



Design and Evaluation of Ability-Based Forehand Drive and Forehand Glass Training Models in Padel: Evidence From Volta Padel Club Medan

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Abstract. This study aims to design and evaluate ability-based training models for the forehand drive and forehand glass in padel, specifically tailored for beginner, intermediate, and advanced players at Volta Padel Club Medan. The study adopts a Research and Development (R&D) approach with a pre-test–post-test design to assess the effectiveness of the proposed models. The participants comprised 36 padel players categorized according to their respective ability levels. Data were collected using forehand drive accuracy tests, forehand glass effectiveness measures, and notational analysis during gameplay to capture performance improvements comprehensively. The findings demonstrate statistically significant improvements across all groups ($p < 0.05$), with the most pronounced gains observed among intermediate and advanced players. These results indicate that the ability-based training models effectively enhance players' technical performance and support structured skill development across different proficiency levels. This study contributes to sport training research by providing a systematic and level-oriented framework for padel skill development, highlighting the importance of aligning training design with players' performance capacities.

Keywords: Forehand drive; Forehand glass; Ability-based training; Skill development; Padel

1 Introduction

Padel is a rapidly growing racket sport that has gained increasing global recognition and has attracted scholarly attention in the field of sport performance analysis [1], [2]. Its distinctive characteristics, particularly the integration of glass walls into gameplay, differentiate it from other racket sports and require players to master specialized technical skills. Among these, the forehand drive and the forehand glass are fundamental strokes that significantly influence match performance. While the forehand drive functions as a primary shot for maintaining rallies and controlling game tempo, the forehand

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glass involves more complex perceptual and motor coordination, including anticipation of ball rebound, spatial awareness, and precise footwork [3].

Match analysis studies indicate that forehand strokes are among the most frequently executed techniques during rallies and contribute substantially to point construction and scoring, either directly or by creating pressure on opponents [4], [5]. However, the effectiveness of these strokes is not uniform across players and is strongly influenced by individual skill levels. Advanced players typically demonstrate higher levels of consistency, accuracy, and tactical decision-making, whereas beginner players often exhibit variability in execution and limited adaptability in dynamic match situations [6]. This disparity highlights the importance of designing training programs that are responsive to players' ability levels.

Despite the growing body of research on padel performance, existing training approaches often apply generalized models without adequately considering variations in player proficiency. Such approaches may limit skill acquisition and reduce the transfer of training outcomes to real match contexts [7]. In response, contemporary sport science emphasizes the need for ability-based training models that align instructional design with the developmental stage of the athlete. This perspective is closely associated with the constraint-led approach, which promotes skill acquisition through representative practice environments that simulate game conditions and encourage adaptive behavior [7], [8].

From a methodological standpoint, notational analysis has been widely used to evaluate technical performance in padel, allowing researchers to examine stroke effectiveness, tactical patterns, and performance outcomes in competitive settings [4]. In addition, physical conditioning strategies, such as medicine ball training, have been shown to enhance upper-body power and contribute to improved stroke execution in racket sports, thereby supporting the development of forehand performance [9], [10]. These findings suggest that effective training models should integrate both technical and physical components to optimize player performance.

However, there remains a limited number of studies that systematically develop and evaluate training models specifically tailored to different ability levels in padel. This gap is particularly evident in emerging padel contexts, such as Indonesia, where structured training programs are still developing. At the Volta Padel Club Medan, which serves as a regional center for padel development, training practices are often not yet fully differentiated according to player proficiency levels, potentially limiting the effectiveness of skill development programs.

Therefore, this study aims to design and evaluate ability-based training models for the forehand drive and forehand glass in padel. By integrating principles of sport performance analysis, motor learning, and strength conditioning, this research seeks to develop a structured and level-specific training framework. The study further evaluates the effectiveness of the proposed models using a quantitative approach to determine their impact on players' technical performance.

This research contributes to the field of sport science by providing a conceptually grounded and practically applicable model for padel training that emphasizes the alignment between training design and player ability levels. In doing so, it addresses the gap

between theoretical advancements in sport training and their application in regional sport development contexts, particularly in emerging padel environments.

2. Literature Review

2.1 Technical Performance in Padel

Padel performance has been increasingly examined within the broader domain of racket sport analysis, with particular attention given to stroke effectiveness, rally structure, and decision-making patterns. Previous studies indicate that technical performance in padel is strongly influenced by the ability to execute fundamental strokes consistently under dynamic match conditions [1], [2]. Among these strokes, the forehand drive is recognized as a primary offensive and control technique, frequently used to sustain rallies and apply pressure on opponents [4], [5].

In contrast, the forehand glass represents a more advanced technical skill that requires players to interpret ball trajectories after rebound from the glass wall. This stroke demands high levels of perceptual anticipation, spatial awareness, and coordinated movement patterns [3]. Research suggests that players with higher levels of expertise demonstrate greater efficiency in executing these complex strokes due to superior motor control and tactical awareness [6].

2.2 Skill Level Differences and Performance Variability

Skill level is a critical factor influencing performance outcomes in padel. Studies in sport performance analysis consistently show that advanced players exhibit higher accuracy, consistency, and adaptability compared to novice players [6]. These differences are not limited to technical execution but also extend to cognitive aspects such as decision-making and game awareness.

Beginner players often rely on basic stroke patterns and demonstrate limited ability to adapt to unpredictable match situations. In contrast, intermediate and advanced players are more capable of integrating technical skills with tactical strategies, enabling them to respond effectively to game constraints. This variation underscores the importance of designing training programs that are aligned with players' developmental stages rather than applying uniform training approaches.

2.3 Ability-Based Training and the Constraint-Led Approach

Contemporary sport science emphasizes the importance of ability-based training models that account for individual differences in skill level. One of the most influential

frameworks in this context is the constraint-led approach, which posits that skill acquisition emerges from the interaction between task, environmental, and individual constraints [7], [8].

Within this framework, training is designed to replicate game-like conditions, allowing players to develop adaptive responses through representative learning environments. This approach has been widely applied in racket sports to enhance decision-making, perception-action coupling, and technical execution under pressure.

Ability-based training further ensures that practice intensity, complexity, and feedback mechanisms are tailored to the learner's current level of competence. Such differentiation is essential to optimize learning outcomes and facilitate the transfer of skills from training to competitive performance.

2.4 Notational Analysis in Padel Performance Evaluation

Notational analysis is a widely used methodological tool in padel research for assessing technical and tactical performance. It involves systematic observation and recording of player actions during matches to identify patterns related to stroke selection, effectiveness, and outcomes [4].

Through notational analysis, researchers can quantify performance indicators such as shot accuracy, error rates, rally length, and point construction strategies. This method provides objective data that can be used to evaluate the effectiveness of training interventions and to inform coaching practices.

In the context of forehand performance, notational analysis enables a detailed examination of how frequently specific strokes are used and how effectively they contribute to match success. This makes it a valuable tool for validating training models and assessing their practical impact.

2.5 Physical Conditioning and Skill Development in Racket Sports

Physical conditioning plays a complementary role in enhancing technical performance in padel. Strength and power development, particularly in the upper body, are essential for generating effective stroke execution. Research in racket sports indicates that exercises such as medicine ball training can improve power transfer, coordination, and stroke velocity [9], [10].

Integrating physical conditioning with technical training is therefore crucial for achieving optimal performance outcomes. Training models that combine skill development with sport-specific strength exercises are more likely to produce improvements in both execution quality and overall game performance.

2.6 Research Gap and Conceptual Framework

Despite the growing body of literature on padel performance, there is limited research that systematically develops and evaluates training models specifically tailored

to different ability levels. Most existing studies focus on isolated aspects of performance, such as technique or physical conditioning, without integrating these components into a comprehensive training framework.

This gap is particularly evident in emerging padel contexts, where structured and evidence-based training programs are still developing. Furthermore, few studies have examined how ability-based training models can be applied to specific technical skills such as the forehand drive and forehand glass.

To address this gap, the present study proposes a conceptual framework that integrates technical performance, ability-based training principles, and performance evaluation methods. The framework emphasizes the alignment between training design and player proficiency levels, incorporating elements of the constraint-led approach, notational analysis, and physical conditioning strategies.

By synthesizing these perspectives, this study aims to provide a more comprehensive understanding of padel training and to develop a structured model that can enhance skill acquisition and performance across different levels of ability.

3. Methods

3.1 Research Design

This study employed a Research and Development (R&D) approach to design and evaluate ability-based training models for the forehand drive and forehand glass in padel. The effectiveness of the developed models was assessed using a one-group pre-test–post-test design, which is widely applied in sport training intervention studies to measure performance improvements before and after treatment.

The participants consisted of 36 padel players from Volta Padel Club Medan. To ensure alignment with the study objectives, participants were categorized based on their ability levels into three groups:

Beginner (n = 12)

Intermediate (n = 12)

Advanced (n = 12)

This classification enabled the evaluation of training effectiveness across different levels of player proficiency.

3.2 Instruments and Data Collection

The research instruments were developed based on established padel performance evaluation procedures reported in previous studies [4], [6]. Data collection focused on measuring technical performance through:

1. Forehand drive accuracy test – to assess precision and consistency in baseline strokes.
2. Forehand glass effectiveness test – to evaluate the ability to execute rebounds using the glass wall.
3. Notational analysis – to capture performance patterns during gameplay, including stroke selection and success rates.

These instruments were selected to provide a comprehensive assessment of both technical execution and in-game performance.

3.3 Data Analysis

Data analysis was conducted using both descriptive and inferential statistical techniques. Descriptive statistics (mean and standard deviation) were used to summarize performance outcomes, while inferential analysis was performed using a paired sample t-test to determine differences between pre-test and post-test scores.

The level of statistical significance was set at $\alpha = 0.05$. This analysis enabled the evaluation of whether the developed training models produced significant improvements in players' technical performance across all ability levels.

4. Result

The statistical analysis indicates a significant improvement in performance across all groups ($p < 0.05$). Table 1 presents the comparison of pre-test and post-test scores for each ability level.

Table 1. Comparison of Pre-test and Post-test Scores

Level	Pre-test (Mean \pm SD)	Post-test (Mean \pm SD)	Improvement (%)
Beginner	56.3 \pm 6.2	68.7 \pm 5.8	22.0
Intermediate	64.8 \pm 5.9	80.1 \pm 5.2	23.6
Advanced	72.5 \pm 5.4	88.4 \pm 4.9	21.9

Visualization of Results

Figure 1 illustrates the comparison of forehand drive and forehand glass performance scores before and after the implementation of the training model. The figure demonstrates a consistent upward trend across all groups, confirming the effectiveness of the ability-based training intervention.

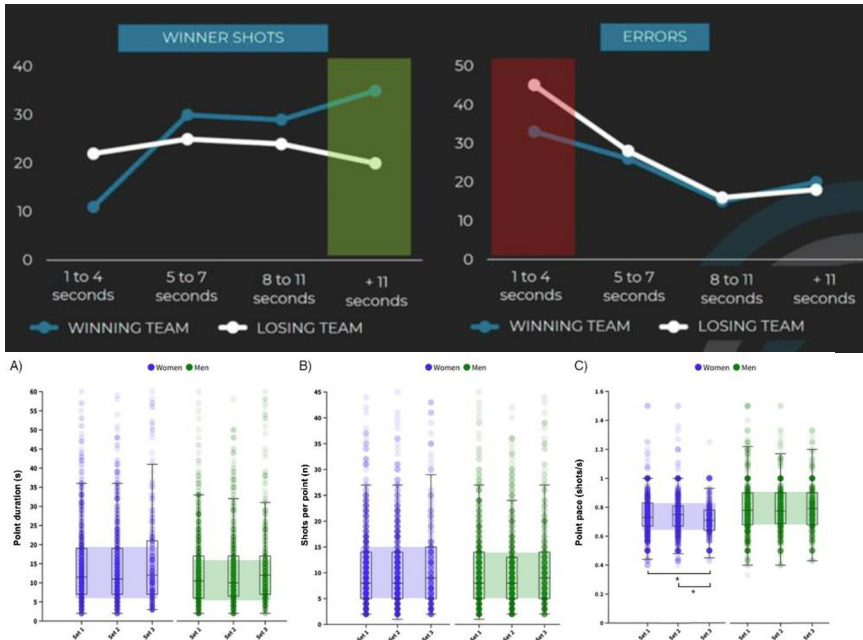


Figure 1. Comparison of forehand drive and forehand glass scores before and after the implementation of the training model.

5. Discussion

The findings of this study demonstrate that the ability-based training model significantly improves players' performance in executing forehand drive and forehand glass techniques. The statistical results indicate consistent performance gains across all ability levels, confirming the effectiveness of the developed training intervention. These results support previous studies emphasizing the importance of contextualized training design and the differentiation of training load according to players' proficiency levels [7], [8].

From a performance perspective, the observed improvements suggest that training models tailored to specific ability levels can enhance both technical execution and adaptability in game situations. The integration of representative practice conditions, consistent with the constraint-led approach, enables players to develop more effective perception–action coupling, which is essential for executing strokes under dynamic match conditions.

A notable finding is the greater improvement observed among intermediate and advanced players compared to beginners. This pattern indicates that players with a more developed technical foundation are better able to benefit from complex and situation-based training environments. These players possess higher levels of motor coordination, tactical awareness, and decision-making capacity, allowing them to translate training stimuli into improved performance more efficiently [6], [9].

In contrast, beginner players demonstrated relatively smaller performance gains, which can be attributed to their limited technical proficiency and reduced capacity to process complex game constraints. This finding highlights the importance of progressive training design, where instructional complexity is gradually increased in accordance with players' developmental stages. Therefore, while ability-based training models are effective across all levels, their implementation should be accompanied by appropriate scaffolding strategies for novice players.

The results also confirm the contribution of integrated physical conditioning to technical performance. The inclusion of sport-specific strength training, such as medicine ball exercises, enhances upper-body power and improves energy transfer during stroke execution. This is consistent with previous intervention studies indicating that strength and power development play a critical role in improving shot quality and consistency in padel and other racket sports [10].

From a conceptual standpoint, these findings reinforce the importance of aligning training design with player characteristics, as suggested by contemporary motor learning theories. The effectiveness of the proposed model can be explained through the interaction between task constraints, individual skill levels, and environmental conditions, which collectively shape skill acquisition processes. This supports the argument that training effectiveness is not solely determined by the volume of practice, but by the relevance and structure of training activities.

Furthermore, the results highlight the practical relevance of notational analysis as a performance evaluation tool. By capturing in-game performance patterns, notational analysis provides a more comprehensive understanding of how training interventions influence actual gameplay, rather than isolated technical execution. This strengthens the ecological validity of the findings and supports the application of the training model in real competitive contexts.

Overall, the integration of ability-based training principles, contextual practice design, and sport-specific physical conditioning creates a comprehensive framework for improving padel performance. The results indicate that such an approach not only enhances technical skills but also supports the development of adaptive and game-oriented performance, which is essential in modern racket sports.

6. Conclusion

This study demonstrates that the ability-based training model for the forehand drive and forehand glass is effective in improving the technical performance of padel players at Volta Padel Club Medan. The findings confirm that training programs designed in accordance with players' ability levels can significantly enhance skill execution, consistency, and adaptability during gameplay.

From a conceptual perspective, the effectiveness of the model can be attributed to the alignment between training design and players' developmental stages. By integrating principles of sport performance analysis, motor learning, and physical conditioning, the proposed model provides a structured framework that supports progressive skill

acquisition across beginner, intermediate, and advanced levels. This reinforces the importance of differentiated training approaches in optimizing learning outcomes in racket sports.

In practical terms, the study suggests that ability-based training models can serve as a valuable reference for coaches and sport practitioners in developing evidence-based padel training programs. The staged implementation of training activities, adjusted to players' proficiency levels, enables more efficient learning and better transfer of skills to competitive situations.

Despite these contributions, this study has several limitations. The use of a one-group pre-test–post-test design limits the ability to establish causal comparisons with alternative training approaches. Therefore, future research is recommended to employ experimental designs with control groups to further validate the effectiveness of the model. In addition, the integration of advanced performance analysis tools, such as video-based analysis and player tracking technologies, is suggested to provide more detailed and objective evaluations of technical and tactical performance.

Overall, this study contributes to the development of padel training methodologies by offering a conceptually grounded and practically applicable model that emphasizes the importance of aligning training strategies with player ability levels. This approach is expected to support the advancement of padel performance and training practices, particularly in emerging sport development contexts.

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