CHAPTER-II

REVIEW OF RELATED LITERATURE
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Andersen et al., (2002) have examined biomechanical differences in soccer kicking with the preferred and the non-preferred leg. Seven skilled soccer players performed maximal speed place kicks with the preferred and the nonpreferred leg; their movements were filmed at 400 Hz. The inter-segmental kinematics and kinetics were derived. A coefficient of restitution between the foot and the ball was calculated and rate of force development in the hip flexors and the knee extensors were measured using a Kin-Com dynamometer. Higher ball speeds were achieved with the preferred leg as a result of the higher foot speed and coefficient of restitution at the time of impact compared with the non-preferred leg. These higher foot speeds were caused by a greater amount of work on the shank originating from the angular velocity of the thigh. No differences were found in muscle moments or rate of force development. We conclude that the difference in maximal ball speed between the preferred and the non-preferred leg is caused by a better inter-segmental motion pattern and a transfer of velocity from the foot to the ball when kicking with the preferred leg.

Andersen and Sorensen (2002) have studied on effect of pelvic motion on soccer kicking performance. A two-dimensional forward
simulation model of one leg was constructed using. The model consisted of four rigid segments (pelvis, thigh, shank, and foot) connected by three joints (ankle, knee and hip) with eight muscle groups (soleus, gastrocnemius, tibialis anterior, vastii, hamstrings, rectus femoris, iliacus and gluteii). Furthermore, a ball was modelled at the beginning of modelled as a damped spring according to results from the simulated motion laboratory experiment. The results showed that (1) kinematically forcing only rotation of pelvis increased ball velocity by 5%, (2) kinematically forcing pelvic translation increased ball velocity by 38%, (3) A combination of rotation and translation yielded a 42% increase, (4). The increases where calculated after the horizontal velocity of the pelvis had been subtracted. Based on the results, it was concluded that there was a slight improvement caused by more optimal working conditions for the hip flexors. A more pronounced improvement was caused by the pelvic translation which facilitated energy transfer to the shank.

Arpınar et al., (2007) have studied consistency of the lower limb acceleration patterns during inside and instep soccer kicks. This study was to examine the consistency of the lower limb acceleration patterns of these two soccer kicks. Thirteen male soccer players (between 15-16 years old) performed 4 trials for each type of kick. Acceleration data were collected by tri-axial accelerometers fixed on subjects' knee and
ankle. The RMS SD (precision error) of the 4 trials was calculated for 3 axes. There were no difference among acceleration curves among trials, the RMS SD would yield a value of 0, corresponds highest repeatability. Comparisons were made between the two kicks using Student t-tests. Differences in the RMS SD values of acceleration waveforms measured at knee were statistically significant for all axes between inside and instep kicks, whereas it was only significant for x- and y-axis at ankle (p<0.05). Correlation coefficient between RMS SD values at knee and ankle in the relevant limb was higher for instep kick. The findings of this study revealed that the inside kick with smaller precision error have higher consistency considering the acceleration patterns of the lower limb. Since the waveform demonstrates different acceleration-deceleration patterns for segments, it might also be used to evaluate consistency in proximo-distal sequence between different types of kick.

Barbieri et al., (2005) have studied on kinematic pattern of the dominant and non-dominant inferior segments during the instep kick with maximum forces and the ball in stationary position. Seven male skillful participants were analyzed with acts between 13 and 14 years. Each participant accomplished five kicks with each member, the 10 mt. goal (free shot) and with the objective of kick of 1 x 1 mt. They were timed with four cameras and were with passive markers placed in the
articulations of interest of the inferior members. After the filming of
the kicks the images were loaded on the computer, measurement,
calibration and three dimensional reconstructions by the software
DVIDEOW. The extracted files of this program were smoothed
through stereographical the LOESS function and accomplishment the
projection visualized. After that, medium bends was calculated
(cinematic pattern) for be each dominant and non-dominant segment of
the support. The performance, the success and mistake of the kicks
were analyzed in the objective. The results presented to better
performance with the dominant to member (28.5% of successes in the
objective) than with the member of non-dominant (5.7% of successes
in the objective). Visual with the analysis of the movement among the
dominant and non-dominant segments. the leg and foot of dominant
and non-dominant segments presented similar kinematic pattern.
presenting differences in the thigh. It was concluded that the kinematic
pattern of the dominant and non-dominant support to member. The
main differences were found in the thigh. Besides, the dominant to
member has better performance than to the member of non-dominant.

Barfield et al. (2002) have studied kinematic instep kicking
differences between elite female and male soccer players. This study
was to examine kinematic instep kicking differences between elite
female and male soccer players in dominant and nondominant limbs.
Eight elite soccer players, six females and two males, volunteered as subjects in the study. Subjects took a two-step angled approach of 45-60 degrees to a stationary soccer ball positioned between two force platforms and kicked the ball with the instep portion of the foot as hard as possible into netting which was draped from the ceiling. Ball velocity was the dependent variable. Study evaluated six additional variables that have previously been shown to be important predictors of instep kicking ball speed. The males generally kicked the ball faster than the females and displayed greater kinematic variables, including maximum toe velocity, ball contact, ball velocity, mean toe velocity, mean toe acceleration, and ankle velocity at ball contact, all of which contributed to faster ball speed. There was one exception, one of the elite females kicked faster than the two elite males and demonstrated higher or similar kinematic patterns when compared with the males. Study conclusions were that females do not instep kick the ball as fast as males, but there were exceptions.

Barfield (1993) has studied effect of selected biomechanical variables on coordinated human movement: Instep kicking with dominant and non-dominant feet. In this study, there exists a relationship between the velocity of ball and the kinematic variables of the dominant side of the kicking limb. The kinematic variables that were correlated have maximum linear velocities of toe (M= 21.50 m/s),
knee (M= 10.05 m/s) and linear velocities of toe (M= 19.17 m/s) and ankle (M= 15.50 m/s) and angular velocity of knee (M= -1599.03 deg/s) at ball contact. Further it was reported that at ball contact the linear velocity of the toe and the angular velocity of knee attained maximum for dominant leg. The released velocity of the ball was also correlated significantly to body anthropometrics (weight, r=0.928; height, r=0.911; age, r=0.932) and also, it was highly correlated to the maximal moments produced during hip flexion (r=0.932), knee extension (r=0.937) and ankle stabilization (r=0.935) in the kicking limb.

Capranica et al., (1992) have studied force and power of preferred and non-preferred leg in young soccer players. The study was conducted to assess the effects of soccer training on strength and power of leg extensor muscles in preadolescent boys and their possible influence in developing a muscular lateral dominance. Twenty male children (mean age 9.6 year), ten soccer players and ten untrained subjects, participated in this study. Force and power were measured at five constant cranking velocities on an isokinetic bicycle dynamometer. Each isokinetic load was given after each trail. Force and power output were calculated for each limb. Soccer players always showed higher and statistically significant differences (p<0.05) for force and power values for all considered pedal frequencies. No
significant differences were observed for the force and power values between preferred and non preferred limb. The result demonstrates the effect of soccer training on the increase of force and power legs regardless of lateral dominance.

Couto (2006) has studied the dynamics and kinematics of a soccer ball in a computer. In this study author analyzed, numerically, the three-dimensional motion of a soccer ball under real conditions, taking into account the effect of the atmosphere by including both the magnus force and the air drag. Study presents an interactive simulation that solves the ball equations of motion, where a number of relevant variables were controlled. Within study simulation it was easy to show why the trajectory was more or less curvilinear as well as the effect of the magnus force on the range of the ball. By controlling the relevant variables author has induced interaction with students by opposing their expectations on a given real physical situation and the "experimental" result given by the computer. The simulation was suitable for students of different ages.

Daisuke et al., (1999) have studied 3D motion analysis of the basic technique in soccer. Comparison of curve kick with instep kick. This study was to clarify the characteristics of the infront curve kick (IFK), the out-front curve kick (OFK) and the instep straight kick (ISK) by a 3D motion capture system (vicon370). The motion analysis
of instep kick has been studied by several investigators. However, there were few studies of curve kick in soccer. The results have been summarized as follows: 1) The direction of back swing was different between ISK and the curve kick. 2) The angles of knee joint and ankle joint were different between the three kick types at impact. (The knee angle of ISK was 119°, that of IFK was 141°, and that of OFK was 98°. The ankle angle of ISK was 113°, that of IFK was 117°, and that of OFK was 90°. 3) The vertical motion range of follow through swing in the curve kicks were wider than the instep straight kick.

Emre et al., (2007) have studied photogrammetric analysis of penalty kick in soccer. Penalty kick has always been the most exciting moment of the soccer game. A perfect technique should be executed in order to put the ball in the goal. Thus, the aim of this study was to investigate the kinetic and kinematic features of the penalty kicking technique of professional soccer players. Five professional soccer players participated in this study. Markers were placed on the thigh, knee and the ankle of the players. Each player executed 10 instep penalty kicks to the targets. Each kick was recorded on two digital cameras with 60 fps. The cameras were placed approximately 90 degree to each other. Photogrammetric analyses of the pictures were done by Pictra Software. The results revealed that for a successful penalty kick a perfect kinetic chain was needed. The analysis showed
that players flexed their knees approximately 60° and laterally rotated their ankles approximately 70° and a follow through were executed by the players. In conclusion, in order to execute a perfect penalty kick, body segments should be in a perfect coordination. Players should be aware of their body segments.

Harrison and Mannering (2006) have studied on a biomechanical analysis of the instep kick in soccer with preferred and non-preferred foot. Using two gen-locked cameras, SHVS video data were obtained for seven players completing eight maximal effort instep kicks at a target with both feet. 3D kinematic analysis was carried out using Peak Motus to obtain joint angles of the standing and kicking legs and the frontal plane pelvic tilt angle. The results showed that when kicking with the preferred limb, the player’s standing foot was closer to the ball and they used a larger frontal plane pelvic tilt angle and greater knee extension of the kicking leg at ball impact. There was greater variability in the kicking leg knee angle and this was consistent with Dynamical Systems Theory.

Isokawa and Lees (1988) have studied a biomechanical analysis of the instep kick motion in soccer. The study showed that peak ball velocity was greatest at an approach angle of 45 degree, although peak ankle velocity was greatest at 30 degree approach angle. Peak velocity

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at the hip was greatest at 15 degree approached angle, and peak knee velocity was greatest with the straight approach (0 degree per second). The authors attributed these notable differences to increase striking mass and greater knee and ankle fixation at the 45 degree approach angle. In the straight ahead approached, there was limited rotation of the leg about the vertical axis through the body. As the approach angle increases, however, the leg must rotate about a vertical axis to kick the ball straight. At an angle of 45 to 60 degrees the active torque created by swing limb completely balance the resistance torque generated by body motion. When the approach engine was greater than 60 degree, the active torque applied to the leg creates a needed new torque and therefore should be considered when assessing methods for sound technique development and prevention of injuries.

Johannes et al., (2002) have studied the relationship of the kicking action in soccer and anterior ankle impingement syndrome: A biomechanical analysis. The study investigated how frequently hyperplantar flexion occurs during kicking and whether the site of impact of the ball coincides with the reported location of the osteophytes, also measured the magnitude of the impact force. The 150 kicking actions performed by 15 elite soccer players by using mobile sensors and high-speed video. In 39% of the kicking actions, the plantar flexion angle exceeded the maximum static plantar flexion
angle. Ball impact was predominantly made with the anteromedial aspect of the foot and ankle, with impact between the ball and the base of the first metatarsal bone in 89% of the kicking actions and between the ball and the anterior part of the medial malleolus in 76%. Postimpact ball velocity averaged 24.6 m/s, with a corresponding average contact force of 1025 N. Hyperplantar flexion was reached only in the minority of the kicking actions. The data on impact location and impact force support the hypothesis that spur formation in anterior ankle impingement syndrome was related to recurrent ball impact, which was regarded as repetitive microtrauma to the anteromedial aspect of the ankle.

Kawamoto et al., (2007) have studied Kinetic comparison of a side-foot soccer kick between experienced and inexperienced players. This study was conducted to identify critical kinetic variables that lead to increased ball velocity during a side-foot passing kick in soccer. Seven experienced male soccer players and eight inexperienced players participated in the experiment. They were instructed to perform side-foot kicks along the ground with maximum effort with an eye on the target line. The joint angles, angular velocities, and torques of the kicking leg were determined based on the three-dimensional kinematics data. The mean ball speed of the experienced group (21.4 +/-1.5m/s) was significantly faster than that of the inexperienced group.
(16.0 +/- 1.0m/s; P < 0.001). The motions of the inexperienced players tended to be less dynamic than those of the experienced players. The most noticeable difference in the kinetics of the kick was found in the hip flexion torque throughout the back-swing phase until the leg-cocking phase. The mean peak value of the experienced group (168 +/- 20 N x or m) was significantly greater than that of the inexperienced group (94 +/- 17 N x or m; P < 0.001). To increase ball speed during a side-foot passing kick, the generation of hip-flexion torque during the earlier stage of kicking was critical.

Kellis and Katis (2007) have studied biomechanical characteristics and determinants of instep soccer kick. This study was to examine latest research findings on biomechanics of soccer kick performance and to identify weaknesses of present research which deserve further attention in the future. Being a multiarticular movement, soccer kick was characterised by a proximal-to-distal motion of the lower limb segments of the kicking leg. Good kicking technique was an important aspect of a soccer player. Angular velocity was maximized first by the thigh, then by the shank and finally by the foot. This was accomplished by segmental and joint movements in multiple planes. During backswing, the thigh decelerates mainly due to a motion-dependent movement from the shank and to a lesser extent, by activation of hip muscles. In turn, forward acceleration of the shank
was accomplished through knee extensor moment as well as a motion-dependent moment from the thigh. The final speed, path and spin of the ball largely depend on the quality of foot-ball contact. Powerful kicks were achieved through a high foot velocity and coefficient of restitution. Preliminary data indicated that accurate kicks were achieved through slower kicking motion and ball speed values. Therefore, understanding the biomechanics of soccer kicking was particularly important for guiding and monitoring the training process.

Kellis et al., (2004) have studied knee biomechanics of the support leg in soccer kicks from three angles of approach. The study was examines the knee joint kinematics, electromyographic (EMG) activity patterns and ground reaction forces (GRF) during an instep soccer kick from three different approaches relative to the ball. Ten male soccer players performed maximum kicks from 0 rad (K0), 0.81 rad (K45) and 1.62 rad (K90) angle between the players, starting position and the position of the ball. GRF data and 3-D kinematics and EMG activity of the vastus medialis (VM), vastus lateralis (VL), and biceps femoris (BF) muscles of the lower leg were recorded. The results showed compared with K0, K90, and K45 demonstrated higher medial and posterior GRF and lower anterior GRF. K90 and K45 also demonstrated higher external rotation displacement, maximum flexion, internal rotation, abduction, and adduction velocity of the tibia relative
to the femur of the support leg compared with K0 (P > 0.01). The BF EMG before and immediately after ground contact was also higher in K90 and K45 compared with K0 (P > 0.01). Soccer kicks using a high angle of approach increase the medial and posterior GRF, which was indicative of an altered stance during the kick, resulting in an altered balance. Such kicks were accompanied by significant alterations in knee joint kinematics and an increased BF activation around ground contact. Soccer kicks from an angled approach may induce significant loads to knee joint structures of the support leg.

Kerwin and Bray (2003) have studied on modelling the flight of a soccer ball in a direct free kick. The study involved a theoretical and an experimental investigation of the direct free kick in soccer. The aim of study was to develop a mathematical model of the ball's flight incorporating aerodynamic lift and drag forces. Trajectories derived from the model have been compared with video analysis that was obtained from experimental kicks. The drag coefficient varied from 0.25 to 0.30 and the lift coefficient from 0.23 to 0.29. These values used with a simple model of a defensive wall. The results reveal how carefully attackers must engineer the dynamics of a successful kick. For a central free kick some 18.3 m (20 yards) from goal with a conventional wall, and initial speed of 25 m[s.sup.-1], the ball's initial
elevation must be constrained between 16.5[degrees] and 17.5[degrees] and the ball kicked with almost perfect sidespin.

Kevin (2007) has studied the use of weighted balls in improving kicking for distance. The study was conducted to examine the effect of maximal distance kicking training using regulation and weighted balls on maximum kick distance. Twenty-eight elite Australian rules footballers were divided into three groups. Group one used regulation balls, Group two used regulation and weighted balls (soaked in water to increase from 450 to 500 g), and Group three was the control. All were tested for maximum kick distance before and after the 4 week (10 sessions) intervention. Groups and changes were compared by ANOVA. There was no difference in kick distance in pre-testing between groups. In post-testing, both Group one and Group two produced significantly longer kick distances than the control group. As well, both group one and group two significantly increased distances from the pre-test to the post-test. Specific kicking for distance improved maximal kick distance in an elite group. The use of regulation balls only or regulation and weighted balls both increased distance. There was no statistical difference between methods, although the weighted ball group improved 0.8m more. A longer intervention might show a significant result. Specific kick distance training was recommended to increase distance.
Kevin (2007) has studied foot-ball interaction in kicking in Australian Rules football. The study was to provide basic information on contact times, the distance the ball moves and change in shank angle during ball contact. The second aim was to see if differences existed for these parameters for short and long kicks. The third aim was to determine if work was done on the ARF ball during kicking. Eight elite level ARF players kicked an ARF ball over 30m and 50m. High speed video focused on the foot and lower leg and was used to calculate contact time between foot and ball. Digitised data was used to calculate the distance the ball moved, shank angle and ball velocity. T-tests compared 30m and 50m kicks. For 30m and 50m kicks mean contact times were 9.8 to 10ms, mean ball distances were 0.19 and 0.24m, and mean change in shank angles were 14 and 18 degrees respectively. 50m kicks were significantly larger for change in shank angle, larger ball distances (small effect, p=0.06 only) and significantly larger change in ball velocity. No difference existed for contact times. Mean contact time and distance the ball moved lay between soccer values. Work was done on the ball during the ARF kick (approx 270J) so using momentum equations was inappropriate. Change in shank angle and distance the ball moves during contact means muscular force were applied and has implications for conditioning.
Kevin (2008) have studied biomechanical considerations of distance kicking in Australian Rules football. Twenty-eight elite players kicked for distance while being videoed at 500Hz. Two-dimensional digitized data of nine body landmarks and the foot ball were used to calculate kinematics parameters from kicking foot toe-off to the instant before ball contact. Longer kick distance were associated with greater foot speeds and shank angular velocities at ball contact, large last step length and greater distance from the ground when ball contact occurred. Foot speed, shank angular velocity, and ball position relative to the support foot at ball contact were included in the best regression predicting distance. A continuum of technique was evident among the kickers. At one end, kickers displayed relatively larger knee angular velocities and smaller thigh angular velocities at ball contact. At the other end, kickers produced relatively larger thigh angular velocities and smaller knee angular velocities at ball contact. To increase kicking distance, increasing foot speed and shank angular velocity at ball contact, increasing the last step length and optimizing ball position relative to the ground and support foot were recommended.

Lees et al., (2007) have studied on influence of Cardan sequence on 3D joint angles during the maximal soccer in-step kick. The purpose of study was to explore the influence of the six Cardan
rotation sequences on the orientation angles of the ankle, knee, and hip of the support leg during a typical dynamic sports movement, typified by a maximal instep kick in soccer. A total of 10 skilled soccer players participated in this investigation (mean+s, age 23.4±2.5 years; mass 71.2±6.8 kg; height 178.1±4.8 cm). The 3D position of a series of markers placed on the lower body were recorded at 240 Hz using an 8 camera opto-electronic motion capture system and then tracked (Proreflex, Qualysis, Gothenburg, Sweden). A total of 10 successful trials were collected and analysed. A 3D motion analysis package (Visual3D, C Motion, Rockville, USA) was used to compute joint kinematics and kinetics based on a 6 degrees of freedom model. The Z axis represented internal/external rotation, Y ab/adduction, and X flexion-extension. Joint angles were computed relative to the proximal segment using an X-Y-Z (flexion, abduction, rotation) Cardan sequence and again using Y-Z-X, Z-X-Y, X-Z-Y, Y-X-Z, and Z-Y-X rotation sequences. It was found that there were major deviations in orientation angles as a function of the Cardan sequence used. The flexion-extension angles were robust for all Cardan sequences except the Y-X-Z rotation, and so this sequence would not be suitable for use. Deviations appeared in all of the Y and Z orientations as a function of rotation sequence, with some being offset while others varying as a function of kick progression. As there was no gold standard for
judging the best Cardan sequence, and as 3D studies in the literature most commonly use the X-Y-Z sequence, it is proposed that this sequenced be used as a de facto standard for future studies.

Levanon and Jesus (1998) have studied the comparison of the kinematics of the full-instep and pass kicks in soccer. The study was to gain a better understanding of the mechanics of the inside-of-the-foot passing shot used in soccer ("pass kick"). The motions of the pass kick were compared with those of the full-instep kick ("full kick"). The study followed an inverse dynamics approach, using three-dimensional cinematographic techniques. At impact, the pelvis and the thigh-shank plane pointed more toward the right in the pass kick; the shank-foot plane also pointed further outward relative to the thigh-shank plane. Knee extension accounted for most of the speed of the foot in both kicks (86% in the full kick; 67% in the pass kick). In the pass kick, pelvis tilt toward the right and hip adduction contributed to a medial component of foot velocity (8.4 ms-1) normal to the thigh-shank plane, which made the resultant foot velocity vector more oblique to the plane than in the full kick. This facilitated ball impact with the medial aspect of the foot. The slower ball speed in the pass kick was because of a slower foot speed (18.3 ms-1 vs 21.6 ms-1). Limitations in the maximum medial velocity that can be generated may force players to restrain the within-plane (and therefore also the resultant) velocity of
the foot to be able to impact the ball squarely with the medial aspect of the foot. To impact the ball with the medial aspect of the foot in the pass kick, the player orients the pelvis, the right leg, and the foot more toward the right and introduces a medial component of foot velocity. However, most of the speed of the foot was still generated through knee extension.

Levanon et al., (1995) have studied on three-dimensional kinematic and kinetic analysis of two common kicking techniques in soccer. Three-dimensional cinematography and inverse dynamics were employed to analyze the full-instep kick (FK) and the pass kick (PK) executed by 6 college varsity soccer players. In FK, the rotations of the leg segments occurred primarily within the thigh-shank plane (TSP). In PK leg motions occurred both within TSP and in the medial direction, normal to TSP. Flexion/extension rotation at the knee accounted for most of the speed of the foot at impact in both kicks. The speed of the foot immediately before impact and of the ball following impact were larger in FK. A clear positive relationship was found between the speed of the foot before impact and of the ball following impact. The flexion/extension torques at the hip and knee joints exhibited a similar pattern in both kicks, with maximum hip flexion and knee extension values in the middle part of the motion. A torque exerted by the thigh on the shank at the knee was found in both
kicks, but in PK it was quite large. Repetitive use of PK could lead to injury.

Manolopoulos et al., (2006) have studied effects of combined strength and kick coordination training on soccer kick biomechanics in amateur players. Ten amateur soccer players (aged 19.9±0.4 years, body mass 74.8±9.1kg, height 177.4±6.7cm) constituted the experimental group (EG) whereas 10 players (age 21.6±1.3 years, weight 71.5±6.7kg, height 175.2±3.4cm) served as controls (CG). The EG followed a 10-week soccer-specific training program combining strength and technique exercises. All participants performed an instep soccer kick using a two-step approach while three-dimensional data and EMG from six muscles of swinging and support legs were recorded prior to and after training. Maximum isometric leg press strength, 10mt sprint performance and maximum speed performance on a bicycle ergometer were also measured and result was found that the EG improved significantly (P<0.05) maximum ball speed, the linear velocity of the foot, ankle and angular velocity of all joints during the final phase of the kick. Training had insignificant effects on EMG values, apart from an increase in the averaged EMG of the vastus medialis, whereas maximum isometric strength and sprint times significantly improved after training (P<0.05). The results suggested
that the application of the training programs using soccer-specific strength exercises would be particularly effective in improving of soccer kick performance.

McLean and Tumilty (1993) have studied left-right asymmetry in two types of soccer kick. The study investigated the characteristics of asymmetry in two types of soccer kick. A low drive and a chip from both the left and right foot of 12 elite junior soccer players were analysed. Kick velocity, kick accuracy, position of the plant foot from the ball centre, and time from foot plant to ball contact were measured for each kick. Knee extension and flexion strength were also determined for each leg. Chi² analysis was used to compare accuracy between shots and between sides, and a paired student’s t-test was used to compare strength parameters between sides. Pearson’s product moment correlation analysis was used to examine the relationship between velocity and both leg strength and the time from foot to ball contact. The result showed that the group had strength dominance at all speeds tested on the right side and better drive kick performance with their right leg as determined by mean (sd) velocity 79 (6) versus 66(8) km-1 and accuracy (66.6% versus 33.3%). There were no differences in these parameters between sides for chip kicks.

Mofrad and Moghadam (2006) have studied on a new biomechanical approach to side-foot soccer shot’s characteristics
determination. The study considers the biomechanical factors that were relevant to succeed in the kicking of a ball into three points; A, B, and C pre-selected in the area of gate. Sixteen amateur of top university players participated in the study. Two cameras at 30 Hz were used in sagittal and frontal planes. The recorded data were processed through computer with Ulead Video Studio and AutoCad softwares. The time of flight, time of ball contact with kicking foot, the angle of volley, ball velocity, and the angle of knee flexion were achieved. Then by biomechanical formulae, ball speed, launch angle, range, force exerted to ball, and finally the torques applied to leg joints; ankle, knee, and hip were obtained. The ball speed, launch angle, and the ball range were theoretically estimated and then verified with the mentioned method.

Nunome et al., (2007) have studied an alternative feature of impact phase kinematics of instep kicking in football. The study was to describe the more representative kinematics of kicking motion through ball impact phase by exploring the influence of both sampling rate and smoothing procedures. Nine male footballers performed maximal instep kicking. The lower limb motion was three-dimensionally captured at 1000 Hz. The displacements were smoothed by a new time-frequency filtering (TFF). Also the co-ordinates were re-sampled (250 Hz) and smoothed by Butterworth digital filter using a 10 Hz cut-off
(RSF) to resemble typical sampling and processing conditions used in the literature. The shank angular velocity was found to be increased during the final phase of kicking (TFF). Meanwhile, a totally different curve (apparent decrease in the shank angular velocity before ball impact) was created when the conventional filtering at 10 Hz cut-off was applied on the re-sampled co-ordinates (RSF). This nature has been consistently observed in the most of previous studies. However, in literature no evidence was shown to support this type of instruction from a biomechanical point of view. The present study was the first to strongly support the above practical advice of kicking by clearly illustrating the true kinematics of the shank during kicking.

Nunome et al., (2006) have studied on impact phase kinematics of instep kicking in soccer. This study was designed to capture the lower limb kinematics before, during and after ball impact of soccer kicking by examining the influence of both sampling rate and smoothing procedures. Nine male soccer players performed maximal instep kicks and the three-dimensional leg movements were captured at 1000 Hz. Angular and linear velocities and accelerations were determined using four different processing approaches: processed using a modified version of a time-frequency filtering algorithm (WGN), smoothed by a second-order low-pass Butterworth filter at 200 Hz cut-off (BWF), re-sampled at 250 Hz without smoothing (RSR) and
re-sampled at 250 Hz but filtered by the same Butterworth filter at 10 Hz cut-off (RSF). The WGN approach appeared to establish representative kinematics, whereas the other procedures failed to remove noisy oscillation from the baseline of signal (BWF), lost the peaks of rapid changes (RSR) or produced totally distorted movement patterns (RSF). The results have indicated that the procedures used by some previous studies may have been insufficient to adequately capture the lower limb motion near ball impact. The study has proposed a new time-frequency filtering technique as a better way to smooth data whose frequency content varies dramatically.

Nunome et al., (2006) have studied segmental dynamics of soccer instep kicking with the preferred and non-preferred leg. The study was conducted to detailed time-series of the resultant joint moments and segmental interactions during soccer instep kicking were compared between the preferred and non-preferred kicking leg. The kicking motions of both legs were captured for five highly skilled players using a three-dimensional cinematographic technique at 200 Hz. The resultant joint moment (muscle moment) and moment due to segmental interactions (interaction moment) were computed using a two-link kinetic chain model composed of the thigh and lower leg (including shank and foot). The mechanical functioning of the muscle and interaction moments during kicking were clearly illustrated.
Significantly greater ball velocity (32.1 vs. 27.1 m[sup.-1]), shank angular velocity (39.4 vs. 31.8 rad [s.sup.-1]) and final foot velocity (22.7 vs. 19.6 m [s.sup.-1]) were observed for the preferred leg. The preferred leg showed a significantly greater knee muscle moment (129.9 N. m) than the non-preferred leg (93.5 N.m), while no substantial differences were found for the interaction moment between the two legs (79.3 vs. 55.7 N. m). These results indicated that the highly skilled soccer players achieve a well-coordinated inter-segmental motion for both the preferred and non-preferred leg. The faster leg swing observed for the preferred leg was most likely the result of the larger muscle moment.

Nunome and Ikegami (2006) have studied on kinematics of soccer instep kicking: a comparison of two-dimensional and three-dimensional analysis. The influence of two and three-dimensional filming procedures on the calculation of soccer instep kicking kinematics was examined in this study. The knee angular velocity calculated three-dimensionally was compared with the data obtained from the following two procedures. 1. The angular velocity vector was computed as a perpendicular component to the sagittal plane (2D projection); 2. The angular velocity was computed only from the two-dimensional coordinates (2D standard). A distorted changing pattern was produced by the 2D standard approach which was most likely
caused by computing segmental angular velocities from quasi-planar projection. It was suggested that researchers treat with caution any comparisons in the literature between three-dimensional angular kinematics and those computed two-dimensionally.

Nunome at el., (2004) have studied kinetic comparison of instep soccer kick between preferred and non-preferred leg in highly skilled players. The kinetic differences of soccer instep kicking between the preferred and non-preferred leg were examined. The kicking motions of both legs were captured for five highly skilled players using a three-dimensional cinematographic technique at 200 Hz. The moments due to muscle force and segmental interactions were computed. Significantly greater ball velocity and shank angular velocity were achieved in the preferred leg. The preferred leg showed a significantly greater muscle moment than that of the non-preferred leg. No marked differences were found for the interactive moment between both legs. The results indicate that the highly skilled soccer players were able to produce a well coordinated inter-segmental motion not only for the preferred leg but also for the non-preferred leg. The faster leg swing observed for the preferred leg was most likely a result of the larger muscle moment.

Nunome, et al., (2002) have studied three-dimensional kinetic analysis of side-foot and instep soccer kicks. This study was to
identify the kinetic aspects of side-foot and instep soccer kicks to understand the different mechanics underlying the two kicks. The motions of both kicks were captured using a three-dimensional cinematographic technique. The kicking leg was modelled as a three-link kinetic chain composed of thigh, shank, and foot, from which joint torques and angular velocities were computed. Results revealed that the ball velocity of the side-foot kick (23.4 ± 1.7 m·s⁻¹) was significantly slower than that of the instep kick (28.0 ± 2.1 m·s⁻¹). Significant differences were also observed between the two kicks for the magnitude of hip external rotation torque (56 ± 12 N·m in the side-foot kick; 33 ± 8 N·m in the instep kick) and hip external rotation angular velocity (11.1 ± 2.4 rad·s⁻¹ in the side-foot kick; 6.0 ± 2.0 rad·s⁻¹ in the instep kick). These results indicated that to hit the ball with the medial side of the foot, a complicated series of rotational motions were required for the side-foot kick. The hip external rotation torque dominantly exhibited in the side-foot kick caused the clockwise rotation of the thigh-shank plane at the later stage of kicking. This has allowed the hip external rotation motion to increase directly the forward velocity of the side foot, with which players would squarely impact the ball.

Opavsky (1988) has studied an investigation of linear and angular kinematics of the leg during two types of soccer kick. The
study conducted with six subjects, to investigate the linear and angular kinematics characteristics of standing and running kicks with the foot making contact with the ball on its dorsal surface. The running kick produced greater linear and angular velocities in the leg. However, the standing kick generated higher acceleration suggesting greater muscular efforts were being applied. Angular foot velocities in both kicks have reached in excess of 20 rad/s. The ball velocity for standing approach kick was recorded 23.48 m/s and for running approach kick it was found to be 30.78 m/s.

Orloff, et al. (2008) have studied on ground reaction force and kinematics of plant leg position during instep kicking in male and female collegiate soccer players. Twenty-three soccer players (11 male 12 female) were filmed in both the sagittal and posterior views while performing a maximal instep kick. Plant leg kinetic data were also collected using an AMTI 1000 force platform. There were no significant differences between the sexes in plant leg position, but female had significantly greater trunk lean, plant leg angle, and medial lateral ground reaction force than the male. Male showed higher vertical ground reaction force at ball contact, but there were no significance differences in ball speed at take off between the sexes. Ball speeds at take off were inversely related to peak anterior posterior ground reaction force (-.65). The anatomical differences between the
sexes were reflected in greater trunk lean and lower leg angle in the female.

Orloff, et al., (2007) have studied on comparison between ground reaction force patterns and angular approach and ball velocities for in-step kicking. The purpose of this study was to determine if patterns in vertical ground reaction forces resulted in differences in hip, knee and trunk angular velocity and efficiency of the open kinetic chain. 20 subjects performed a maximal in-step kick while ground reaction forces of the plant leg, as well as angular approach and ball velocities were recorded. Although approach and ball velocity were unchanged between groups, the decreasing vertical force group had significantly higher initial peak vertical ground reaction forces and angular hip velocities than subjects with a double vertical peak pattern. There was a significant relationship between approach velocity and ball velocity, as well as a negative relationship between posterior lean on contact and leg angular velocity. It reflected that the pattern of vertical force with the plant leg was not a key factor in ball velocity.

Petrone (2006) has studied on correlation between support foot placement and goal accuracy for instep kicks in the soccer field. The placement of the support foot relative to the ball was supposed to have an effect on the shot precision for a given target. The goal was divided with a visual grid enabling to identify six possible targets of the shot,
high/low for vertical placement and left/center/right for horizontal placement. Skilled players were asked to perform repetitive penalty instep kicking in the soccer field with a defined target such as high/left or low/right: ground reaction loads were recorded by means of a force platform installed in a suitable board and the movements were video recorded. The position of COP at the kick instant with respect to the ball and the average trajectory of COP on the platform resulted to be correlated with successful target in such a way that training procedures were defined to improve the player coordination for precision shooting. Finally, differences between free kicking and kicking with a goalkeeper were recorded, enabling to analyze a realistic player behaviour in the study.

Shan (2002) has studied full-body kinematic characteristics of the maximal instep soccer kick by male soccer players and parameters related to kick quality. The study tried to understand fundamental soccer skills, most focusing on kicking. However, a full picture of an efficient kick remains incomplete owing to constraints of test designs and difficulties that arise in synchronizing and analyzing information generated by multiple assessment techniques. This study remedies deficiency and defined a full-body model capable of revealing more detailed characteristics of kicking. It revealed effects of long-term
training by comparing novices with skilled athletes and explored new parameters that have potential to aid quantitative evaluations of skill. Results showed effective upper-body movements to be a key factor in creating better initial conditions for a more explosive muscle contraction during kicking. It permitted a more powerful quasi whip-like movement of the kicking leg. Finally, the timely change of distance between the kick-side hip and the non-kick-side shoulder provided a quantitative means of measuring kick quality.

Shan has studied on biomechanical analysis of soccer kicking and passing - a synchronized analysis of 3D kinematics and EMG. The study targeted two goals; one - to capture left and right kicks as well as passes of ten elite and ten novice female soccer players, and two - to do primary kinematical comparison between the two groups. Ten novice subjects (21.5±2.2) were recruited from an Introductory Kinesiology class at the University of Lethbridge and an equal number of elite soccer players (20.4 ±3.5) volunteered from the University’s varsity women’s soccer team. For obtaining 3D data, 42 reflective markers were placed on bony landmarks (4 on heads, 10 on the trunk, 7 on each arm and leg) and 3 reflective markers were placed on the ball. All participants completed twelve trials, consisting of six kicks and six passes. Three trials were completed with each foot. The ball was placed in front of the participant and no restrictions as to the approach
to the ball or the type of kick were given to the subject. Primary analysis showed that elite female soccer players demonstrated larger range of motion of hip flexion-extension when performing kicks with both their dominant and non-dominant legs (96.0°±6.7 and 81.6°±7.0) as compared to novice soccer players (77.2°±7.7 and 66.5°±6.9).

Shinkai, et al., (2007) have studied ball-foot interaction in impact phase of instep soccer kick. The study were to illustrate the three-dimensional motion of the foot (plantar / dorsal flexion, abduction / adduction, inversion / eversion) and the motion of center of gravity of the ball during ball impact, and to examine the interaction between the motion of the foot and the ball behavior during ball impact. Eleven experienced male soccer players participated in this study. To analyze the interaction between foot and ball in detail, two ultra high-speed video cameras (NAC Inc., Tokyo, Japan) were used to capture the motion of kicking limb and ball at 5000 Hz. Ball deformation and position of center of gravity of the ball were calculated from the lateral side image. The foot was plantarflexed, abducted and everted during contact with the ball. In particular, the foot was dorsallyflexed slightly at the beginning of the impact, and begins to plantarflexed after middle of the impact. The peak force acing on the foot almost coincides with the peak ball deformation, and magnitude of peak force reached approximately 2700N. In this study it
was seen that the foot was forced into plantar flexion by the force of
the ball. The ball velocity exceeded foot velocity when the ball was
maximally deformed. It was suggested that the foot has not directly
increase the ball velocity after this moment, nevertheless the foot
contact with the ball.

Shinkai, et al., (2006) have studied on foot movement in impact
phase of instep kicking in soccer. Six experienced male soccer players
participated in this study. They performed several types of maximum
instep kicking with various ball contact positions on the foot. The foot
and shank motions during ball impact were recorded using two ultra
high-speed cameras (MEMRECAM fx6000, nac, Inc., Tokyo, Japan) at
5000fps. The three-dimensional movement of the foot was calculated
from the local coordinate system fixed on each segment. The average
ball velocity was 29.8±1.2 m·s⁻¹ and the average ball-foot velocity ratio
was 1.40±0.9. During ball impact, the largest angular displacement
was observed for plantar flexion motion and the smallest was
represented for abduction motion. The foot was forced into plantar
flexion, abduction and eversion during ball impact phase of the instep
kicking. As the foot was easily forced to be plantary flexed thereby
spoiling the quality of ball impact, restraining this motion during ball
impact has been an essential to kick the ball efficiently. Moreover,
horizontally inclined foot against the ball may have served a likely configuration of the foot.

Smith, et al., (2006) have studied the application of an exploratory factor analysis to investigate the inter-relationships amongst joint movement during performance of a football skill. This study investigates the inter-relationships among three-dimensional kinematic variables during performance of a lofted instep soccer kick. A motion analysis system was used to collect kinematic data for 13 skilled amateur soccer players attempting a standardized lofted instep kick. Three-dimensional angular displacement patterns were reported for the thoracolumbar spine and right hip joints. Two-dimensional angular displacement data was reported for the right knee and ankle joints. An exploratory rather than confirmatory factor analysis was applied, as there was no established theory regarding the kinematics of a lofted instep kick. Factors were extracted using the Maximum Likelihood Solution and Orthogonally Rotated using Varimax with Kaiser normalisation. The inter-relationship among biomechanical variables within the seven extracted factors were analyzed with each factor revealing previously unknown inter-relationships among variables for different aspects of the kick. The use of exploratory factor analysis has shown the complex three-dimensional kinematic inter-relationships for a lofted instep kick. An understanding of these
relationships has proved useful to coaches when instructing and in the development of coaching programmes related to the lofted instep kick.

Sporis, et al., (2007) have studied how to evaluate full instep kick in soccer? This study was to present a way on how to evaluate the full instep kick in soccer. The instep kick test was comprised of three parallel tests; the ball speed test (km/h measured by stalker radar gun, Texas), the full instep kick accuracy test (goal divided into six fields) and the full instep kick technique test (seven aspects of the full instep kick). The sample was comprised of elite male soccer players, members of first league clubs in the Croatian League (n=21), age 22.13±0.85. Reliability of kicking performance test was determined by reliability analysis (alpha) and test-retest. (p < 0.05). Ball Velocity was measured using the radar gun (Stalker-Pro, Texas). All tests had normally distributed data. Mean ball velocity measured by radar was 104.4 (4.38) km/h. Reliability coefficient alpha and test-retest analysis for all three tests was 0.96. The soccer full instep kick test with parallel evaluation of technique, ball accuracy and speed was a very good diagnostic procedure. A similar test was used for the evaluation of other soccer kick types.

Tanaka, et al., (2006) have studied on manipulability analysis of kicking motion in soccer based on human physical properties. This study has presented an analysis tool of kicking motion in soccer based
on robotic techniques. The developed tool had been used to calculate kinematics, dynamics, and manipulability of trainee's movements with considerations of human physical characteristics from the trainee's postures measured by a motion capture system and has visually provide the quantitative analysis to users in the main window of the tool. The effectiveness of the proposed approach was varied through basic experiments with skilled and unskilled subjects in soccer.

Tsaousidis and Zatsiorsky (1996) have studied on an attempt to a closer examination of the ball-foot interaction at the instant of soccer kicking using high speed videotaping. This allowed a detail biomechanical analysis of the collision. A central question was whether the ball-foot interaction be modeled as an elastic impact, or as a mixture of 'impact-like' and 'throwing-like' patterns. The findings proved that the theory of conservation of momentum alone was not adequate for modeling kicking: additional momentum and mechanical energy has been supplied to the system during the collision phase because of the muscle work. This was due to the relatively long duration of collision (about 16 ms) and the large ball-foot displacement (about 26.0 cm). More than 50% of the ball's speed and at least 30% of its kinetic energy has been imparted to the ball without any contribution of the potential energy of the ball deformation.
Vaverka, et al., (2003) have studied the velocity of soccer kicking and the laterality of the lower extremities. This research has focused on the study of differences in the maximum velocity of the soccer ball kicked with the preferred and non-preferred leg and the kinematic variables of the kick. The kinematic analysis (3D, 50 Hz, system APAS) of the kick using the preferred and non-preferred leg was applied to a set of 12 skilled soccer players (age: 15.75 ± 0.45 years, body weight: 69.5 ± 7.59 kg, body height: 177.73 ± 5.82 cm). The execution of the kick was described in addition to the velocity of the ball (preferred leg: 27.68 ± 1.32 m.s⁻¹ non-preferred leg: 23.49 ± 2.05 m.s⁻¹) using 26 measured variables and 13 symmetry indices. Non-parametric statistical methods (STATGRAPHICS, version 5.0) were used. The results confirmed differences in the execution of the kick using the preferred and non-preferred leg and different levels of the relationships between measured variables and the kick ball velocity.