5 and 25 % to area 1. The most used area to serve jump serves was area 5 (46 %) followed by area 6 (31 %) and 1 (23 %) and the most common direction of jump serves from every area was area 6 (42–51 %) followed by diagonal serves (from area 5 to area 5 and area 1 to area 1) (figure 9). Jump floats were also most commonly served from area 5 (40 %) followed by area 6 (39 %) and 1 (21 %) and like jump serves the most common direction of jump floats from every area was area 6 (39–44 %) followed by diagonal serves (figure 10). Float serves were most often executed from area 6 (54 %) followed by areas 1 (29 %) and 5 (17 %). Direct serves (from 5 to 1, from 6 to 6 and from 1 to 5) were most commonly used float serve directions. (Figure 11.)

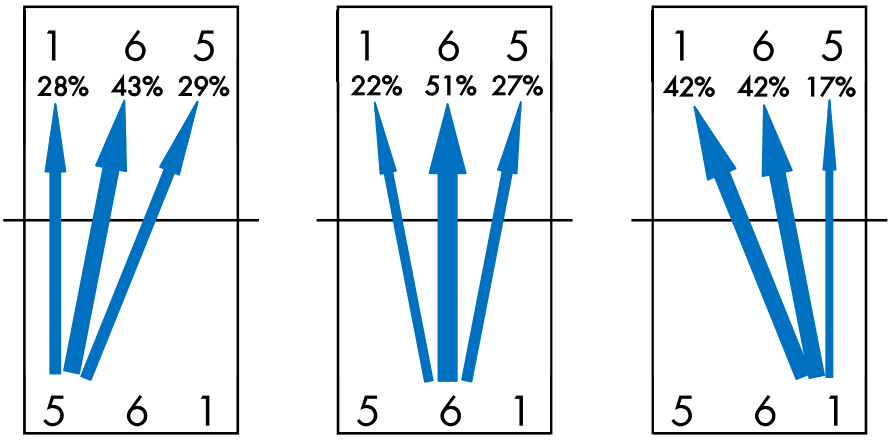

Figure 9. The proportion of jump serves served from different areas to different directions.

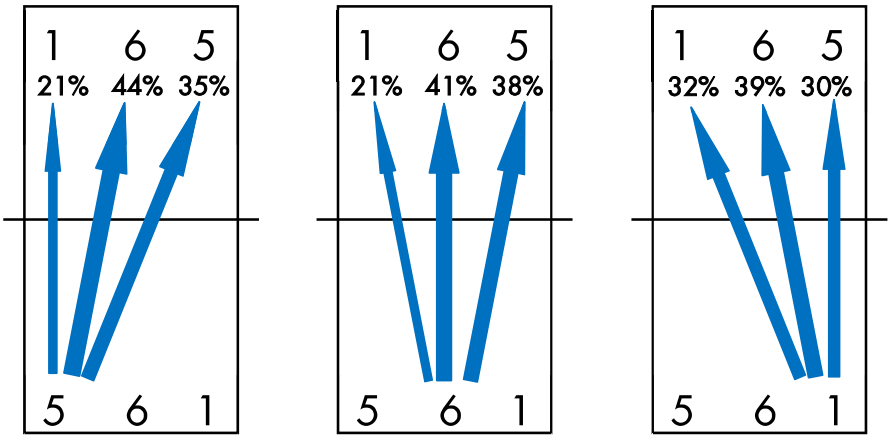

Figure 10. The proportion of jump float serves served from different areas to different directions.

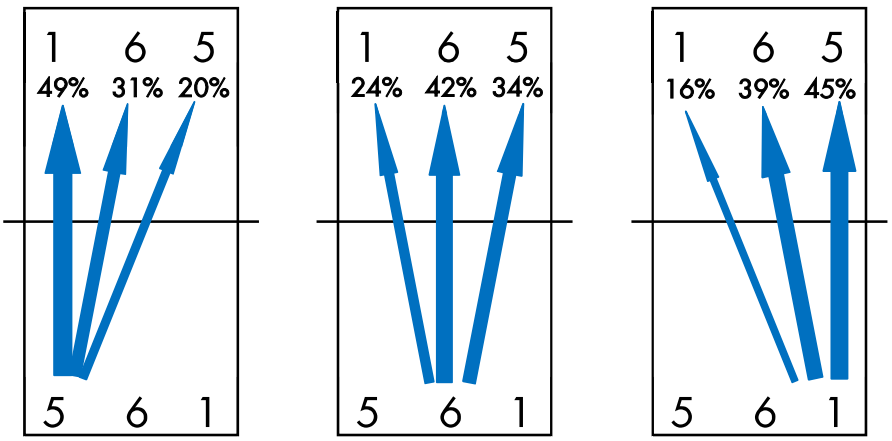

Figure 11. The proportion of float serves served from different areas to different directions.

The most common area for receiving different serves was area 6 followed by areas 5 (27–36 %) and 1 (23–26 %). The observed differences between areas were not significant (figure 12).

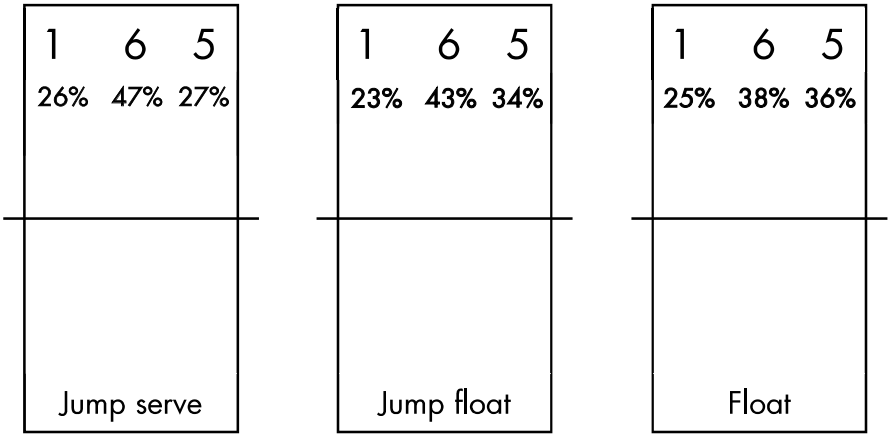

Figure 12. The proportions of receiving areas for different serve techniques.

Jump serve receptions were most often made from serves coming from area 5 in every reception area (figure 13). Jump float receptions were made quite evenly from serves coming from serve areas 6 and 5 and least reception were made from serves from area 1 (figure 14). More than half of the float serve receptions were made from serves coming from area 6 in every reception area (ns.) (figure 15).

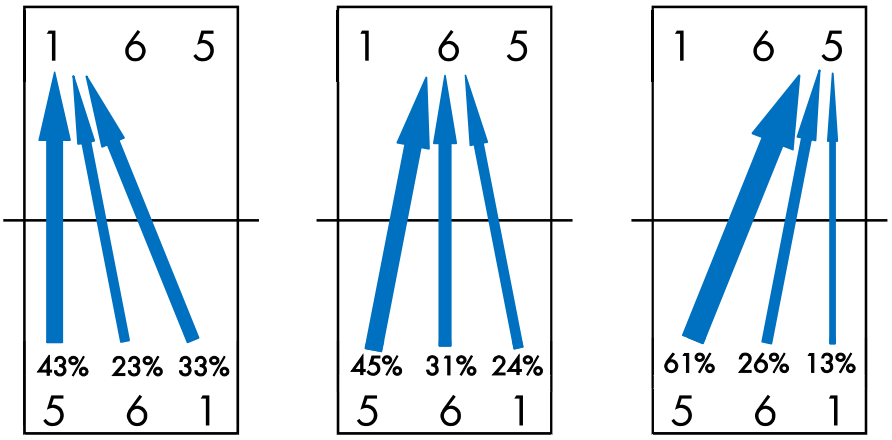

Figure 13. The proportions of the receptions of jump serves coming from different serve areas.

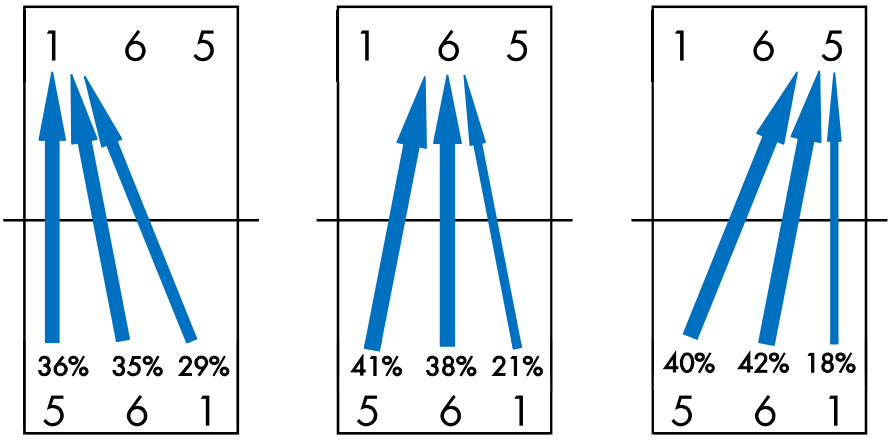

Figure 14. The proportions of the receptions of jump float serves coming from different serve areas.

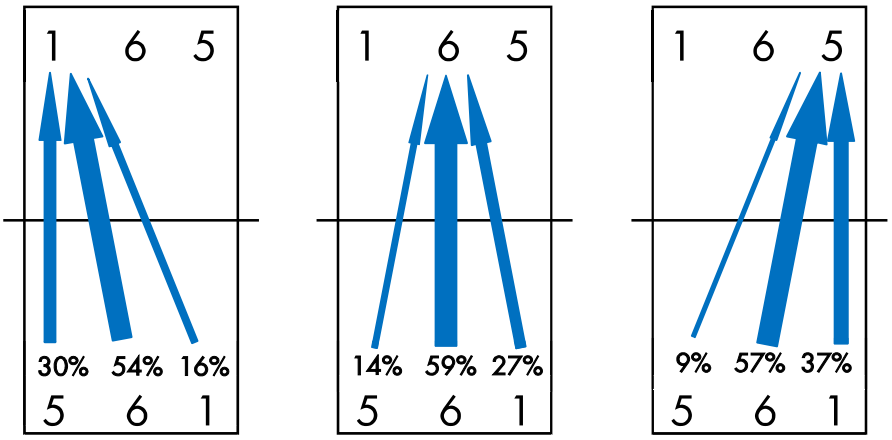

Figure 15. The proportions of the receptions of float serves coming from different serve areas.

No significant difference was found between the success percentages of different serve techniques. Jump serve had the highest error percentage ($p<0.001$). Also no significant differences were found between the success and error percentages of receiving serves executed with different techniques. (Figure 16).

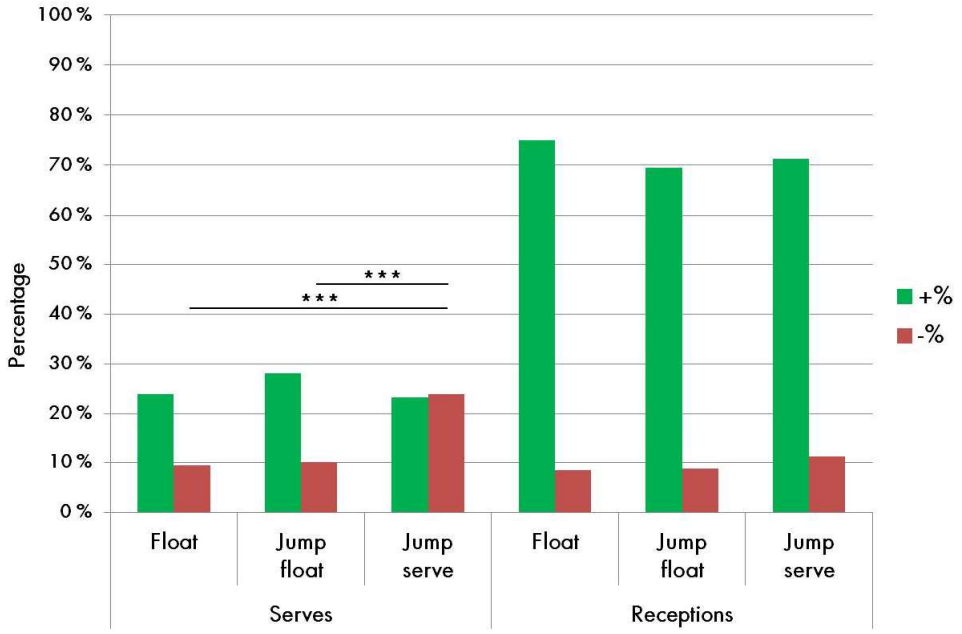

*Figure 16. The success and error percentages of different serve and reception techniques (***=p<0.001).*

No significant differences in the success and error percentages of different serve techniques were found between the serve areas. Significantly more errors were made using jump serve technique and significantly less errors using float serves from area 6 (p<0.001). (Figure 17.) No significant differences were found in the success and error percentages of receiving different kind of serves between the reception areas (figure 18).

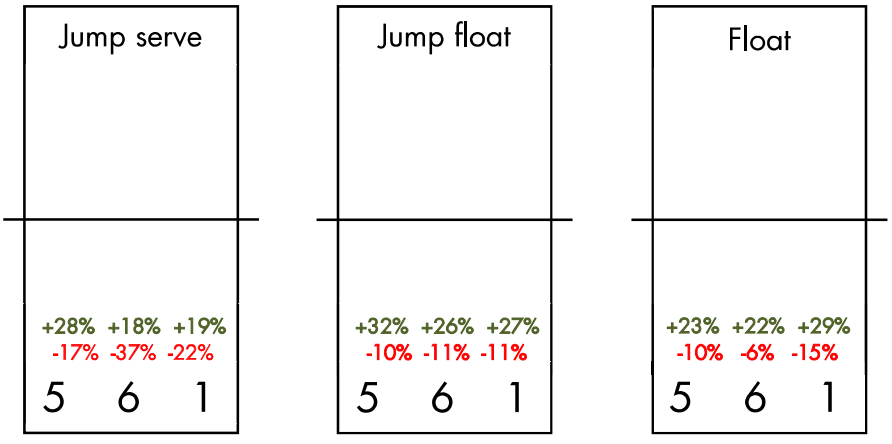

Figure 17. The success and error percentages of different serve techniques from different areas.

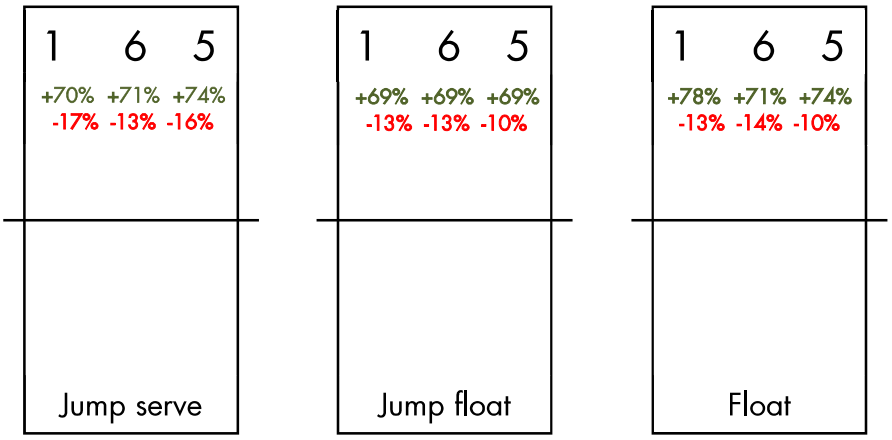

Figure 18. The success and error percentages of receiving different kind of serves in different receiving areas.

3.4.2 Attack

Area 3 was the most used attack area in both side out and counter attack situations (29 % in both situations). Second touch attack was clearly the least used in side out situation, but second most used in counter attack situation ($p<0.001$). (Figure 19.)

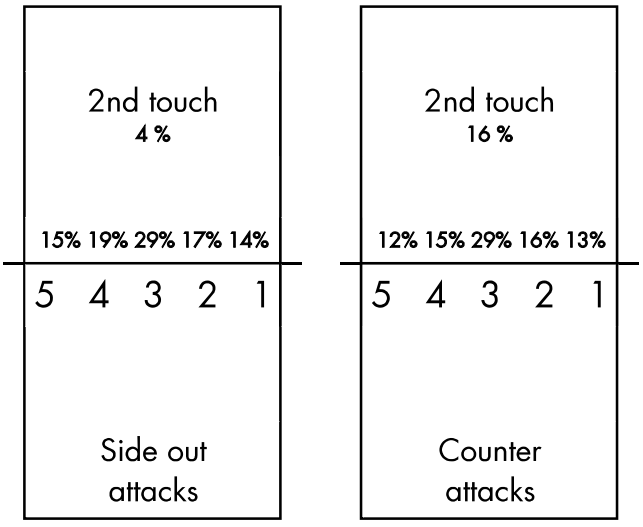

Figure 19. The proportions of attacks executed from different areas in different situations.

In side out attack situations spikes were used more than shots in areas 1, 3 and 5 and on the contrary shots were used more in areas 2 and 4 and also in second touch attacks. In counter attacking spikes were used more in areas 1 and 2 and shots in areas 3, 4 and 5 and in second touch attacks ($p<0.01$). The difference between the use of the attacking techniques was most clear in second touch attacks. (Figures 20 and 21.)

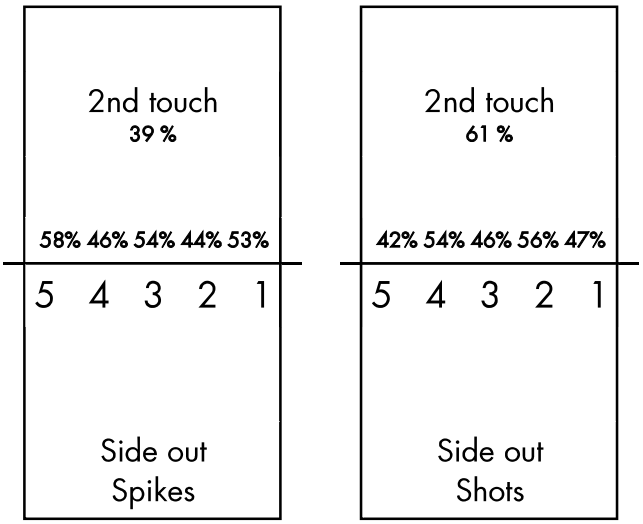

Figure 20. The proportions of spike and shot techniques in side out attacks from different areas.

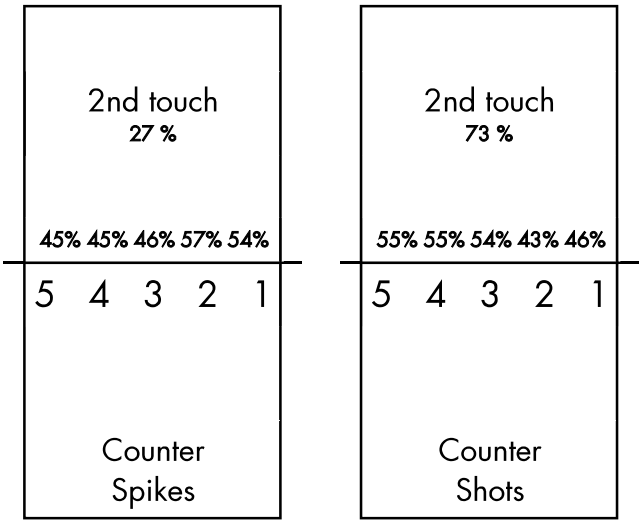

Figure 21. The proportions of spike and shot techniques in counter attacks from different areas.

The most common direction of spikes was clearly diagonal from areas 1, 2 and 4. From areas 3 and 5 spikes to both corners were as common. Position 6 was the least used spike direction from every attack area except area 1, from where line direction was least used. Spikes from area 2 to position 1 and from area 4 to position 5 were used significantly more than from other areas ($p<0.01$ for both). On the contrary spikes from area 1 to position 5 were used significantly less than from other areas ($p<0.01$). (Figure 22.)

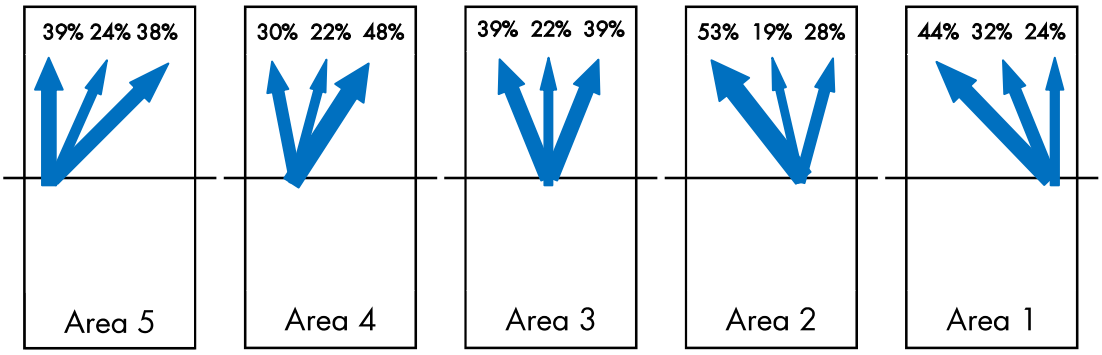

Figure 22. The proportions of different spike directions from different attack areas.

Shots to line were clearly most used from areas 1, 4 and 5. From areas 2 and 3 shots to both corners were almost as common. Position 6 was the least used shot direction from every area. The shots were significantly more common from area 1 to position 5 and from area 4 to position 1 than from any other area ($p<0.001$ for both). On the contrary shots from area 1 to position 1 and from area 4 to position 5 were used significantly less than from other areas ($p<0.001$ for both). (Figure 23.)

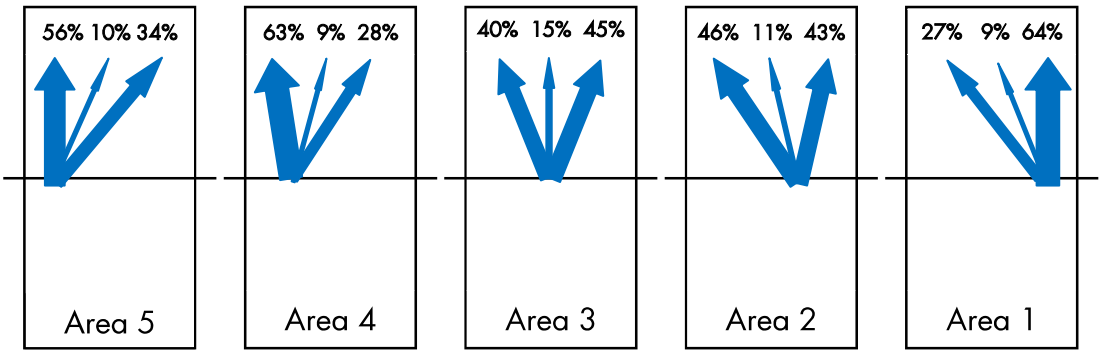

Figure 23. The proportions of different shot directions from different attack areas.

The success percentages in attacking were little bit higher in side out attacking than in counter attacking and also in spikes than in shots in all attacks and in side out attacks (ns.). In counter attacks the success percentage in shots was higher than in spikes (ns.). On the other hand the error percentages were higher in spikes in all and side out attacks ($p<0.001$). (Figure 24.)

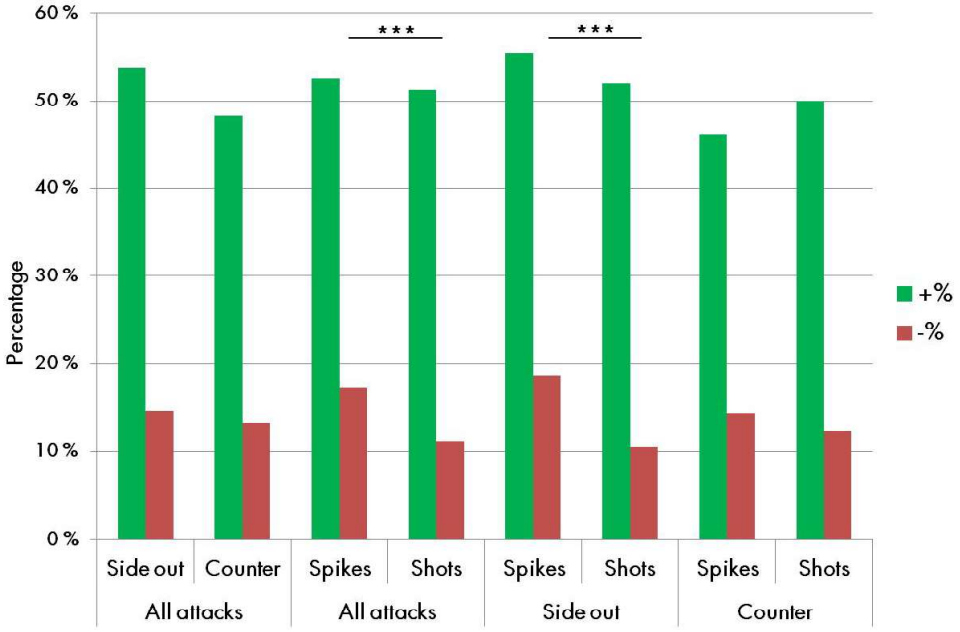

*Figure 24. The success and error percentages of different attack techniques in different attack situations (***=p<0.001).*

No significant differences were found in either side out or counter attack situation in the success or error percentages between attack areas. Although second touch attack had the highest efficiency (+% 59 %, -% 13 %) followed closely by the attacks from areas 2 (+% 57 %, -% 12 %) and 4 (+% 56 %, -% 12 %). Area 3, which was the most used area, had the lowest efficiency (+% 51 %, -% 18 %). In counter attack situations areas 5 (+% 56 %, -% 8 %) and 4 (+% 52 %, -% 9 %) had the highest efficiencies and areas 1 (+% 39 %, -% 13 %) and 3 (+% 48 %, -% 19 %) had the lowest efficiencies. (Figure 25.)

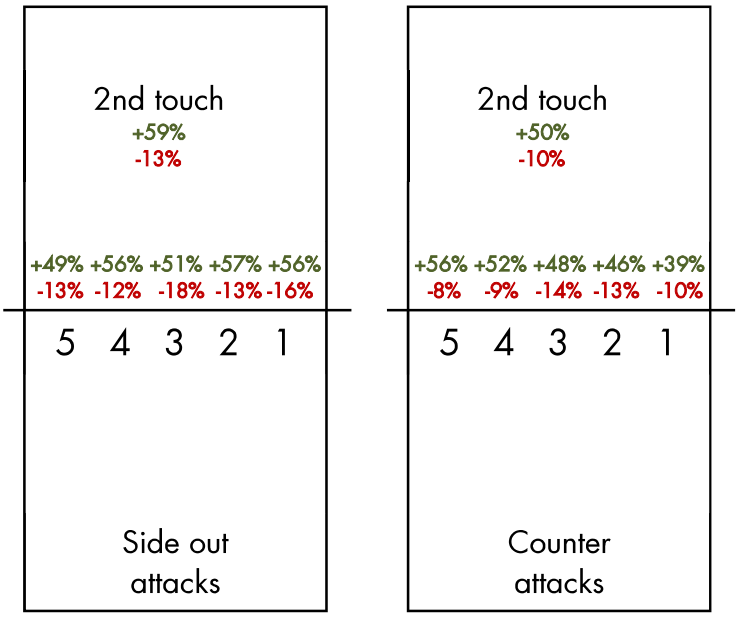

Figure 25. The success and error percentages of attacks from different areas in side out and counter attack situations.

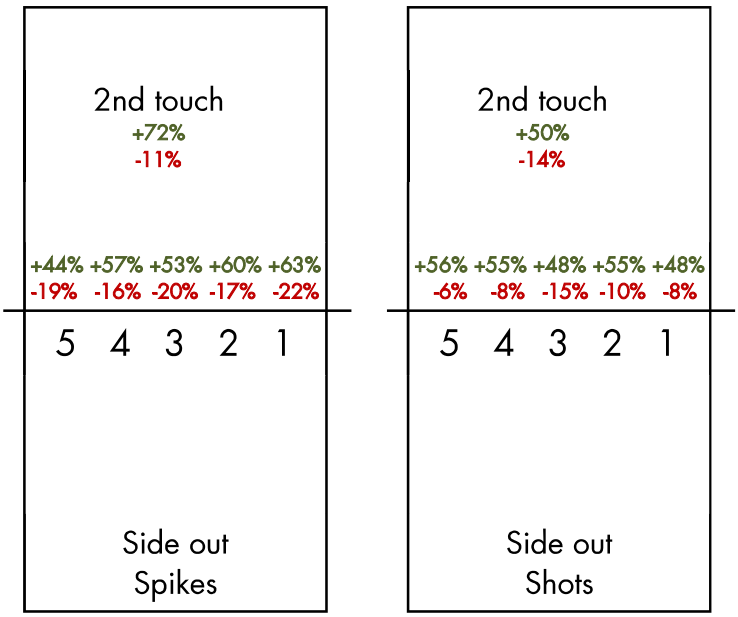

Figure 26. The success and error percentages of spikes and shots from different areas in side out attack situation.

Also no significant differences were found in the success or error percentages of spikes or shots from different areas in side out or counter attack situation. In side out attack situation spiking from the second touch was the most efficient attack type (+% 72 %, -% 11 %) followed

by shots from areas 5 (+% 56 %, -% 6 %) and 4 (+% 55 %, -% 8 %). The worst efficiencies were found in spikes from area 5 (+% 44 %, -% 19 %) and in both spikes (+% 53 %, -% 20 %) and shots from area 3 (+% 48 %, -% 15 %). (Figure 26.)

In counter attack situation shots from area 5 was clearly the most efficient attack type (+% 69 %, -% 6 %) followed by shots from areas 4 (+% 57 %, -% 10 %). The worst efficiencies were found in shots from area 1 (+% 34 %, -% 13 %) and area 3 (+% 46 %, -% 21 %) and spikes from area 2 (+% 43 %, -% 17 %). (Figure 27.)

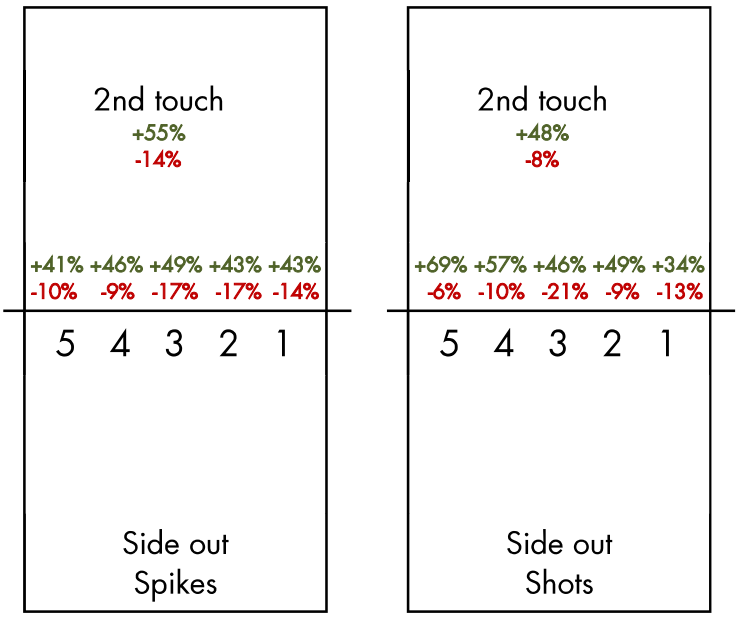

Figure 27. The success and error percentages of spikes and shots from different areas in counter attack situation.

3.4.3 Block and defence

On average a team made 3.9±2.1 block touches in one set. From these touches 59 % came after opponent's spike attack and 41 % after opponent's shot attacks. 26 % of the block touches ended to a killing block e.g. to a point. So a team got 1.0±1.0 kill blocks in one set. From these blocks 68 % came after opponent's spike attack and 32 % after opponent's shot attacks.

Most block touches were achieved after opponent's attacks from area 3 for both spikes (17 %) and shots (11 %) and least from 2nd touch spikes and shots (figure 28). Similarly most kill blocks were achieved from area 3 for both spikes (20 %) and shots (14 %). Least kill blocks were made after 2nd touch spikes and shots from area 5. (Figure 29.)

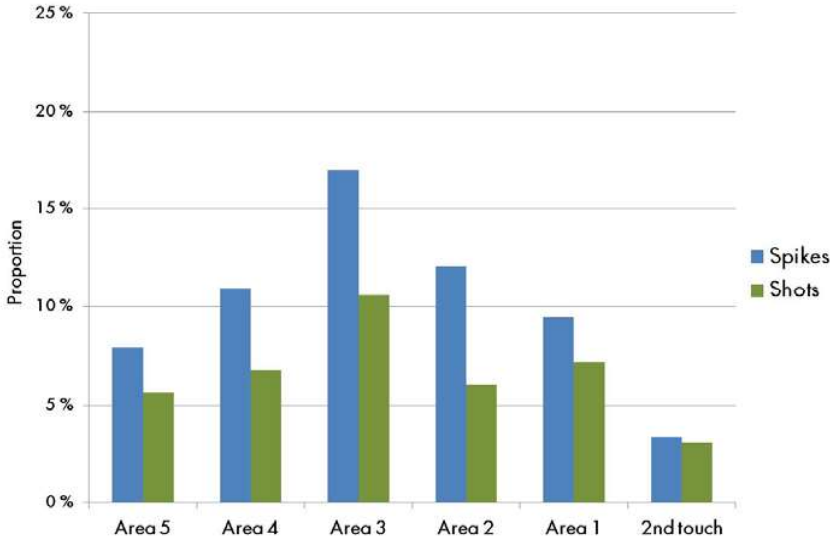

Figure 28. The proportions of block touches after opponent's attacks from different areas.

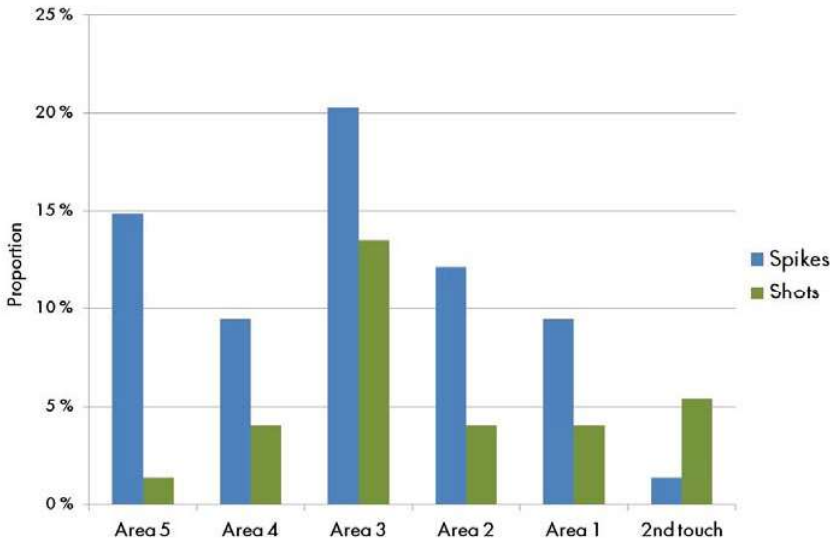

Figure 29. The proportions of kill blocks after opponent's attacks from different areas.

46 % of the kill blocks after opponent's spikes were made from spikes directed to area 5, 36 % on spikes directed to area 1 and 18 % on spikes directed to area 6. 42 % of the kill blocks after opponent's shots were made on shots directed to areas 1 and 6 and 17 % on shots directed to area 5. The proportions of the kill blocks made after opponent's spikes and shots from different areas are presented in more detail in figures 30 and 31.

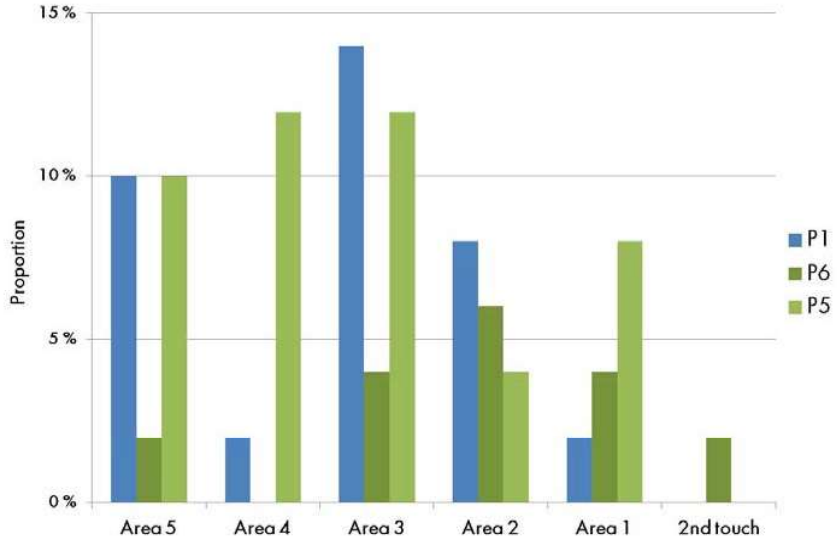

Figure 30. The proportions of kill blocks after opponent's spikes from different areas to different areas.

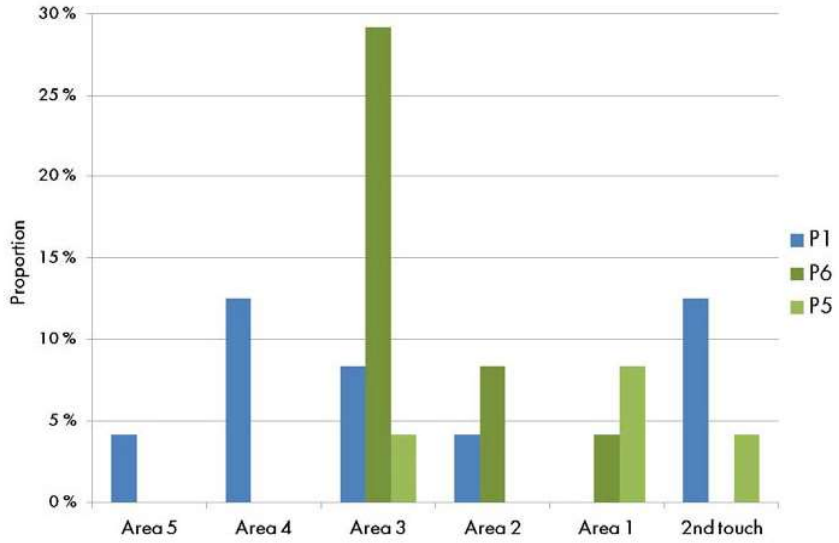

Figure 31. The proportions of kill blocks after opponent's shots from different areas to different areas.

On average a team made 8.8±3.3 dig attempts in one set. From these attempts 51 % came after opponent's spike attack and 49 % after opponent's shot attacks. 63 % of the dig attempts were successful e.g. the defending team could attack after the dig. So a team made about 6 successful digs in one set. From these successful digs 39 % came after opponent's spike attack and 61 % after opponent's shot attacks.

Most dig attempts were made after opponent's attacks from area 3 for both spikes (16 % of all dig attempts) and shots (11 % of all dig attempts) and least from 2nd touch spikes and from area 5 and 2nd touch shots (figure 32). Similarly most successful digs were made from area 3 for both spikes (14 %) and shots (16 %). Least successful digs were made after 2nd touch spikes and shots from area 5. (Figure 33).

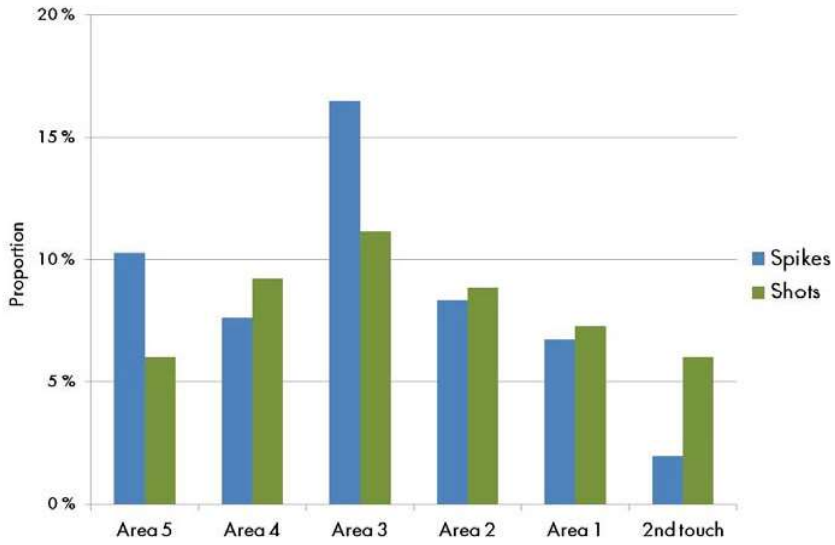

Figure 32. The proportions of dig attempts after opponent's attacks from different areas.

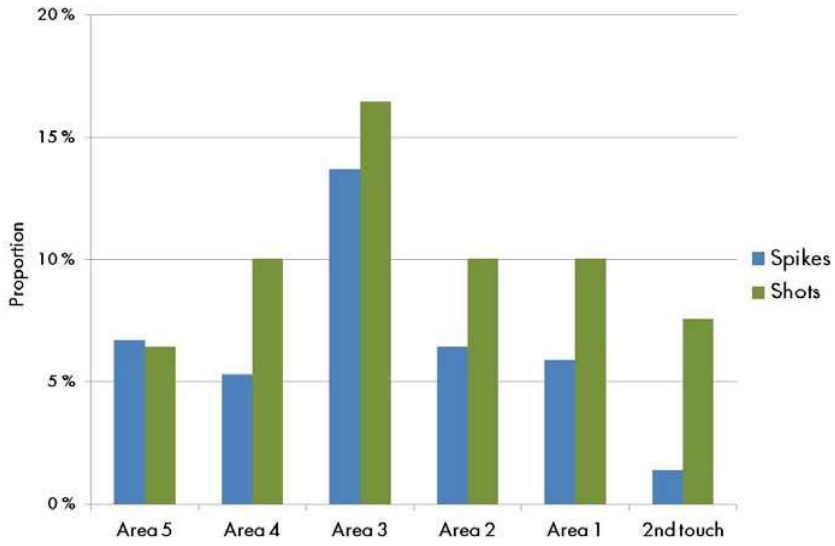

Figure 33. The proportions of successful digs after opponent's attacks from different areas.

35 % of the successful digs after opponent's spikes were made from spikes directed to area 5 and 32 % on spikes directed to areas 1 and 6. 39 % of the successful digs after opponent's

shots were made on shots directed to area 1, 35 % on shots directed to area 5 and 26 % on shots directed to area 6. The proportions of the successful digs made after opponent's spikes and shots from different areas are presented more exactly in figure 34 and 35.

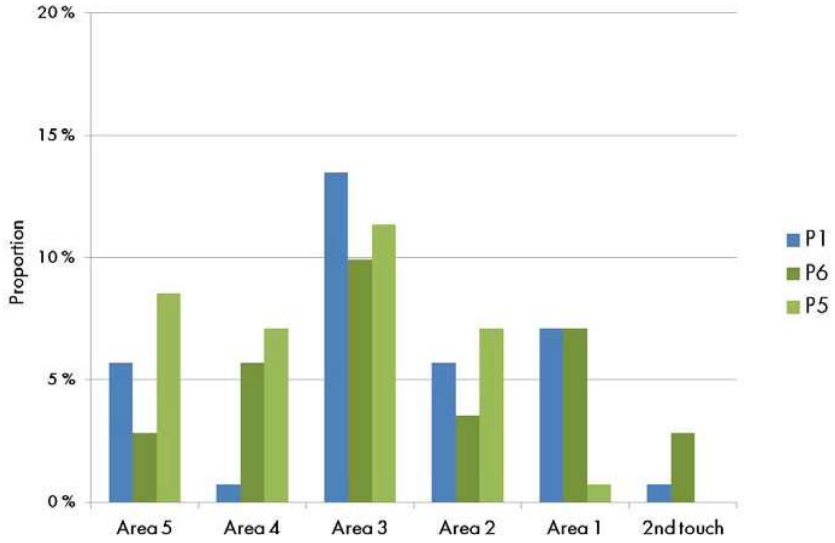

Figure 34. The proportions of successful digs after opponent's spikes from different areas to different areas.

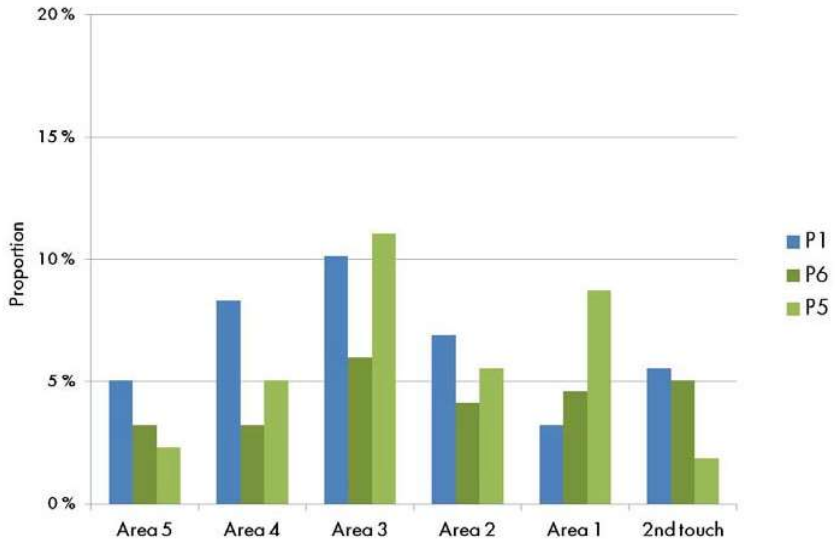

Figure 35. The proportions of successful digs after opponent's shots from different areas to different areas.

The success percentage for blocking against spikes and shots was quite similar (42–45 %), but against spikes the error percentage was higher than against shots (44 % vs. 32 %; ns.). In

digging the success percentage was a lot higher against shots (81 %) than against spikes (49 %) or after dropping (59 %). On the other hand the error percentage was lower against shots (10 %) than against spikes (36 %) or after dropping (31 %) (for all p<0.001). (Figure 36.)

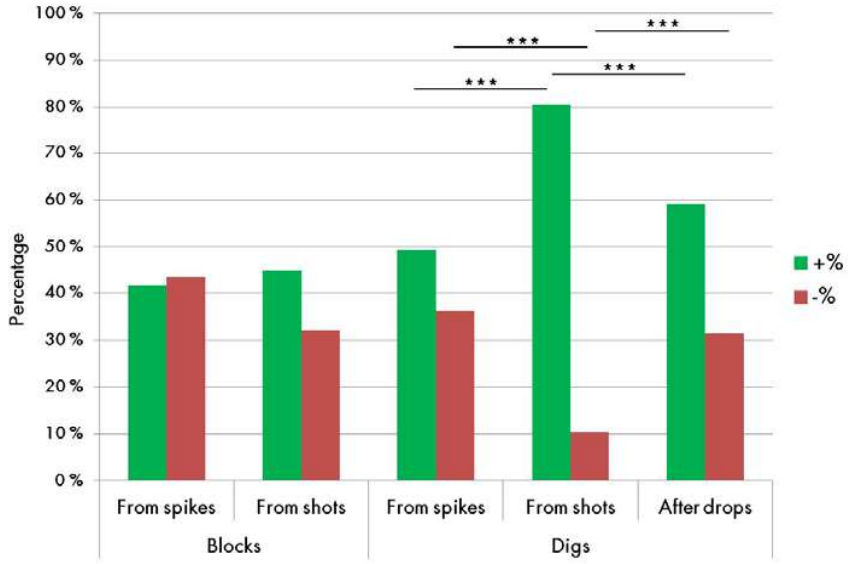

*Figure 36. The success and error percentages of blocking and digging in different situations (***=p<0.001).*

3.4.4 Succeeding in skill executions in the ends of close sets

When the success in the ends of close sets was compared to the overall succeeding in different skills, it was found that the success percentages of blocking and counter attacking differed more than 5 %, so that in the ends of close sets the success percentages were lower than in total (figure 37). On the other hand the error percentage of serving was 9 % higher and of blocking 12 % lower in the ends of close sets than in total (figure 38).

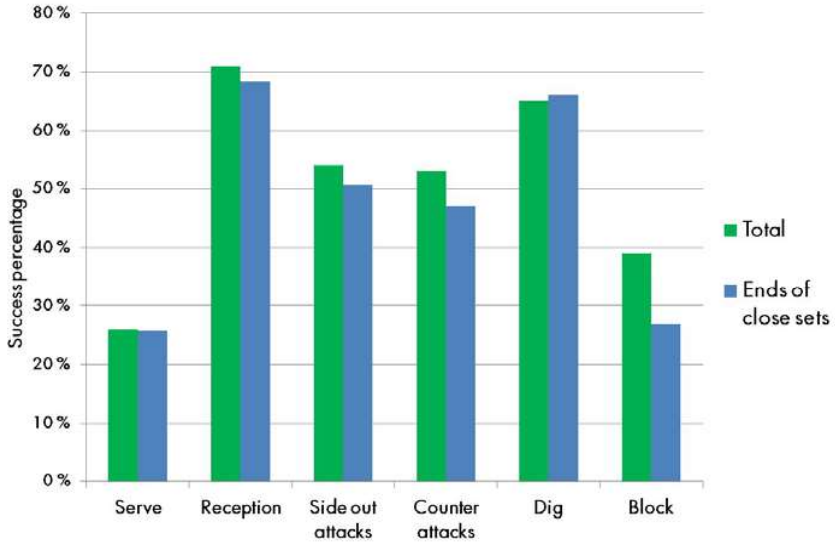

Figure 37. The success percentages of different skills in total and in the ends of close sets.

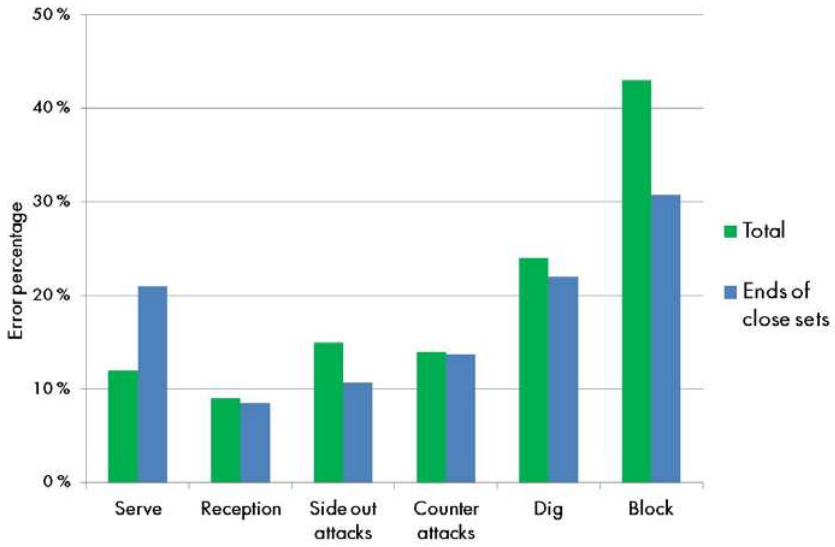

Figure 38. The error percentages of different skills in total and in the ends of close sets.

3.5 Comparison between the set winners and losers

3.5.1 Point scoring

Set winners scored significantly more points by serving (2.3±1.4 vs. 1.2±1.1; $p<0.01$), side out attacking (8.1±2.5 vs. 7.3±2.5; $p<0.05$), counter attacking (4.7±1.9 vs. 3.0±1.7; $p<0.001$) and blocking (1.5±1.2 vs. 0.5±0.7; $p<0.01$). No difference was found in the amount of opponent's errors (4.8±1.7 vs. 4.4±2.0). When the opponent's errors were studied

more exactly, it was found that the set winners made significantly less errors in receiving (1.0±1.0 vs. 2.0±1.2; p<0.01) and side out attacking (1.1±1.0 vs. 1.6±1.0; p<0.05). In the amount of errors of serving (2.3±1.6 vs. 2.1±1.3), counter attacking (0.8±0.8 vs. 0.9±1.0) and setting (0.1±0.3 vs. 0.2±0.5) no differences were found. Figure 39 presents the proportions of the different ways of scoring points and suffering error points by the set winners and losers.

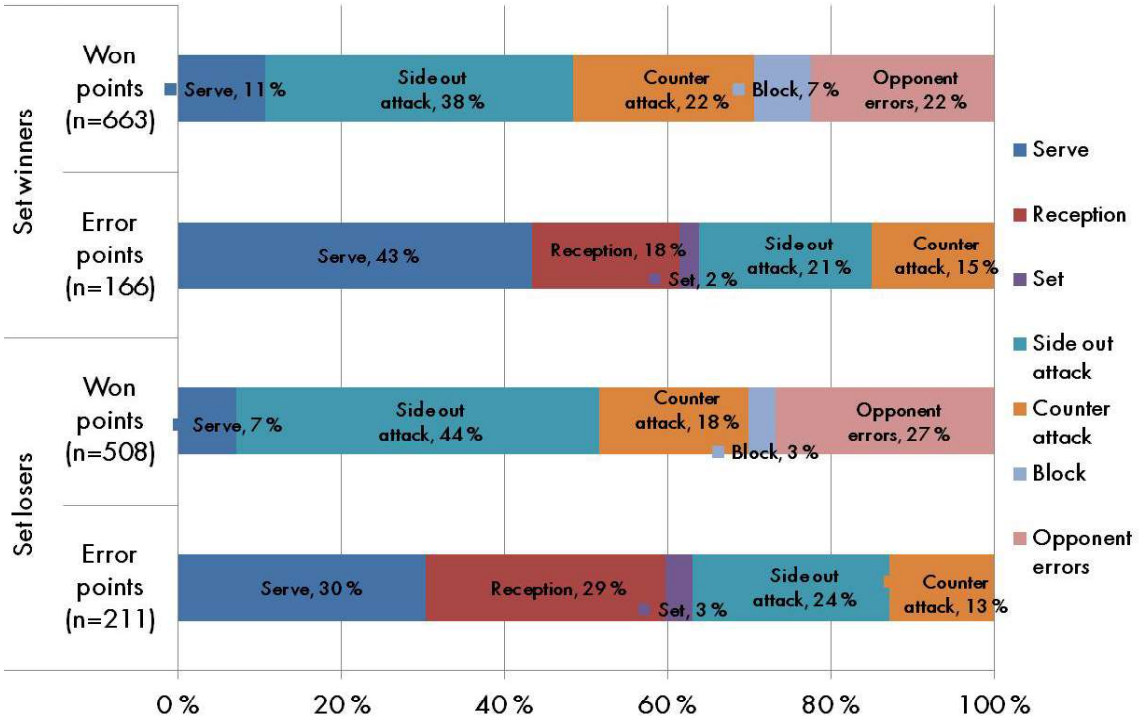

Figure 39. The proportions of the different ways of scoring points and losing points by errors by the set winners and losers.

The set winners scored significantly more of their points in side out situation (55 % vs. 30 %; p<0.001) and less in break point situation (45 % vs. 70 %; p<0.001) than the set losers. When the sets were divided to four phases the winning percentage in side out and break point situations was significantly higher (p<0.001) in all phases for set winners (figure 40).

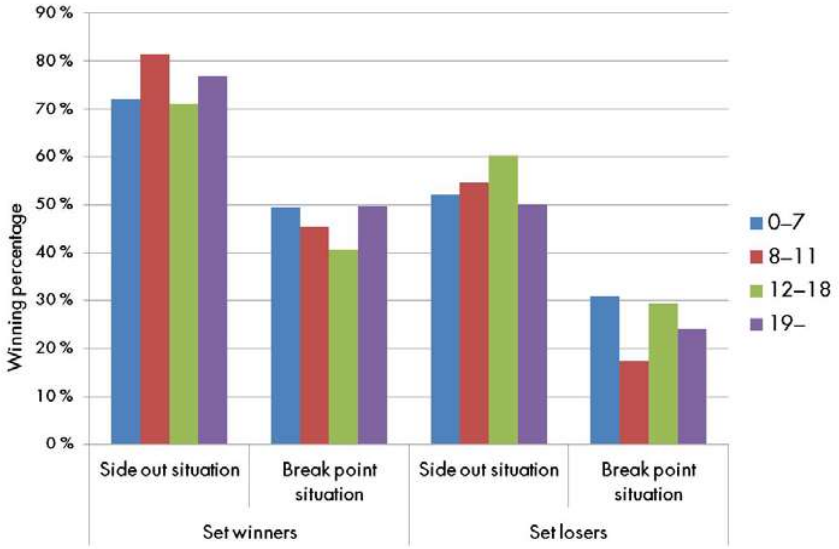

Figure 40. The winning percentages of rallies in side out and break point situations in different phases of sets for the set winners and losers.

3.5.2 Success in different skill executions with different techniques

The set winners had significantly higher success percentages in side out ($p<0.001$) and counter attacking ($p<0.01$) and also in blocking ($p<0.001$) (figure 41). On the other hand the set winners had significantly lower error percentages in receiving ($p<0.05$), side out attacking ($p<0.01$) and blocking ($p<0.01$) (figure 42).

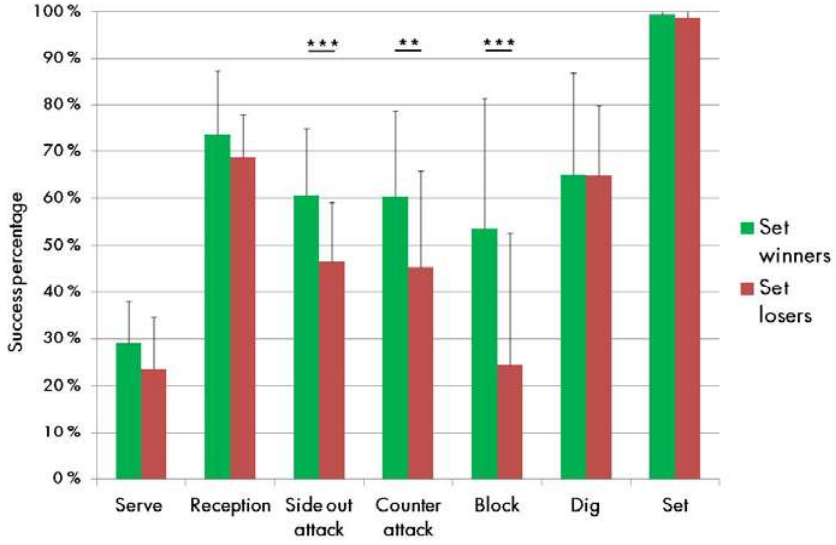

*Figure 41. The overall success percentages of different skill executions for the set winners and losers (**=p<0.01 and ***=p<0.001).*

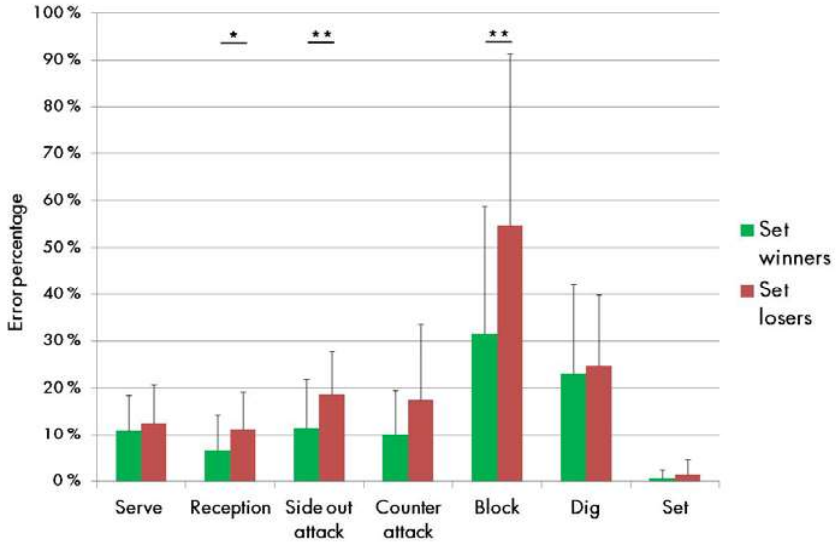

Figure 42. The overall error percentages of different skill executions for the set winners and losers (=p<0.05 and **=p<0.01).*

In serving the set winners had higher success percentages in every technique and lower error percentages in jump float and jump serves. In float serves the winners had a higher error percentage. In receiving serves made with different techniques the set winners had higher success percentages and lower error percentages. The differences were not statistically significant in serving or receiving. (Figures 43 and 44.)

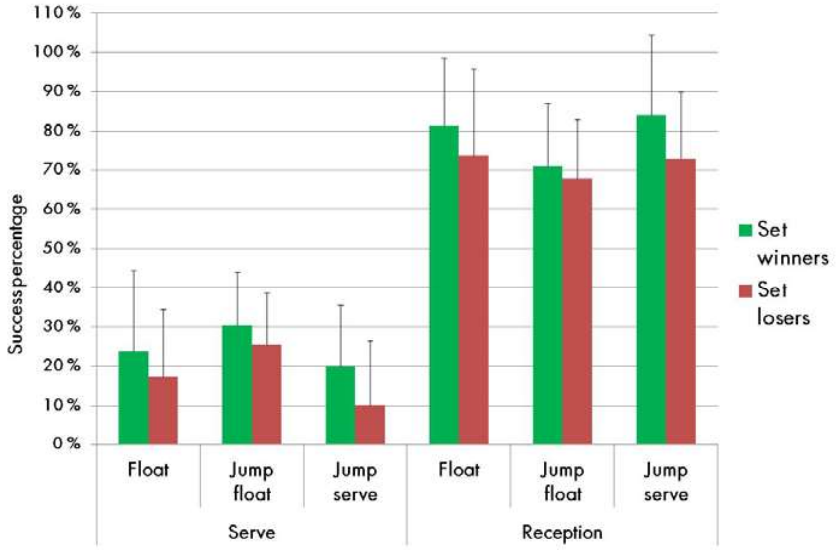

Figure 43. The success percentages of different serve and reception techniques for the set winners and losers.

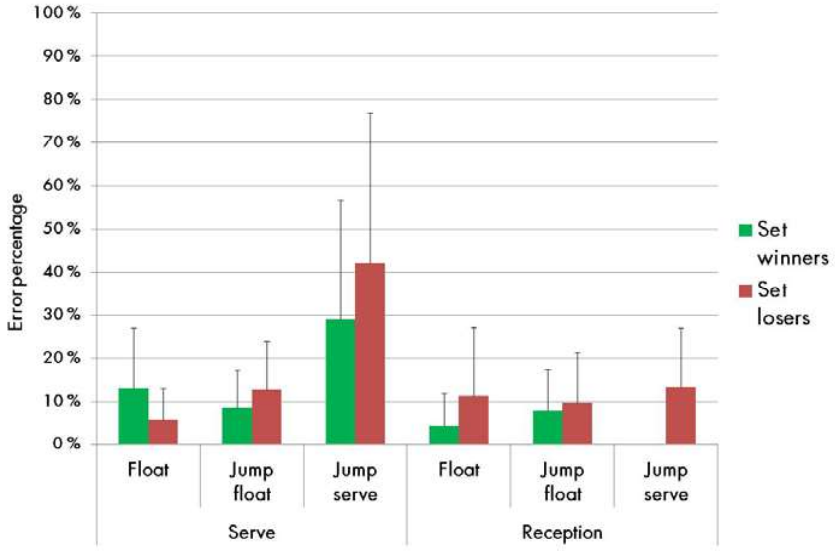

Figure 44. The error percentages of different serve and reception techniques for the set winners and losers.

The set winners had significantly higher success percentages in spikes and shots ($p<0.01$ for both) in total, in both side out ($p<0.001$) and counter attack ($p<0.01$) situations in total, in spikes in side out attack situation ($p<0.01$) and finally in shots in counter attack situation ($p<0.05$) (figure 45). On the other hand the error percentages of the set losers were higher in spikes and shots in total ($p<0.05$ for both), in side out attack situations ($p<0.01$) and in spikes in counter attack situation ($p<0.05$) (figure 46.)

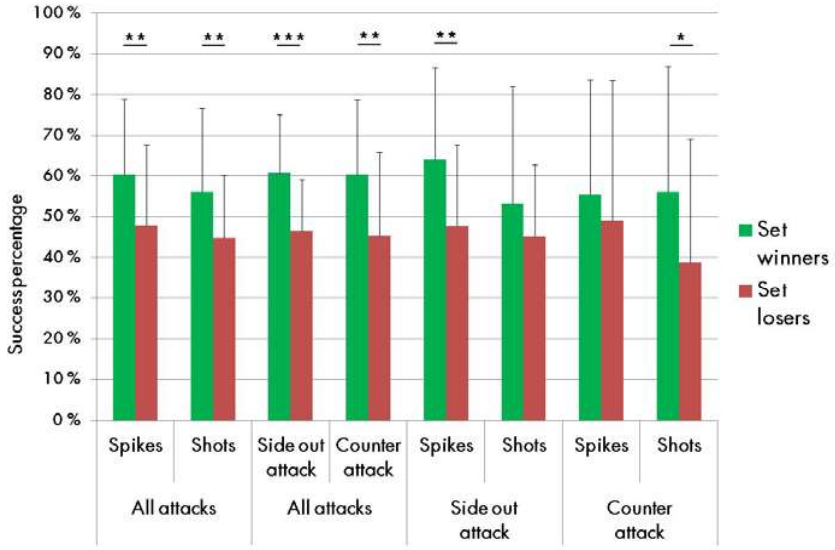

Figure 45. The success percentages in different attack situation using different attack techniques for the set winners and losers (=p<0.05, **=p<0.01 and ***=p<0.001).*

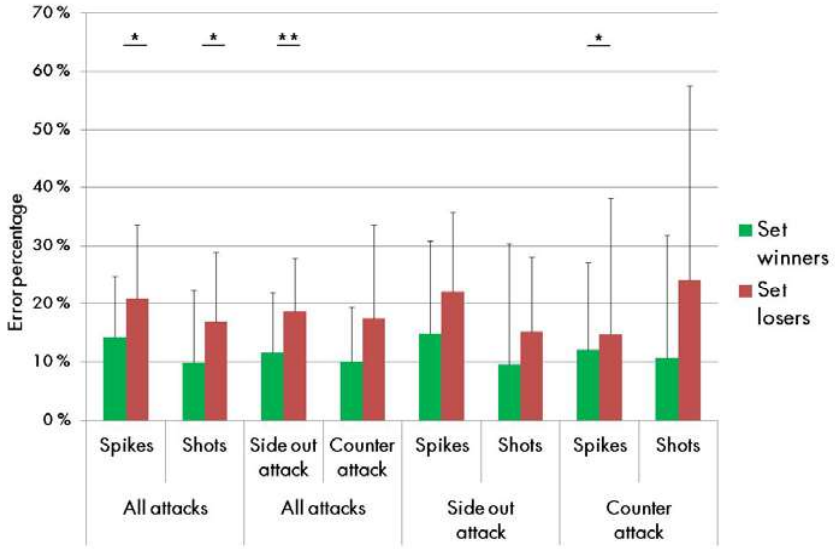

Figure 46. The error percentages in different attack situation using different attack techniques for the set winners and losers (=p<0.05 and **=p<0.01).*

The success percentage for blocking against spikes was significantly higher and error percentage lower (p<0.01 for both) for the set winners. In digging no significant differences were found between the set winners and losers. (Figures 47 and 48.)

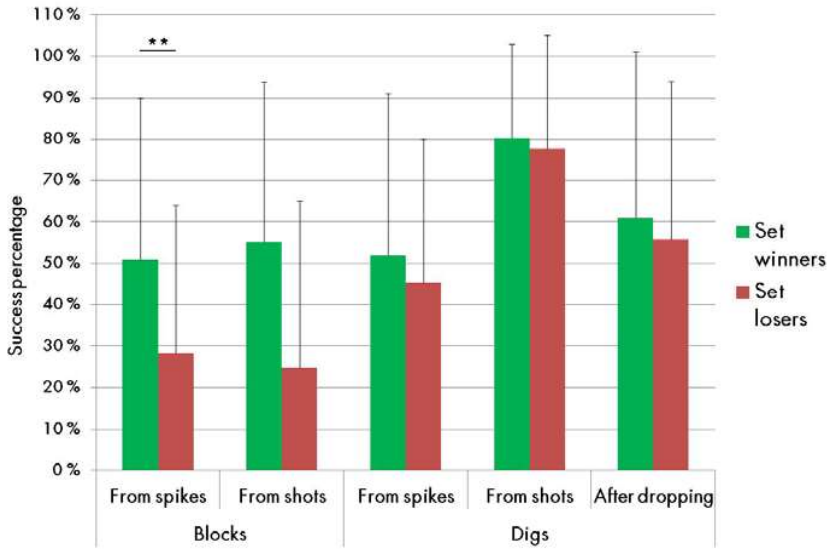

*Figure 47. The success percentages for blocking and digging from different kind of attacks from the opponent for the set winners and losers (**=p<0.01).*

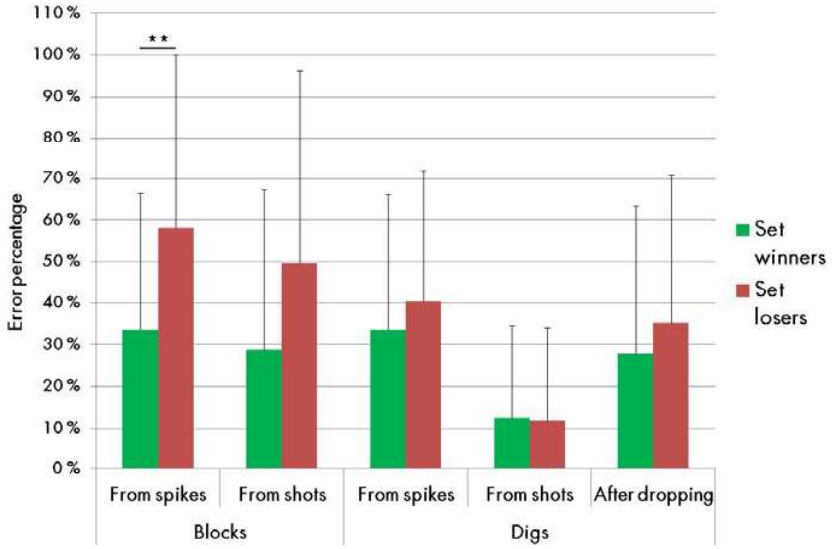

*Figure 48. The error percentages for blocking and digging from different kind of attacks from the opponent for the set winners and losers (**=p<0.01).*

In the ends of close sets the set winners were better (higher success percentage and lower error percentage) in side out and counter attacking, digging and blocking. On the other hand the set losers were better (higher success percentage and lower error percentage) in serving and receiving. (Figures 49 and 50.)

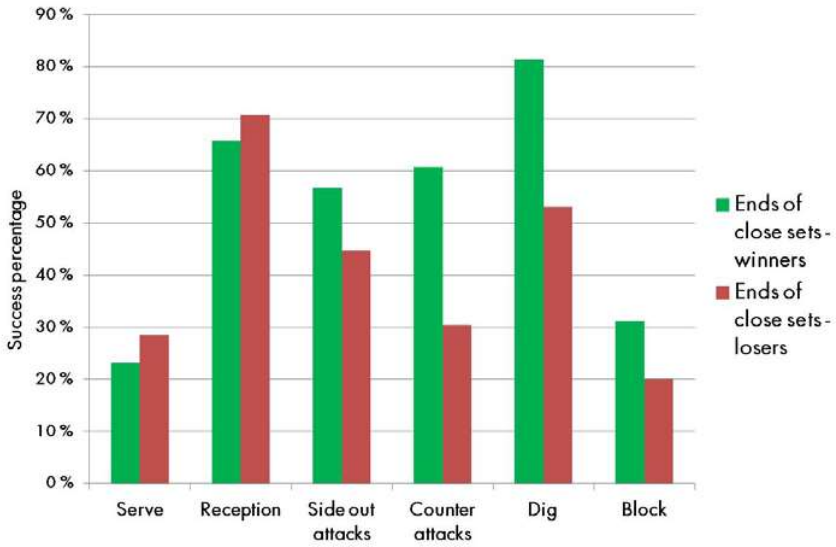

Figure 49. The success percentages of different skill executions for the set winners and losers in the ends of the close sets.

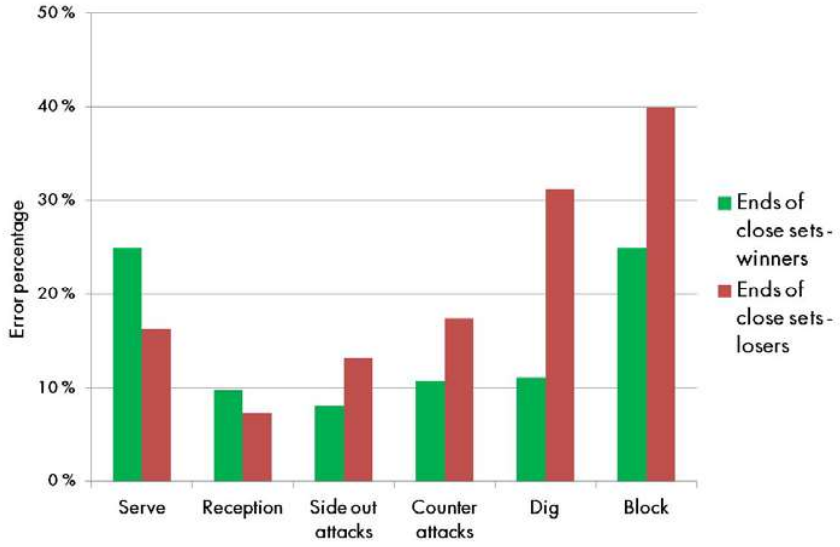

Figure 50. The error percentages of different skill executions for the set winners and losers in the ends of the close sets.

4 DISCUSSION

The average rally duration in female elite beach volleyball was 6.9 seconds which was shorter than in the previous studies by Kröger (2006) from 2005 World Championships (10.2 s) and Pérez-Turpin et al. (2006) from 2006 European Championships (7.4 s). The real playing time in one set was shorter (4 min 26 s vs. 6 min 12 s) and the duration of a set quite similar (18 min 10 s vs. 18 min 28 s) than in study of Kröger (2006). Also the number of rallies in a set was similar (Kröger 2006) so it can be judged that the duration of the breaks has increased. When compared to the results of an analysis of the women's volleyball 2010 World Championships (Inkinen et al. 2012), it was found that the average duration of a rally was almost similar (6.9 vs. 6.7 s), duration of a break (24 s vs. 30 s) and a set (18 min 10 s vs. 24 min 16 s) was shorter in beach volleyball.

61 % of the points were scored by attacking, 24 % from the opponent's errors, 9 % by serving and 5 % by blocking. 39 % of the points were scored in break point situation and 61 % in side out situation. In the 2004 Olympic Games 31 % of the points were scored in break point situation (Laios 2008). In women's volleyball teams scored 60% of their points by attacking and 24 % by opponent's errors so the values are similar to results of this study. On the other hand in volleyball teams scored approximately 43 % of points in break point situation. (Inkinen et al. 2012.) In the study of Giatsis & Zetou (2003) matches of the 2001 World Tour were little bit more even than the matches of this study, because 28 % of the sets ended with two point difference compared to 23 % in this study. The start of the set proved to be very important, because 87 % of the sets were won by the teams which were ahead at the technical time-out.

Attacking was the most used skill followed closely by setting and serving. Blocking was the least used skill; still a lot of blocking attempts without ball contact were made. The attacks were divided equally to spikes and shots whereas majority of the attacks were executed in side out situation. Jump float serve was the most used serving technique and so the most used reception type was jump float receiving. When compared to the results of Koch & Tilp (2009a and 2009b) from the 2005 and 2007 Klagenfurt World Tour tournaments one exception was found: the proportion of float serves has declined and especially the proportion of jump float serves has increased. This is even more obvious when the results of this study are compared to the studies from the 2004 Olympic Games and 2003 World Championships (Laios 2008; López-Martinez & Palao 2009) where the proportion of the standing float serves was over 50 %. In the most recent published study of Buscá et al. (2011) from the 2008 Barcelona World Tour tournament the use of jump serve was a lot higher (36 %) than in this or any other study, especially the top 6 teams used jump serve very much (65 %). The results in using different attacking techniques differ between this study and the study of Koch & Tilp (2009a) from 2007 Klagenfurt tournament where spikes were used more (55–59 %) than shots in both side out and

counter attack situation. On the other hand in 2005 Klagenfurt tournament spikes and shots are used like in this study (Koch 2009b).

The most common area for serving was area 5 for jump and jump float serves and area 6 for float serves. When compared to the study of López-Martinez & Palao (2009), it can be found that the serve techniques including jumping were now executed more from the left side of the court (area 5) and standing serves quite similarly than before. In this study the players favoured diagonal serves when using jump serve technique, serves to area 6 when using jump float technique and direct serves when using float serve technique. In the study of Koch & Tilp (2009b) the line serves were favoured overall, but no results were presented for different techniques. In this study serves were directed more often to the middle of the court (42 %) (E.g. between the receiving players) when compared to the study of López-Martinez & Palao (2009) where only 16 % of the serves were directed to area 6.

Serve analysis indicated that jump float and float serves were equally effective and jump serve was the least effective serve technique in this study. Especially the error percentage in jump serving was high like also in the studies of Laios (2008), Koch & Tilp (2009b) and Buscá et al (2011). In the study of López-Martinez & Palao (2009) the serves were divided only to stand and jump serves, so jump and jump float serves were not analysed separately. Still their findings were that both the success and error percentages were higher for jump serves (jump float and jump serves together) than for standing serves. (López-Martinez & Palao 2009.) The most efficient area to execute jump and jump float serves was area 5, for float serves all areas were almost as efficient. So the use of different serve areas was in line with the efficiency of jump and jump float serve techniques when area 5 was the most used serve area for jump and jump float serve. At the ends of close sets the error percentage increased compared to all serves.

Area 6 was the most common reception area for all serves executed with different techniques. No differences were found between the receiving efficiency of different kind of serves as was also found in the study of Koch & Tilp (2009a). No differences were also found between the receiving efficiency in different reception areas in receiving different kind of serves.

In attacking area 3 was the most used area in both side out and counter attack situations (29 %) even if the overall attack efficiency was lowest in the attacks from this area. From area 3 attacks to both corners were used quite equally in both spikes and shots. From the other areas diagonal spikes and line shots were favoured. Overall position 6 was the least used attack direction. Koch & Tilp (2009b) found that cross court spikes were used more than line spikes and line shots more than cross court shots and thus their results were in line with the results of this study.

The efficiency of spikes in side out attack situations was little lower than shots, still both were used almost equally. In counter attack situations the efficiency of shots was higher and shots

were also used more. The success percentage in side out attack situation was higher than in counter attack situation (54 % vs. 48 %) and error percentage little higher (14 % vs. 12 %), respectively. In the study of Koch & Tilp (2009a) the success percentage of counter attacks was a lot higher (58 %). Otherwise the percentages were quite similar compared to this study. (Koch & Tilp 2009a.) In the other study of Koch & Tilp (2009b) the success (52 %) and error (17 %) percentages of all attacks were quite similar to this study. In the ends of close sets the efficiency of counter attacking lowered as the success percentage was smaller than in total.

Block touches were more frequent after opponent's spike attacks when compared to shot attacks and also the kill blocks were more frequent after spike attacks. Still the success percentages were equal after spikes and shots and after spikes the error percentage was higher. Most block touches and kill blocks were made from Area 3, which was the most used attacking area. The blocking was more successful at the ends of the close sets than overall.

The digs were performed almost as often after opponent's spike and shot attacks. Koch & Tilp (2009b) on the other hand found that digs were performed more often after shot attacks. Players were more successful in defending opponent's shot attacks than spike attacks. When the attacking area 3 was the most used, it was quite natural that most digs were made against attacks from area 3. Digs were performed quite equally from different areas.

The comparison between the set winners and losers revealed that the set winners were clearly better in side out attacking and blocking and also in counter attacking, receiving and serving. In side out attacking the winners and losers differed especially in successful spiking. In blocking the difference in blocking against spikes was clear. In digging or setting no differences were found. On the other hand in the ends of close sets set winners were now better in side out and counter attacking, digging and blocking and set losers in serving and receiving.

In conclusion it can be said that the time analysis suggests that the physical load in female beach volleyball has decreased slightly, because the duration of the rallies has decreased and the duration of the breaks has increased. On the other hand more serves were performed using jumping (e.g. jump float or jump serves) which increases loading. The results further suggest that attacking and blocking were the most decisive skills concerning winning a set in top-level female beach volleyball. Especially the side out attacking was considered to be highly important in winning a set in top-level female beach volleyball.

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