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TENNIS RACKET HANDLES, OVERGRIPS, AND MOTOR SKILL LEARNING: A NARRATIVE REVIEW

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Abstract: Overgrips modify the geometry and surface of a tennis racket handle, but their role in skill learning is unclear. This narrative review evaluates articles published since 2016 on grip measurement, vibration, hand loading, and equipment adaptation for beginners. The review distinguishes the properties of the finished grip from hand position and the force applied during a stroke. Recent techniques measure grip pressure and estimate tendon forces, although some studies include only one or two participants. Comparisons between playing levels describe differences in grip-force timing and magnitude without establishing their causes. Vibration measurements also depend on how firmly a player holds the racket. Most publications on equipment adaptation deal with balls, racket size, and court dimensions. In the evaluated literature, direct evidence linking overgrip wrapping characteristics with motor learning remains limited. Research on the topic in Chinese university tennis courses could start with measuring the finished grip, then examine immediate use and stroke control before assessing retention and transfer. This sequence would allow manufacturing consistency and learning outcomes to be tested separately. An automated overgrip wrapping system requires a usable prototype and its direct evaluation.
Keywords: Tennis racket; Grip size; Overgrip; Grip force; Motor skill learning; Task constraints

1 INTRODUCTION

The handle transmits forces from the tennis player's hand to the racket and from impact back to the hand and forearm. The way it is used is integral to the stroke, which results from a complex interaction between the player, the ball, and the surroundings. In the case of the university tennis learner, variations in hand size, grip thickness, or overgrip wear may influence how the same racket feels. An understanding of this needs to include an explanation of the handle and the manner in which it is gripped.

The term grip has several meanings. Physical grip size describes the circumference, cross-sectional shape, and thickness of the handle once all its coverings have been applied. Overgrip refers to the layer placed on top of the grip and contributes to grip geometry through its thickness and overlap. Grip material and wrapping parameters include friction, moisture absorbency, wrapping pitch, tension, and thickness. On the other hand, grip technique involves the hand's alignment in relation to the bevels of the handle. Grip force is not constant during the swing and depends on time. Rigozzi et al. established connections between grip force, experience of players, and grip technique [1].

These differences matter when considering shared rackets and overgrip replacement in Chinese universities. It is necessary to gather data on usage, the size of grips and their condition for those particular classes. This review highlights the available research on the player-racket interaction and suggests measurements for university tennis research. The educational question is whether an apparent benefit is seen both in a controlled stroke test and in sustained rallies.

2 REVIEW SCOPE AND INTERPRETATION OF EVIDENCE

The present review is limited to papers published from 2016 onward. The sources were checked through journal websites, PubMed and open-access full-text articles by using the search terms “tennis racket grip size,” “overgrip,” “grip force,” “vibration,” “motor learning,” and “equipment scaling.” Reference lists in relevant papers were also checked. Original papers were assessed in light of player expertise, stroke execution, equipment variables and measurements. Systematic and scoping reviews offered an overview of literature on the subject. The review did not use a comprehensive systematic search or formal risk-of-bias assessment. No systematic screening flowchart or pooled effect estimate is presented.

The interpretation of any piece of research depends upon the context within which it was performed. In mechanical studies, vibrations are analyzed in relation to controlled holding conditions. In stroke analyses, muscle activity, grip force, or movement is recorded in relation to the stroke performed by a participant. In both cases, the results can be used to interpret some element of the interaction between hand and racket. Learning research involves repeated task practice and a test that can detect the change in skill produced by practice. This type of evidence has special relevance for education, although it is rarely available in overgrip research.

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3 MEASURING GRIP SIZE, GRIP FORCE, AND COORDINATION

Christensen et al. used measurements of grip pressure, grip size, and racket-head speed during forehand strokes [2]. The test included one elite male participant. This technique illustrates how both the grip characteristics and the response of the user can be captured during the same shot, but there is little basis for choosing the grip size for university beginners. The validity of the relationships for students and different tasks needs to be established empirically. Such a study conducted in class should capture all these characteristics of the finished grip and not rely only on the nominal size of the grip.

The model created by Goislard de Monsabert et al. takes another step towards measurement [3]. The researchers employed data from electromyography to estimate hand tendon forces during forehands by two tennis players. Grip force, wrist moments, and coordination affected the estimates, and there was substantial variation between players. This makes the way the player uses the handle important in the context of equipment studies. The interpretation is limited due to the sample size and to the modeled outcome, which is estimated tendon force rather than observed injury incidence.

Xiao et al. investigated combined kinematics and grip through synchronous measurement of ankle acceleration and undergrip pressure [4]. The study included 30 right-handed male participants: 15 nationally certified second-level athletes and 15 beginners studying physical education. Mean ages were 18 and 19 years, with about six and one years of playing experience, respectively. All used a semi-western forehand and a two-handed backhand. Across three movement and stroke tasks, the athletes had lower mean grip-sensor outputs and shorter reported force duration. The findings remain exploratory because the paper reports grip outputs in units of electrical current despite describing force calibration, and some statistical entries are inconsistent. Data were collected in one observational session without manipulating overgrip conditions or training programs.

The measurement question is not merely about the amount of force. Peak values cannot capture the duration and timing of pressure within a swing. The studies presented above provide the means to study these variables, as long as the task performed, prior experience, and habitual grip technique are known. Repeated measurements could help distinguish an initial response to a new handle from a pattern that persists with practice. More evidence supports this measurement approach than a particular grip size or wrapping method. General claims that a larger grip protects the elbow or that a small grip increases the speed of a racket have no basis in the discussed research.

4 OVERGRIPS, VIBRATION, AND SURFACE CONDITIONS

Amaro et al. compared combinations of overgrips and vibration dampers during serves by six players and reported no consistent significant effect of overgrips on arm vibration [5]. The sample size and the equipment combinations limit interpretation of the results, and it remains unknown how other overgrips perform during groundstrokes or longer training sessions. In their work on the modal behavior of five commercial rackets, Chadefaux et al. revealed that the force applied to the grip affected the vibration frequency and damping [6]. All of these works demonstrate that it is crucial to define the type of stroke, measurement point and holding conditions for equipment comparison.

In relation to the study of wrapping, grip force should be managed according to the research question. Standardizing grip force can help isolate the mechanical response to an equipment change. Allowing players to vary their grip force while measuring it can help show how they use the wrapped handle. This is because if there are differences in gripping the two handles, the difference in the reaction of the racket may reflect both equipment and player behavior.

Grip security, comfort, and shot accuracy also need to be taken into account. An individual who reports less racket slipping does not necessarily use less force or hit more accurately. If one measures how secure they feel along with measuring how much slipping there is and what the grip force is, the connections between these factors will be available for study. The same principle holds for vibrations and comfort, since if one of these changes, one can compare it with a measurement of the other.

Finished grip dimensions should not be overlooked either. Both thickness and overlap have an effect on the circumference, meaning that any comparison between materials might become a size comparison as well. It is important to record information regarding thickness, circumference, overlap width in various spots, as well as surface wear and the time when the measurements were made. Measurements made only before use may not describe the handle condition during later classroom tests.

5 EQUIPMENT CONSTRAINTS AND MOTOR SKILL LEARNING

According to Woods et al., the learner, the task, and the environment are part of an ecological approach to skillful action [7]. Both the theory and the Australian football examples focus on practice structure and the information that influences movement. Qiu and Qiu also propose a conceptual framework about body, brain, and environment in relation to the acquisition of motor skills [8]. This provides a reason to investigate the equipment as it is used in the context of the task. Neither article tests an overgrip intervention, and the Chinese theoretical paper does not evaluate a tennis teaching method.

Krause et al. provided a specific example of this task issue in tennis. These authors noted that there were differences between practice tasks and match play in stroke and movement characteristics [9]. Consequently, a grip test in a static position and a sustained rally are two aspects of the training task that need to be considered separately. The former can

reveal the reaction to the handle in isolation, whereas the latter can show the effect of the equipment in the dynamic situation of play.

There is some relevant information about equipment in the wider literature, but this is based on different kinds of modification. According to a review by Buszard et al. of 25 studies in children's sports, scaling of equipment often led to improvement in immediate performance but with less evidence of sustained learning and transfer [10]. Similarly, Piquer-Piquer et al. undertook a scoping review of 35 studies of novice tennis players, mostly regarding balls, racket size, courts and competition formats [11]. This is a strong reason to pay attention to equipment conditions. It does not show that more consistent overgrip wrapping improves learning. Another scoping review found no peer-reviewed original effectiveness studies of devices that physically constrain hand position within its search scope [12].

The outcome selected for an educational study should always be kept close to its intended purpose. According to Kekelekis et al., there is limited information available about factors associated with risk of upper limb injury in tennis players [13]. Measurement of grip force, estimated tissue loading, or comfort alone does not provide enough evidence of injury prevention. Pain and discomfort may serve as indicators of safety and experience during educational research. A brief classroom study is unlikely to show a reduction in tennis elbow incidence.

6 MEASURING THE PATH FROM WRAPPING QUALITY TO CLASSROOM OUTCOMES

The reviewed literature provides little direct evidence linking wrapping pitch, tension, overlap, and uniformity with tennis skill learning. Any research on these variables will need to start with the finished handle. Records of handle circumference before and after wrapping, thickness variation along the handle, width of the overlap, batch number of the wrapping material used, wear and slippage should be kept.

The next issue is immediate use. Issues such as comfort, perceived slipping, grip-force changes, and shot accuracy can be tested in a clearly defined task. This can be followed by a learning phase where students can be monitored for multiple weeks as they practice. The areas of technique, rally performance, retention, and transfer present an opportunity to test the theoretical link in each instance. Greater wrapping uniformity may be observed in the grip itself without having the same change occur in terms of use or learning.

Manual wrapping could be used in early tests as long as the finished properties are measurable and repeatable. With the racket model, materials, and wrapping procedures controlled, it will be possible to introduce measurable variations and see whether the beginner players recognize them or modify their shots. A comparison of manual and automated wrapping would require a usable, tested prototype. The comparison would first assess wrapping consistency, then examine player outcomes.

This also affects causal interpretation. If manual and machine wrapping produce grips with similar measured properties, any difference in the responses of players would need another explanation. If there are differences between the grips prepared by machines and by hand in terms of their circumference and overlap, the analysis must first document these differences before drawing any conclusions about the influence of a machine on the results obtained.

Table 1 summarizes the conclusions supported by the reviewed research and those requiring further evidence.

Table 1 Recent Findings Concerning the Hand-Racket Interface and Their Limitations

Evidence	Supported interpretation	Conclusion requiring further evidence
Christensen et al. [2] and Goislard de Monsabert et al. [3]: small-sample measurements and modeling	Grip pressure, stroke speed, and estimated tissue loading can be studied together.	A universal grip size or wrapping method has been established.
Amaro et al. [5] and Chadefaux et al. [6]: vibration studies	Vibration results depend on the tested conditions, including the force applied by the player.	A measured vibration change proves better learning or injury prevention.
Xiao et al. [4]: comparison of players at two skill levels	Dynamic grip-sensor measures differed between groups, but reporting inconsistencies limit interpretation.	Changing the overgrip produces those differences or improves coordination.
Buszard et al. [10] and Piquer-Piquer et al. [11]: reviews of equipment adaptation	Modified task conditions can affect some aspects of novice performance.	Overgrip wrapping quality has been shown to improve skill learning.

7 RESEARCH IN CHINESE UNIVERSITY TENNIS COURSES

General physical education electives and specialist tennis courses for physical education majors present two different contexts for conducting the study. A preliminary description will include the type of the class, prior tennis experience, hand size, habitual grip technique, racket features, and overgrip condition. Task difficulty will depend on performance at the start of the study. Students taking the elective may need easier strokes, but physical education majors may be able to handle more complex decision making regarding stroke execution.

In such conditions, the comparison of the equipment requires comparable practice tasks and stroke counts. A crossover study in which students use measured wrapping conditions can address immediate experience. For the issue of learning, equipment exposure and teaching methods have to be controlled in both practice sessions and delayed test sessions. The study by Ma and Shi shows the importance of specifying the stroke task [14]. By employing two high-speed cameras

for three-dimensional analysis, they analyzed the performance of 10 players hitting the kick serve towards T, body and wide targets. Contact location and velocity components varied with the direction of hitting. They did not manipulate the grip conditions. Keeping target direction constant in the overgrip comparison and changing it in a transfer task is a design implication of their results, not a tested overgrip intervention.

This potential contribution to contextualized instruction could be framed as a question about practice opportunities. If a grip helps the player maintain racket control, does the player complete more successful rallies? Observation is required in order to answer this question. Reported comfort alone cannot show whether practice has changed. Testing could start with measurement of the handle difference and proceed through analysis of grip force or perceived slippage to opportunities for successful shots and ultimately to retention and transfer. A null result at any stage would help to establish where the limit of the equipment's contribution lies. Comparison of results of classroom tests with those of rally performance would test whether the two outcomes agree.

8 CONCLUSIONS

Recent developments in grip research have produced techniques to measure grip pressure and vibration, estimate tendon loading, and track force changes during a stroke. The reviewed literature does not identify an optimal grip size or wrapping method for university students. An obvious follow-up study would be to measure finished grips and test their effects in controlled stroke tests and sustained rallies in a classroom setting. A retention or transfer test would be necessary to demonstrate the educational effect. Automated grip wrapping introduces a second issue of preparation consistency, which requires a working prototype before comparison with manual wrapping.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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