

Biomechanics To Improve Taekwon-Do Technique

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1.0 Theory

1.1 Biomechanical Principles

Concept (1) "Ground Reaction Force"

Newton's third law of motion tells us that every force has an equal and opposite reaction force.

Concept (2) "Torque"

To produce rotation, for example - hip twist, we need to produce eccentric forces to create rotation these forces do not act through the centre of gravity, but on each side of it. The turning effect "Torque" is a product of force applied outside of the centre of rotation, for example - pulling hand.

Concept (3) "Equilibrium"

Stability is increased by increasing the area of the base of support and lowering the centre of gravity toward the expected perturbing force and lowering the centre of gravity toward the base of support for example 70:30 distribution on L-stance.

Concept (4) "Sequence of Movement"

Momentum is first established in the large body segments and then transferred to the projectile by a coordinated sequence of joint actions. The force from each joint action must be combined to produce maximum power.

Use a large number of joints as possible in the movement in a progressive sequence. Firstly the large (mass) muscles the small (mass) muscles, for example - the twist of the hip in Taekwon-Do.

The movement must be fast, continuous and must accelerate once started.

Concept (5) "Speed and Momentum"

Force equals mass multiplied by acceleration or speed.

To increase force we can either increase our mass or increase our speed or both. If we increase our mass by 3 times, but keep our speed the same we will generate 3 times more force. However, if we increase our speed by 3 times and leave our mass the same, force is 9 times greater.

Concept (6) "Mass"

Mass is the maximum weight we can produce with our bodies. Mass helps produce force and is increased by directing it toward the point of impact, for example - sine wave.

Concept (7) "Concentration"

By applying the impact force into the smallest target area we can produce a sharper, more concentrated force - the smaller the projectile the greater the force.

Concept (8) "Projecting Ourselves"

The maximum height or distance is dependant on the projection of the centre of gravity.

When height is required project the centre of gravity in an upward motion. When distance is required project the centre of gravity at a 45° angle to maximise height and distance.

1.2 Applying Biomechanical Principles to Taekwon-Do

Concept (1) Ground reaction force

When we strike an opponent or bag the opponent or bag gives back an 'equal and opposite force'. This force travels through our body in a direct line to the base of support "stance". If the base of support is not strong and allows force to be lost we can not utilise the ground and opponent reaction force, for example - the back leg of a walking stance must be locked.

Concept (2) Torque

Torque is another name for rotation, almost all Taekwon-Do techniques require some sort of rotation, eg - hip twist and the pulling back of the opposite hand. Torque is the force achieved when we transfer half of our weight "mass" away from the target.

The faster and harder the opposite mass is withdrawn, the faster and harder the direct force is.

Rotation must occur through the centre of gravity.

Concept (3) Equilibrium

Balance must be maintained at all times - before, during and after the application of a technique. Poor balance interferes with our mass, speed, focus, concentration and recovery.

Concept (4) Sequence of movement

To produce maximum power in Taekwon-Do we must use the correct sequence of each movement. Always use the big muscles before the small ones and as many joints throughout the movement as possible.

Concept (5) Speed and Momentum

Taekwon-Do techniques have no foundation if not performed with power. Speed is the most important factor in generating force. Students should relax their muscles, keep arms and legs bent throughout the movement to enhance speed.

Concept (6) Mass

We are all born and develop a certain amount of mass "weight", some of us more than we want in certain areas. However mass is important in generating power. A large person with the same speed can produce more power than a small person.

Concept (7) Concentration

When striking a vital spot, bag, or board we should use the smallest attacking tool that is practical. A poke to the eye with a finger will do more damage than a punch to the eye when the same amount of force is applied.

Concept (8) Projecting ourselves

Taekwon-Do techniques require a lot of jumping, spinning and flying. The more "air time" we get the better delivery and recovery of the technique. When we jump etc, we are transferring our centre of gravity toward the target to achieve height and distance.

1.3 Identifying Correct Technique

We need to be able to identify what is a good technique and whether improvements can be made. This requires the instructor to have a knowledge of the technique, a knowledge of the mechanical principles that make up the technique and a knowledge of the students' strengths, weaknesses and limitations.

One of the most common ways of identifying correct technique is to measure the results. These results could be a number of boards broken, distance jumped, height jumped or points awarded in competition. Many skills may be involved in determining the final result - such as timing, speed, flexibility and accuracy. When we identify correct technique by the result, we must be aware of factors which influence the result such as the student's mass (how big is he/she), the amount of resistance an object projects - eg, how hard are the boards, how high is the board in comparison to the student and how well were the opponents matched in a tournament.

Most instructors have enough experience and knowledge to identify a good or bad technique this knowledge will help to identify faults a student may have that interfere with the results they want to achieve. Instructors may also use books, videos, personal experience and models to identify and demonstrate correct technique.

1.4 Evaluation of faults

Once we have a clear picture of how the technique should look and what result the technique should produce, we can make a comparison between the identified correct technique and the actual technique being performed.

To make a detailed comparison the technique needs to be broken down into smaller parts especially techniques that are very complex such as a jumping reverse turning kick. There are four main segments of this kick to be observed- the take off or jump, the rotation in the air, the impact of the attacking tool and the landing.

The fault in the technique could be any or all of the above segments, each fault ultimately interfering with the next segment. In the next section - "procedures for improvement", I will explain the process of correcting faults found during your observation.

When we evaluate a technique we must also be aware of other factors that relate to performance such as fear and excitement, environmental restraints such as noise and other distractions. Some techniques are very hard to see because they are performed so fast in this situation the use of a video camera is very useful, not only can you see the movement over again, but in a good machine the movement can be viewed frame by frame.

The technique can also be performed in slow motion by the student. This is a good way of detecting faults although some faults cannot be detected in this way such as speed and timing.

1.5 Procedure for improvement

After our observation and evaluation of the technique or movement we may have found one or more faults. It is recommended that no more than two or three of the faults be addressed at one time. Always remember to reinforce what is being done well as well as recommending improvements.

As it is difficult for a student to work on correcting more than two or three techniques at a time it is necessary to establish an order of priority among the various faults identified. The first step is to exclude (at this stage) all faults that appear to be affected by other faults rather than faults themselves. An example would be a student who had poor balance (equilibrium) this fault would ultimately affect all other faults and techniques. Therefore, a balancing programme would be a prerequisite to any further fault improvements.

We must also consider the affect of modifying one aspect of performance on the rest of the performance, for some students modifying too quickly one part of a technique may lead to total disruption of the other techniques, an example would be to completely change the way sine-wave is performed. Once improvement is achieved it is important to return as soon as possible to doing all of the movement together with full power and speed.

When designing a programme it is important that the student fully understands what is wrong with their technique and the correct procedure to improve it. The practical section gives some example to how best recognise and fix incorrect techniques.

As an instructor there are a number of ways to correct a problem. Students that learn well by listening (auditory), will respond well to verbal explanation and correction. The student who likes to see the technique "visual", will learn well by having the technique demonstrated to them correctly and the student that learns best from doing, "kinaesthetic", may need you to physically move their body through the desired motion.

1.6 Re-evaluation of Technique

The final phase is to re-check the movement or technique to see if improvement has been made.

Asking the student to perform the movement with full speed and power in real situations such as patterns, breaks, step sparring or free sparring, show us if the fault has been rectified. As there is no perfect technique repetition is needed to maintain and improve all techniques. Below is a chart that can help instructors and students identify and record progress.

Name: John Smith

Technique	Evaluation Date	Faults Found	Suggested Programme	Re-evaluation
Walking Stance	1-1-1999	Weight Distribution	Explain Reason for 50/50	Weight Distribution
		Back leg not locked	Explain ground reaction force	More on Back Leg

2.0 Biomechanical Analysis

2.1 "Walking Stance Middle Obverse Forefist Punch"

Common Faults

- Stance too narrow
- Stance not long enough
- Loss of Balance
- Incorrect Facing
- Lacking Power

Biomechanical Principles that apply

Concept (1) Ground Reaction Force

Concept (2) Torque

Concept (3) Equilibrium

Concept (4) Sequence of movement

Concept (5) Speed

Concept (6) Mass

Concept (7) Concentration

Concept (8) N.A.

Factors affecting result

- Environmental constraints - N.A.
- Knowledge of technique - Good
- Comparative mass - O.K.

Process of assessment

Result 1 x 25 mm Pine Board

Medium for assessment

Visual

Student Information

Name: Sarah Ward

Age: 23

Sex: Female

Mass: 56 Kg

Grade: 8th Cup

Strengths: Good Stances

Weaknesses: Moderate Power

Limitations: N.A.

Evaluation

Result achieved - no

Faults found

Lack of power

Incorrect attacking tool

Not pulling opposite hand back properly

Biomechanical faults

Torque Concept (2)

Sequence of movement Concept (4)

Speed Concept (5)

Mass Concept (6)

Concentration Concept (7)

Process for improvement

Because the "sequence of the movement" would have affected the speed and mass of this technique the main areas of concern are the torque which in this case is related to the pulling back of the opposite hand. The concentration as the whole fist hits the board, rather than just the first two knuckles and not using the big muscles before the small muscles were the primary reasons for this result. Sarah was further instructed on how to make a proper fist, how to coordinate her feet, hands, eyes and breath into one movement.

Reassessment

Process of assessment - Result 1 x 25 mm board

Medium for assessment - Visual

Evaluation - Able to break one board

- Uses well in 3 step sparring

2.2 "Middle side piercing kick"

Common faults

- Hitting with flat foot
- Penetration of kick
- Power
- Balance

Biomechanical Principles That Apply

Concept (1) Ground reaction force

Concept (3) Equilibrium

Concept (4) Sequence of movement

Concept (5) Speed

Concept (6) Mass

Concept (7) Concentration

Factors affecting result

- Environmental -N.A
- Knowledge of technique - Good
- Comparative mass - O.K.
- Fear and excitement - Normal

Process of assessment

Result 4 x 25 mm boards

Medium for assessment

Visual

Student information

Name: Krishna Reddy

Age: 37

Sex: Male

Weight 85 Kg

Grade: 2nd Grade

Strengths: Very Powerful

Weaknesses: Accuracy of technique

Limitations: None

Experience: Has broken 3 boards

Evaluation

Result achieved - No

Faults identified

Incorrect attacking tool

Biomechanical faults

Concentration - Concept (4)

Process for improvement

In this analysis the only important fault found was that although there was plenty of power and the mechanics of the movement were good, the required force was lost because it was not concentrated into the attacking tool.

Further instruction and practise on bags, concentrating on hitting with the foot sword was applied.

Reassessment

Process of assessment - Result 4x 25 mm boards

Medium for assessment - Visual

Evaluation - Able to break 4 boards

- Side kick looks better in patterns

2.3 "Jumping Reverse Turning Kick"

Common faults

- Missing the board
- Power
- Recovering balance

Biomechanical principles that apply

Concept (2) Torque

Concept (3) Equilibrium

Concept (4) Sequence of movement

Concept (5) Speed and momentum

Concept (6) Mass

Concept (7) Concentration

Concept (8) Projecting ourselves

Factors affecting result

- Environmental- N.A.
- Knowledge of technique- Good
- Comparative Mass- O.K.
- Fear and excitement- Normal

Process for assessment

Result - 1 x 25 mm board

Practical - Step sparring

Medium for assessment

Visual

Video

Student information

Name: Ross Collet

Age: 27

Sex: Male

Weight: 68 Kg

Grade: 1st Dan

Strengths: Good at sparring

Weaknesses: Focus

Limitations: N.A.

Experience: Good

Evaluation

Step sparring - Timing good, technique fell short of target

Result 1 x 25 mm board - no

Faults identified

Height not achieved

Focus poor

Kick not peaking on impact

Not spinning fast enough

Biomechanical faults

Concept (8) Projection of body

Concept (4) Sequence of movement

Concept (2) Torque

Process for improvement

This analysis showed weakness mainly in achieving the required height which is similar to poor focus, therefore for improvement we need to concentrate on how to lift the body up off the ground - concept (8) and how to rotate correctly in the air - concepts (2,4 & 8). Plyometrics and knee lifts are a good way to improve height, to improve rotation practise jumping around fast without performing the kick. Ensure arms are kept close to the body while spinning, so not to allow eccentric forces to slow down the movement. Training on focus pads will help the focus and help to peak the kick on target.

Reassessment

Process for assessment - Result 1 x 25 mm board

Medium for assessment - Visual

Evaluation - Able to break 1 board at eye level

- On target in step sparring

- Uses well in free sparring