

Analysis of Biomechanical Structure and Passing Techniques in Basketball

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Abstract

The basketball is a complex sport, which these days has become increasingly linked to its' psychophysical aspects rather than to the technical ones. Therefore, it is important to make a through study of the passing techniques from the point of view of the type of the pass and its' biomechanics. From the point of view of the type of the used passes, the most used is the two-handed chest pass with a frequency of 39.9%. This is followed, in terms of frequency, by one-handed passes - the baseball, with 20.9% - and by the two-handed over the head pass, with 18.2%, and finally, one- or two-handed indirect passes (bounces), with 11.2% and 9.8%. Considering the most used pass in basketball, from the biomechanical point of view, the muscles involved in the correct movement consider all the muscles of the upper extremity, adding also the shoulder muscles as well as the body fixators (abdominals, hip flexors, knee extensors, and dorsal flexors of the foot). The technical and conditional analysis considers the throwing speed, the throw height and the air resistance. In conclusion, the aim of this study is to give some guidelines to improve the mechanical execution of the movements in training, without neglecting the importance of the harmony of the movements themselves.

Key words: *basketball, pass, biomechanics, technique.*

Rezumat

Baschetul este un sport complex, care devine tot mai legat de aspectele psiho-fizice, în detrimentul celor tehnice. Din acest motiv este foarte important să realizăm un studiu al tencilor utilizate la pase, din punct de vedere al tipului de pasă cât și al biomecanicii acestora. În ceea ce privește tipurile de pase utilizate, varianta cea mai frecventă este cu două mâini de la piept, cu o frecvență de 39.9%. Urmează pasa „baseball” cu o singură mână, cu o frecvență de 20.9%, urmată cu o frecvență de 18.2% de pasa cu două mâini peste cap și, în fine, de pasele indirecte, prin lovirea mingii de sol, cu o mână (11.2%) sau cu două mâini (9.8%). Luând în discuție pasa cea mai utilizată, din punct de vedere biomecanic, aceasta face apel la întreaga musculatură a membrului superior, antrenând în mișcare musculatura umerilor și, nu în ultimul rând musculatura fixatoare a întregului corp. Analiza tehnică ia în discuție viteza aruncării, înălțimea ei și rezistența aerului. În concluzie, scopul acestui studiu este acela de a oferi câteva linii directoare în scopul îmbunătățirii execuției mecanice a mișcărilor din cursul antrenamentelor, fără a neglija importanța armoniei mișcărilor.

Cuvinte cheie: *baschet, pasă, biomecanică, tehnică.*

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Introduction

These days, basketball has become increasingly linked to psychophysical aspects rather than technical ones. In the last few years, this has and continues to be the picture we see from the United States and its NBA, the very cream of world basketball, as well as in our own top-level championships in Italy. In fact, we feel that a peak has been reached and that now a return to a more careful consideration of technique is desirable, if not essential. Players' excessive specialization in the various positions, which has led to a significant drop in technical skills, should make way for training that while obviously still being specialist, is also more versatile and for all players in all positions, above all at pre-senior age (18/19 years).

Subject

In a certain sense, those in the field have recognized a need for this process, which has been started in part, leading to proposals for a more correct "grammar" when it comes to the technical language of basketball during training. Command or even domination of technical elements will, as a result, consist of the possibility to use them in an increasingly productive, successful manner [1, 2]. Basically, this return to the past should be backed up with teaching proposals that are more profoundly linked to the fundamental nature of the technical elements, even in a biomechanical sense, to analyze the athlete's strengths and weaknesses. This will allow more knowledgeable use of teaching and above all, a more focused programme when it comes to correcting movements themselves [3].

Technical Analysis

Looking specifically at a characteristic feature of basketball, we can see that of the two ways of

advancing the ball, the pass is certainly the most suitable, the quickest and if we like, the most modern. We should add that in today's basketball, and perhaps in that of yesterday, high speed is not always the best method to deal with an attack action but that probably, in some cases, it would be better to deal with these actions more slowly, leaving control of the ball – in the case of setting up an attack, for example – not to anyone, but to the person appointed to the role of playmaker. This will certainly give the action a more considered feel, one that seeks a more desirable and less instinctive solution. This is often an intelligent choice for older players, but we feel it to be less applicable to younger players at entry level. By this we mean players aged between 12 and 15, where the possibility to encourage these young people to make choices and decisions within a shorter time frame are, in our opinion, an excellent technical and teaching means to their growth as athletes. Of course, this does not mean that a part of training should not be dedicated to more reflective play, in anticipation of what will be the all-round nature of the game at a "more mature" age. After this important, in our opinion, introduction to the two fundamental means of transferring the ball into the basket, we can now take a better look at passing or better still, at the most used passes in basketball, given that even though there is a vast number of passes [4] only some of these are used all the time, by the majority of cases, which is why we define them as the most important.

Method

Looking at numerous games and also comparing them with previous studies, such as those by Allen and Ruffner (1984), for example, we have come to some conclusions that may be of use in the methodology and teaching used by basketball

trainers and instructors. We are aware of the distinctions that should be made to establish the playing level to which we refer and we have based our study on top-level Italian matches and American championship games in both NCAA and NBA leagues, for a total of some 150 matches. Data have shown that in spite of everything, the pass most used is the two-handed chest pass, with 39.9%.

This is followed, in terms of frequency, by one-handed passes - the baseball, with 20.9 % - and by the two-handed over the head pass, with 18.2 %, and finally, one- or two-handed indirect passes (bounces), with 11.2 % and 9.8 % [5].

Form and mechanics (technique)

The “baseball” one-handed pass is the one with the worst success rate in percentage terms compared to all other passes, the most successful one being also the most popular: the two-handed chest pass. The results are more or less the same as those found for other studies carried out, as mentioned, also in periods prior to the one looked at here and therefore, the reliability of the data is rather high.

We shall now take a brief look at the techniques of some of the more popular passes used, starting with the two-handed chest pass.

The two-handed chest pass is made by moving the ball from the basic stance, giving it a half turn downwards for greater force, extending both arms together and snapping the wrists outwards as the arms extend fully, before pushing with the fingers (the last of which being the thumbs). As well as providing the main propulsion for short passes, the fingers also “steer” the pass, giving it its direction. For longer passes, the muscles in the upper body will also play a role, especially the back muscles, amongst others, which we will look at in more detail later. At the end of the pass, the final stance is

maintained for a few seconds to prevent any sudden movement from influencing the trajectory of the throw. The optimum point of aim, and obviously, the one required by the receiver, must be the one furthest away from the defence of the receiver himself. As far as concerns receiving the pass in question, which is unique out of all types of pass, we could say that it occurs by extending the arms in the direction of the ball’s arrival trajectory with the hands open and four fingers close together and facing upwards, while both thumbs are facing each other and almost touching: a position that makes the catch much easier once the ball has entered the hands. The arms are extended to absorb the impact of the pass’s arrival by bending and this is also a good stance for getting into position for the next action.

As far as the regards the “Baseball” pass, which is frequently used to launch a counter-attack action or for long throw-ons, it is similar to a pitch in the sport that gives it its name. From the basic stance, the player moves his arms and at the same time, he slightly rotate his hips and shoulders towards the passing hand, moving his opposite leg forwards to rebalance his centre of gravity. The ball is then advanced by a quick push of the arms as well as by the rotation and forward movement of the shoulders, with a final downwards “snap” of the fingers after the arms have been totally extended parallel to the ground, the passing arm in particular [6].

To conclude, we will look briefly at the two-handed over the head pass: from the basic stance, the arms are lifted up and extended to a point where the back is slightly arched and the arms are slightly bent back just past the head, giving the right amount of force to the pass that will then offload through the tension in the back and arms, to just after the head, ending with a fast outward movement of the wrists, with propulsion that mainly comes from the thumbs but

which is obviously in synergy with the other fingers [7].

Technical and conditional analysis

Before proceeding, however, we are going to look at the pass from a purely physical viewpoint, or even a ballistic one, which is more suited to our case. We find that the task of the player making the pass is therefore that of achieving a combination of the three following factors to obtain the best possible result [8].

1. Throwing speed: the speed with which the ball leaves the player's hand or hands is determined by its speed before the player begins the pass and the force that he exerts on it.

Generally, a player with a certain amount of muscular strength uses it to make sure that the ball achieves the required throw speed and intensity as well as direction. Nonetheless, since success mainly depends on completing the action before the defense player can react and intercept the pass, it is important for priority to be given to these muscle strengths so that they can be used more rapidly. Muscle strengths are what produce finger flexion, wrist flexion and elbow extension and therefore, should be the first to be called into play. Only when these are insufficient, perhaps in cases of longer passes, will the muscle strengths of the upper body be used. We should bear in mind that in passes, the ball needs to be thrown from a sufficient distance to give time to the receiver to perform the receiving action as best he can.

2. Throw height: while considering a height for each type of pass, it is possible to say that, as a rule of thumb, it must be the same as when leaving the hands of the passing player, keeping a straight trajectory and staying parallel to the court.

3. Air resistance: while the section of the ball is large compared to that of a bullet, the speed with which it

moves through the air is quite low. However, since speed is a very important factor in determining friction, in this case, friction is relatively low. When a player makes a pass, the ball will inevitably be rotated. In the majority of passes, the rotation is in reverse (backspin) and tends to slow it down under the effects of gravity (see *Magnus* effect). Backspin is doubtless useful for greater precision when aiming the ball and therefore, it provides greater accuracy, although it should not be increased excessively so as not to create problems for the person on the receiving end of the pass.

Biomechanics of technique

As we mentioned above, a pass is the technical action by means of which players transfer the ball over the court in the direction of a team mate, usually the one in the best position. Now we will look at the one which, according to simplicity and the muscles used, is the most important or as already mentioned, the *two-handed chest pass* [1].

This pass is executed as follows:

- **Forearm flexion towards the arm**, using the biceps brachii, brachialis and brachioradialis.
- **Extension of the forearm on the arm**, using the head along the triceps brachii and anconeus.
- **Flexion of the wrist and hand**, with use of the flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis and flexor digitorum profundus.
- **Flexion of the fingers**, using the flexor digitorum profundus, flexor digitorum superficialis, lumbricals, and the palmar and dorsal interossei.
- **Extension of the fingers**, with the use of the extensor communis and the extensors of the index and little fingers.

Also involved in the complexity of the action are the serratus anterior, the abductors of the shoulder, the external rotators of the shoulder, and the fixators

(abdominals, hip flexors, knee extensors, and dorsal flexors of the foot) [2].

What we have written about here is a complex analysis of the technical and constituent phenomenon of the sport in question, or rather, of one of these technical elements. The aim is to be an aid in making more precise and accurate contributions to improving the mechanical execution of the different movements in training, but always without neglecting any of the fundamental importance of the harmony of the movements themselves.

References

1. Anokhine P.K. (1974), *Teoria generale dei sistemi funzionali in progressi della cibernetica biologica e medica*, Moscow, pp.34-45;
2. Calligaris A., Mondoni M. (1993) *Analisi funzionale e biomeccanica della pallacanestro*, S.S.S., Rome, p. 21-7;
3. Hay J.G. (1993) *The biomechanics of sport techniques*, second edition, Prentice Hall, pp.42-51;
4. Izzo R.E. (1996) *Pallacanestro: Tecnica oggi*, CESI, Rome;
5. Izzo R.E. (1996) *Guida ragionata all'esercizio nella pallacanestro*, Montefeltro Ed., Urbino; pp.34-42;
6. Tipler P.A. (1991) *Invito alla fisica*, Zanichelli, Bologna;
7. Lanzetta A. A. (1982) *Biomeccanica del movimento; il manuale medico-scientifico dell'allenamento*, A. Mondadori, Milan;
8. Hochmuth G. (1983) *Biomeccanica dei movimenti sportivi*, Ed. Nuova Atletica dal Friuli.