Chapter II

REVIEW OF RELATED LITERATURE
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A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area. It gives an overview of what has been said, who the key writers are, what are the prevailing theories and hypotheses, what questions are being asked, & what methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other findings.

The present reviews are based upon the available literature in respect to the study under investigation and therefore confined to the studies to which the investigator has accessed. All the relevant literature thus obtained by the researcher has been presented in this chapter to furnish necessary background material to evaluate the significance of the study. The research scholar has made every possible effort to go through the literatures related to the problem in the game of volleyball wherever available. The scholar has gleaned through almost every source like research quarterly, journals of various kinds, periodicals, encyclopedias, relevant books and e-resources to pick up related material.
2.1. Studies of Related Topics

A.Nedunchezhiyan et al., (2016) evaluated the effectiveness of concentric and eccentric exercises in improving hamstring muscle strength and power among futsal players. For this study thirty recreational futsal players were recruited for the study and were randomly divided into two groups. Each group received either hamstring curl exercise (concentric) or Nordic hamstring exercise (eccentric) twice a week for 4 weeks. The manual muscle test (MMT) and 40-yard dash test was used to evaluate the muscle strength and power respectively by comparing the pretest and posttest values for both groups. Wilcoxon signed rank test showed that there is no statistically significant difference between pre and post test values of MMT (Concentric (right side, z=.317; left side, z=.157), Eccentric (right side, z=.157; left side, z=.317)) in both groups. Based on paired 't' test there is a significant difference between the pre and post test on improving muscle power [Concentric group, P=.020; Eccentric Group, P=.000]. Mann–Whitney U test and unpaired 't' test showed that there is no significant difference between both groups of MMT (z=.775) and 40-yard dash test (P=.707) respectively. The concentric strength training and eccentric strength training have a similar effect in improving hamstring muscle power in futsal players.

I. Amin et al., (2016) conducted a study to correlate the effect of different therapeutic techniques (active release, muscle energy and Mulligan) on increasing hamstring flexibility. Fifty seven normal healthy male subjects with hamstring tightness were assigned randomly to one of the four study groups: Group (1) 13 subjects received active release technique. Group (2) 15 subjects received muscle energy technique. Group (3) 12 subjects received Mulligan’s technique. Group (4) 17 subjects did not get any intercession. Popliteal angle (active knee extension test) and sit-reach flexibility test were measured pre and post the intervention period. MANOVA test for active knee
extension test and sit-reach test among the four groups for post intervention values showed that there was no significant difference between Group 1 and Group 2 in the post values of AKE with both groups showing significant increases than Group 3. Group 1 versus Group 3: p < 0.0001, CI: 3.5-11.8; Group 2 versus Group 3: p < 0.0001, CI: 4.6-12.8). It can be reasoned that both active release and muscle energy techniques had similar impact in enhancing hamstring flexibility rather than Mulligan technique in normal male adults.

_Chesterton, P., Payton, S. (2016)_ compared the immediate effects of Posterior Anterior (PA) L4 and L5 mobilizations on range of motion and muscle activity measures in the lumbar and hamstring regions of asymptomatic individuals. Thirty-eight participants were randomly allocated to a mobilization (n=20) and control (n=18) group. The mobilization group received central PA mobilizations to the L4 and L5 vertebrae, three times for two minutes. The control group received no mobilization. Pre- and post-test measures included lumbar range of motion, measured by the modified Schober test and hamstring extensibility by the active knee extension test. Local Erector Spinae and Biceps Femoris muscle activation were also measured by surface Electromyography. Data were analyzed using magnitude-based inferences. Lumbar mobilizations had a most likely beneficial effect on active lumbar flexion 18.6% (90% CL 11.8% ± 25.8%) and active knee extension range 22.8% (-29.6% ± 15.2%). Mobilizations had a possible beneficial effect in sEMG activation reduction of the Erector Spinae -4.7% (-10.5% ± 1.4%) and Bicep Femoris -6.1% (-13.1% ± 1.6%) during lumbar flexion. Likely beneficial effects of reduced sEMG were found following mobilizations during the active knee extension test for the Erector Spinae -18.3% (-27.7% – 7.6%) and Biceps Femoris muscle activity -20.8% (-30.9% ± 9.2%). L4 and L5 mobilisations increased lumbar and hamstring range of motion in the
immediate term. Their unique finding was that in that sample population, muscle
activity in both local Erector Spinae and Biceps Femoris reduced, most likely due to the
mobilisations applied.

M. Ateef et al., (2016), assessed the primary osteoarthritis (OA) of knees. Several clinical tool including 6 minutes walk test (6 MWT) were used. The objective of this study was to analyze the test-retest reliability of 6 MWT and its correlation with various parameters. Eighty patients (age, 56-79 years) with OA of knees met the inclusion criteria. Demographic and clinical characteristics including radiological severity of OA (by X-ray K/L grading) were recorded. Patients filled in the knee injury and osteoarthritis outcome score (KOOS) questionnaire. All patients performed 6 MWT twice with at least 48 h gap in-between. Test-retest reliability of 6 MWT in primary OA knee patients was excellent with ICC 0.991 (95% confidence interval was 0.986–0.994). 6 MWT had a weak correlation with KOOS-symptom and KOOS-activities of daily living (rho = 0.397 and 0.364 respectively), a strong correlation with KOOS-pain and KOOS-sports (rho = 0.605 and 0.521 respectively), and a very strong correlation with KOOS-quality of life (rho = 0.758). It had a weak correlation with age and height (r = 0.497 and 0.302), a strong correlation with VAS, weight, and BMI (rho = –0.655, r = –0.510, and – 0.691, respectively), and a very strong correlation with disease severity (rho = –0.849). 6 MWT was a reliable test and positively correlated with all KOOS subscales and negatively correlated with other parameters except height in primary OA knee.

A. Zakir et al., (2016) found out the effectiveness of Manual therapy verses Exercise therapy for the management of knee osteoarthritis. Sixty patients including both male and female with mean age (51 years) and SD of (5.1) were enrolled in the
study and divided randomly to in two groups. Those who were assigned as group A had received Manual therapy and those who were assigned as group B had received Exercise therapy. Participants had received three treatment sessions of 30 min per week for consecutive 4 weeks. WOMAC index score for pain, stiffness and physical function was used to evaluate the baseline score and treatment effects after 12 therapy sessions. Study showed significant improvement in both groups before and after the treatment but in comparison manual therapy group showed significant results with respect to pain subscale (p=0.003) and physical function subscale (p=0.004). Significant difference was found between manual therapy and exercise therapy treatment approaches in treating knee osteoarthritis. Findings of this study revealed the fact that short term treatment sessions of manual therapy were superior to exercise therapy in terms of alleviating pain, stiffness and functional limitation.

*G. Behm et al., (2016)* compared the effects of SS, DS, and PNF on performance, range of motion (ROM), and injury prevention. The data indicated that SS- (−3.7%), DS- (+1.3%), and PNF- (−4.4%) induced performance changes were small to moderate with testing performed immediately after stretching, possibly because of reduced muscle activation after SS and PNF. A dose–response relationship illustrated greater performance deficits with ≥60 s (−4.6%) than with <60 s (−1.1%) SS per muscle group. Conversely, SS demonstrated a moderate (2.2%) performance benefit at longer muscle lengths. Testing was performed on average 3–5 min after stretching, and most studies did not include poststretching dynamic activities; when these activities were included, no clear performance effect was observed. DS produced small-to-moderate performance improvements when completed within minutes of physical activity. SS and PNF stretching had no clear effect on all-cause or overuse injuries; no data are available for DS. All forms of training induced ROM
improvements, typically lasting <30 min. Changes might result from acute reductions in muscle and tendon stiffness or from neural adaptations causing an improved stretch tolerance. Considering the small-to-moderate changes immediately after stretching and the study limitations, stretching within a warm-up that includes additional post stretching dynamic activity was recommended for reducing muscle injuries and increasing joint ROM with inconsequential effects on subsequent athletic performance.

S. Duhig et al., (2016) investigated possible relationships between mean session running distances, session ratings of perceived exertion (s-RPE) and HSIs within AFL footballers. Global positioning system (GPS)-derived running distances and s-RPE for all matches and training sessions over two AFL seasons were obtained from one AFL team. All HSIs were documented and each player’s running distances and s-RPE were standardized to their 2-yearly session average, then compared between injured and uninjured players in the 4 weeks (weeks −1, −2, −3 and −4) preceding each injury. Higher than ‘typical’ (ie, z=0) HSR session means were associated with a greater likelihood of HSI (week −1: OR=6.44, 95% CI=2.99 to 14.41, p<0.001; summed weeks −1 and −2: OR=3.06, 95% CI=2.03 to 4.75, p<0.001; summed weeks −1, −2 and −3: OR=2.22, 95% CI=1.66 to 3.04, p<0.001; and summed weeks −1, −2, −3 and −4: OR=1.96, 95% CI=1.54 to 2.51, p<0.001). However, trivial differences were observed between injured and uninjured groups for standardised s-RPE, total distance travelled and distances covered whilst accelerating and decelerating. Increasing AFL experience was associated with a decreased HSI risk (OR=0.77, 95% CI 0.57 to 0.97, p=0.02). Furthermore, HSR data modeling indicated that reducing mean distances in week −1 might decrease the probability of HSI. Exposing players to large and rapid increases in HSR distances above their 2-yearly session average increased the odds of HSI. However, reducing HSR in week −1 might offset HSI risk.
A. Perez et al., (2016) evaluated the extent to which psychological factors interact with a particular manual therapy (MT) technique to induce hypoalgesia in healthy subjects. Seventy-five healthy volunteers (36 female, 39 males), were recruited in this double-blind, controlled and parallel study. Subjects were randomly assigned to receive: High velocity low amplitude technique (HVLA), joint mobilization, or Cervical Lateral glide mobilization (CLGM). Pressure pain threshold (PPT) over C7 unilaterally, trapezius muscle and lateral epicondyle bilaterally, were measured prior to single technique MT was applied and immediately after to applied MT. Pain catastrophizing, depression, anxiety and kinesiophobia were evaluated before treatment. The results indicated that hypoalgesia was observed in all groups after treatment in the neck and elbow region (P < 0.05), but mobilization induced more hypoalgesic effects. Catastrophizing interacted with change over time in PPT, for changes in C7 and in manipulation group. All the MT techniques studied produced local and segmental hypoalgesic effects, supporting the results of previous studies studying the individual interventions. Interaction between catastrophizing and HVLA technique suggested that whether catastrophizing level was low or medium, the chance of success was high, but high levels of catastrophizing might result in poor outcome after HVLA intervention.

G. Plaza et al., (2016) found out the effects of proprioceptive/strengthening exercises versus the same exercises and manual therapy including mobilizations to influence joint and nerve structures in the management of recurrent ankle sprains. A randomized single-blind controlled clinical trial. Fifty-six patients with recurrent ankle sprains and regular sports practice were randomly assigned to experimental or control group. The control group performed 4 weeks of proprioceptive/strengthening exercises; the experimental group performed 4 weeks of the same exercises combined with
manual therapy (mobilizations to influence joint and nerve structures). Pain, self-reported functional ankle instability, pressure pain threshold (PPT), ankle muscle strength, and active range of motion (ROM) were evaluated in the ankle joint before, just after and one month after the interventions. The within-group differences revealed improvements in all of the variables in both groups throughout the time. Between-group differences revealed that the experimental group exhibited lower pain levels and self-reported functional ankle instability and higher PPT, ankle muscle strength and ROM values compared to the control group immediately after the interventions and one month later. A protocol involving proprioceptive and strengthening exercises and manual therapy (mobilizations to influence joint and nerve structures) resulted in greater improvements in pain, self-reported functional joint stability, strength and ROM compared to exercises alone.

*K. Jay et al., (2015)* investigated the acute effect of massage applied using a simple device Thera-band roller Massager on laboratory induced hamstring muscle soreness, and the potential cross over effect to the non-massaged limb. For the purpose 22 healthy untrained men (Mean age 34 +/- 7 years; mean height 181.7 +/- 6.9 cm; mean weight 80.6 +/- 6.4 kg; BMI: 24.5 +/- 1.3) with no prior history of knee, low back or neck injury or other adverse health issues were recruited. Participants visited the researchers on two separate occasions, separated by 48 hours, each time providing a soreness rating (modified visual analog scale 0-10), and being tested for pressure pain threshold (PPT) and active range of motion (ROM) of the hamstring muscles. During the first visit, delayed onset muscular soreness of the hamstring muscles was induced by 10 x 10 repetitions of the stiff-legged dead-lift. On the second visit participants received either 1) 10 minutes of roller massage on one leg, while the contralateral leg served as a cross over control, or 2) Resting for 10 minutes with no massage at all.
Measurement of soreness, PPT and ROM were taken immediately before and at 0, 10, 30, and 60 min., after treatment. There was a significant group by time interaction for soreness (p < 0.0001) and PPT (p = 0.0007), with the massage group experiencing reduced soreness and increasing PPT compared with the control group. There was no group by time interaction for ROM (p = 0.18). At 10 min. post massage there was a significant reduction in soreness of the non-massaged limb in the cross over control group compared to controls but this effect was lost 30 minutes post massage. It was found that massage with a roller device reduced muscle soreness and was accompanied by a higher PPT of the affected muscle.

_C. Hongswaan et al., (2015)_ determined the effects of Thai massage on physical fitness in soccer players. Thirty-four soccer players were randomly assigned to receive either rest (the control group) or three 30-minute sessions of Thai massage over a period of 10 days. Seven physical fitness tests consisting of sit and reach, hand grip strength, 40 yards technical agility, 50-meter sprint, sit-ups, push-ups, and VO₂ max were measured before and after Thai massage or rest. All the physical fitness variables or conditions significantly improved after a single session of Thai massage, whereas only the sit and reach, and the sit-ups were improved in the control group. Thai massage could provide an improvement in physical performance in soccer players.

_N.Van Der et al., (2015)_ investigated the preventive effect of the NHE on the incidence and severity of hamstring injuries in male amateur soccer players. Study Design: Randomized controlled trial; Level of evidence, Male amateur soccer players (age, mean 6 SD, 24.5 6 3.8 years) from 40 teams were randomly allocated to an intervention (n = 20 teams, 292 players) or control group (n = 20 teams, 287 players). The intervention group was instructed to perform 25 sessions of NHE in a 13-week
period. Both the intervention and control groups performed regular soccer training and were followed for hamstring injury incidence and severity during the 2013 calendar year. At baseline, personal characteristics (eg, age, injury history, field position) were gathered from all participants via a questionnaire. Primary outcome was injury incidence. Secondary outcomes were injury severity and compliance with the intervention protocol. A total of 38 hamstring injuries were recorded, affecting 36 of 579 players (6.2%). The overall injury incidence rate was 0.7 (95% CI, 0.6-0.8) per 1000 player hours, 0.33 (95% CI, 0.25-0.46) in training, and 1.2 (95% CI, 0.82-1.94) in matches. Injury incidence rates were significantly different between the intervention (0.25; 95% CI, 0.19-0.35) and control groups (0.8; 95% CI, 0.61-1.15), χ² (1, n = 579) = 7.865; P = .005. The risk for hamstring injuries was reduced in the intervention group compared with the control group (odds ratio, 0.282; 95% CI, 0.110-0.721) and was statistically significant (P = .005). No statistically significant differences were identified between the intervention and control groups regarding injury severity. Compliance with the intervention protocol was 91%. Conclusion: Incorporating the NHE protocol in regular amateur training significantly reduced.

Steve Marsh (2014) concluded that utilizing a progressive agility and trunk stabilization programme was more effective than a stretching and strengthening programme in helping athletes with hamstring strains in less time and with less of a risk of reinjury.

CM. Askling et al., (2014) compared the effectiveness of two rehabilitation protocols after acute hamstring injury in Swedish elite sprinters and jumpers by evaluating time needed to return to full participation in the training process. Prospective randomised comparison of two rehabilitation protocols was employed for this study.
Fifty-six Swedish elite sprinters and jumpers with acute hamstring injury, verified by MRI, were randomly assigned to one of two rehabilitation protocols. Twenty-eight athletes were assigned to a protocol emphasizing lengthening exercises, L-protocol, and 28 athletes to a protocol consisting of conventional exercises, C-protocol. The outcome measure was the number of days to return to full training. Re-injuries were registered during a period of 12 months after return. Time to return was significantly shorter for the athletes in the L-protocol, mean 49 days (1SD±26, range 18-107 days), compared with the C-protocol, mean 86 days (1SD±34, range 26-140 days). Irrespective of protocol, hamstring injuries where the proximal free tendon was involved took a significantly longer time to return than injuries that did not involve the free tendon, L-protocol: mean 73 vs 31 days and C-protocol: mean 116 vs 63 days, respectively. Two reinjuries were registered, both in the C-protocol. A rehabilitation protocol emphasising lengthening type of exercises is more effective than a protocol containing conventional exercises in promoting time to return in Swedish elite sprinters and jumpers.

E. Chinnavan et al., (2014) found out the rehabilitation programme that could improve proprioception in patient with grade-II anterior cruciate ligament (ACL) injury. Methods: 30 subjects fulfilling the inclusion criteria were recruited. Subjects were randomly distributed into standard non-operative ACL injury rehabilitation group (control group, n = 15) and proprioceptive training group (experimental group, n = 15). Standing balance was assessed by single leg stance and time HOP test. Control group subjects were given knee rehabilitation programme like strengthening exercise, flexibility exercise while experimental group were given knee rehabilitation along with proprioception training on wobble board. Subjects completed 12 training sessions, each approximately 30 minutes for the duration of three weeks (4 sessions a week). Results: The results showed that the experimental group significantly improved with (P < 0.05)
than control group. Conclusions: The study showed that impaired proprioceptive were improved by giving training on wobble board in grade-II ACL injury in athletes.

Z. Lacross(2014) examined the effectiveness of two different hamstring soft tissue treatments; myofascial decomposition (MFD) and a moist heat pack with self-myofascial release using a foam roller (SMR). Myofascial decompression, or cupping therapy, is a traditional Chinese therapy that has been adapted to the field of sports medicine. This treatment served as the intervention group, a foam roll treatment and heat pack served as the control. Participants consisted of 17 division I student athletes from Oklahoma State University of both male and female genders (4 females and 13 males). All subjects signed an IRB approved consent form prior to any participation. Range of motion measures and a Perceived Functional Ability Questionnaire (PFAQ) scale, to assess patient perception, were used before and after each treatment. The Global Rating Of Change (GROC) scale was completed by all subjects after each treatment to reflect each subject’s perception of treatment effect. Subjects were randomly assigned to either the control group (SMR) or the intervention group (MFD). A paired samples T-test was used to determine differences in pre and post measures and a one-way ANOVA was used to compared differences between the two treatment groups. Statistically significant differences were found for range of motions measures regardless of the treatment subjects received. The same was found comparing overall flexibility and comparing the flexibility of the hamstrings on the PFAQ scale. A statistically significant difference was found in favor of the intervention group for the GROC values. The results of this study suggested that either treatment might be beneficial for range of motion increases in patients with hamstring injuries. It also provided a foundation for future researchers inquiring about the clinical effects of myofascial decompression as it pertains to sports medicine. Future research should
include a larger patient population and possibly different patient populations. Adding more functional and objective measures might also prove beneficial in future studies to better document treatment outcomes.

*C. Dembowski et al., (2013)* reported to present the management and outcomes of a patient with hamstring strain, treated with functional dry needling and eccentric exercise. The subject was an 18-year-old collegiate pole-vaulter was presented for physical therapy with an acute hamstring strain and history of multiple strains on uninvolved extremity. He was treated in Physical Therapy three times per week for 3 weeks with progressive eccentric training and 3 sessions of functional dry needling. By day 12, his eccentric strength on the involved extremity was greater than the uninvolved extremity and he reported clinically meaningful improvement in outcome scores. By Day 20, he was able to return to full sports participation without pain or lingering strength deficits. The patient in this case reported that he was able to return to sport within 20 days and without recurrence. He demonstrated significant decreases in pain and dysfunction with dry needling. He had greater strength on the injured extremity compared to contra-lateral previously injured extremity. This case illustrated the use of functional dry needling and eccentric exercise leading to a favorable outcome in a patient with hamstring strain.

*J. Wetzel et al., (2013)* proposed a Platelet-rich plasma (PRP) injection at the muscle origin as a novel treatment for proximal hamstring injuries. A retrospective review yielded 15 patients with 17 proximal hamstring injuries. Twelve injuries failed traditional conservative treatment and were ultimately treated with a PRP injection at the hamstrings muscle origin. Five patients were treated with traditional conservative treatment alone. Analysis included pre- and post treatment visual analog scale scores, Nirschl Phase Rating Scale scores, and return to sport. No significant difference existed
between the groups’ pretreatment visual analog scale scores ($P=.28$) and Nirschl Phase Rating Scale scores ($P=.15$) and their post treatment visual analog scale scores ($P=.38$) and Nirschl Phase Rating Scale scores ($P=.22$). The PRP group demonstrated a reduction in visual analog scale scores ($P<.01$) and Nirschl Phase Rating Scale scores ($P<.01$), but the traditional conservative treatment group did not demonstrate the same reduction ($P=.06$ and .06, respectively). All athletes returned to their desired activity level with no major complications.

**R. Hinman et al., (2013)** compared the immediate effect of a single 15-minute treatment of ultrasound (US) and deep oscillation (DO) on the extensibility of hamstring muscles. Design: Randomized controlled trial Setting: University research laboratory Participants: Fifty athletes and non-athletes between the ages of 18 and 39 who demonstrated at least 15 degrees of hamstring tightness bilaterally. Interventions: Participants were randomly assigned to receive 15 minutes of treatment with US or DO applied to either their right or left hamstring muscle (also randomly assigned). Main Outcome Measure: Hamstring extensibility measured in both extremities with an inclinometer using a passive straight-leg raise method. Differences were compared within subjects (treated vs. untreated muscles) and between treatment groups (US vs. DO) using a repeated measures analysis of variance. Results: Changes in hamstring extensibility were significantly greater in treated vs. untreated extremities (3.5 vs. 0.5 degrees; $p < 0.01$). Although the DO treatment generally produced slightly greater improvements than the US treatment, the mean difference was not statistically significant (4.8 vs. 2.4 degrees; $p = 0.10$). Conclusions: DO treatments produced slightly greater improvements in hamstring muscle extensibility compared to US. However, changes associated with both modalities were relatively minor and probably not enough to substantially reduce injury risk. Further studies were needed to
investigate the combined effect of each modality with stretching exercise vs. exercise alone to determine whether their application was justifiable as part of rehabilitation programme for individuals with tight hamstrings. Clinical Relevance: This study suggested that a single, 15-minute treatment of DO or US might cause slight improvements in the extensibility of healthy hamstring muscles.

CM. Askling et al., (2013) compared the effectiveness of two rehabilitation protocols after acute hamstring injury in Swedish elite football players by evaluating time needed to return to full participation in football team-training and availability for match selection. Prospective randomized comparison of two rehabilitation protocols was employed for this study. Seventy-five football players with an acute hamstring injury, verified by MRI, were randomly assigned to one of two rehabilitation protocols. Thirty-seven players were assigned to a protocol emphasizing lengthening exercises, L-protocol and 38 players to a protocol consisting of conventional exercises, C-protocol. The outcome measure was the number of days to return to full-team training and availability for match selection. Reinjures were registered during a period of 12 months after return. Time to return was significantly shorter for the players in the L-protocol, mean 28 days (1SD±15, range 8-58 days), compared with the C-protocol, mean 51 days (1SD±21, range 12-94 days). Irrespective of protocol, stretching-type of hamstring injury took significantly longer time to return than sprinting-type, L-protocol: mean 43 vs 23 days and C-protocol: mean 74 vs 41 days, respectively. The L-protocol was significantly more effective than the C-protocol in both injury types. One reinjury was registered, in the C-protocol. A rehabilitation protocol emphasizing lengthening type of exercises would be more effective than a protocol containing conventional exercises in promoting time to return in Swedish elite football.
S. Carl et al., (2013) conducted a study on acute hamstring injuries in Swedish elite football and it was prospective randomized controlled clinical trial comparing two rehabilitation protocols. Hamstring strain injury is the single most common injury in European professional football and therefore, time to return and secondary prevention are of particular concern. To compare the effectiveness of 2 rehabilitation protocols after acute hamstring injury in Swedish football players by evaluating time needed to return to full participation in football team training and availability for match selection. Prospective randomized trial on 2 rehabilitation protocols seventy five players with acute hamstring strain verified MRI and assigned to each rehabilitation protocol, one group was included in lengthening exercises (eccentric training) and other group in conventional exercises n=37 each. The outcome is to find out the effect of lengthening exercises to the muscle and conventional pattern to find the reparticipation in the games early and avoid recurrences.

JL. Sanfilippo et al., (2013) determine the hamstring strain reinjury rates can reach 30% within the initial 2 wk after return to sport (RTS). Incomplete recovery of strength may be a contributing factor. However, relative strength of the injured and unaffected limbs at RTS is currently unknown. The purpose was to characterize hamstring strength and morphology at the time of RTS and 6 months later. Twenty-five athletes who experienced an acute hamstring strain injury participated after completion of a controlled rehabilitation program. Bilateral isokinetic strength testing and magnetic resonance imaging (MRI) were performed at RTS and 6 months later. Strength (knee flexion peak torque, work, and angle of peak torque) and MRI (muscle and tendon volumes) measures were compared between limbs and over time using repeated-measures ANOVA. The injured limb showed a peak torque deficit of 9.6% compared to the uninjured limb at RTS (60°·s, P < 0.001) but not 6 months after. The knee flexion
angle of peak torque decreased over time for both limbs (60°·s, P < 0.001). MRI revealed that 20.4% of the muscle cross-sectional area showed signs of edema at RTS with full resolution by the 6-month follow-up. Tendon volume of the injured limb tended to increase over time (P = 0.108), whereas muscle volume decreased between 4% and 5% in both limbs (P < 0.001). Residual edema and deficits in isokinetic knee flexion strength were present at RTS but resolved during the subsequent 6 months. This occurred despite MRI evidence of scar tissue formation (increased tendon volume) and muscle atrophy, suggesting that neuromuscular factors might contribute to the return of strength.

N. Sarabon and B. Fonda (2013) examined the effects of whole body cryotherapy (WBC) on biochemical, pain and performance parameters among 5-day recover period after damaging exercise for hamstrings. Participants completed about of damaging exercises for the hamstring muscles on two separate occasions (control and experimental condition). Separated by 10 weeks. During the control condition subjects received no treatment after the damaging exercise. The experimental condition consisted of WBC everyday during the recovery period subjects were tested for biochemical markers perceived pain, sensation and physical performance (squat jump, counter movement jump, maximal isometric torque production and maximally explosive isometric torque production). Majority of the observed variables showed statistically significant time effects (p<0.05) in control group which indicated the presence of muscle damage significant interaction between the control and WBC condition was evident for the rate of torque development (p<0.05) pain measures substantially differed between the WBC and the control condition after the exercise. Results of this study were not completely supportive of use of WBC for recovery enhancement after strenuous training.
A. Silder et al., (2013) assessed differences between a progressive agility and trunk stabilization rehabilitation programme and a progressive running and eccentric strengthening rehabilitation programme in recovery characteristics following an acute hamstring injury, as measured via physical examination and magnetic resonance imaging (MRI). Determining the type of rehabilitation programme that most effectively promotes muscle and functional recovery is essential to minimize reinjury risk and to optimize athlete performance. Individuals who sustained a recent hamstring strain injury were randomly assigned to 1 of 2 rehabilitation programmes: (1) progressive agility and trunk stabilization or (2) progressive running and eccentric strengthening. MRI and physical examinations were conducted before and after completion of rehabilitation. Thirty-one subjects were enrolled, 29 began rehabilitation, and 25 completed rehabilitation. There were few differences in clinical or morphological outcome measures between rehabilitation groups across time, and reinjury rates were low for both rehabilitation groups after return to sport (4 of 29 subjects had reinjuries). Greater craniocaudal length of injury, as measured on MRI before the start of rehabilitation, was positively correlated with longer return-to-sport time. At the time of return to sport, although all subjects showed a near-complete resolution of pain and return of muscle strength, no subject showed complete resolution of injury as assessed on MRI. The 2 rehabilitation programmes employed in this study yielded similar results with respect to hamstring muscle recovery and function at the time of return to sport. Evidence of continuing muscular healing was present after completion of rehabilitation, despite the appearance of normal physical strength and function on clinical examination.

N. Garrido et al., (2013) assessed the acute effects of classic muscle massage before a session of strength training on biochemical markers of
delayed onset muscle soreness. Twenty-four healthy men with no history of strength training were randomized into two groups, one submitted to a classic muscle massage technique before strength training exercises (n=12; 23.54±1.94 years, 21.57±2.64 kg/m²); and a control group with no muscle massage before the strength training exercises (n=12; 22.57±1.65 years, 22.25±1.23 kg/m²). Classical manual massage was applied to muscle groups involved in strength exercises (biceps brachii and quadriceps femoris) with 10-min duration for each muscle group. Strength training session consisted of two exercises: elbow flexion and knee extension at an intensity of 85% of one maximum repetition (6 to 10 repetitions, four sets). Muscle damage biochemical markers (creatine kinase; lactate dehydrogenase, and C reactive protein) were assessed by venous blood samples from the antecubital vein before exercise (1st collect), immediately after exercise (2nd collect), 24 and 48 hours later (third and fourth collect). Experimental protocol was conducted in the laboratory of the Center of Experimental Design of the University Hospital Lauro Wanderley, Brazil. No significant differences were observed between muscle massage before the strength training exercises and control for the creatine kinase (p=0.380), lactate dehydrogenase (p=0.700), and C reactive protein (p=0.292) at all moments. The results suggested that delayed onset muscle soreness induced by two classical strength training exercises was not prevented or attenuated by muscle massage before exercise.

Goldman EF, Jones DE(2011) assessed by systematic review, the effects of interventions used for preventing hamstring injuries on physically active individuals. Randomised or quasi-randomised trials of interventions for preventing hamstring injuries were included, as were trials testing interventions for the prevention of lower limb injuries, provided that hamstring injuries were reported. Risk ratios (RRs) and 95% confidence intervals (95% CIs) were calculated for dichotomous variables and are
reported for individual and pooled data. Seven randomized controlled trials involving 1919 participants were included. Some trials were compromised by poor methodology, including lack of blinding and incomplete outcome data. Four trials, including 287 participants, examined interventions directly targeted at preventing hamstring injuries. Three of these trials, which tested hamstring strengthening protocols, had contradictory findings, with one small trial showing benefit, although the control rate of mainly minor hamstring injury was unusually high. The other two trials found no benefit, with a greater incidence of hamstring injury in the intervention group. One unpublished and underpowered trial provided some evidence that manual therapy might prevent lower limb muscle strain (RR 0.13, 95% CI 0.02 to 0.97), although the finding for hamstring injury did not reach statistical significance (RR 0.21, 95% CI 0.03 to 1.66). There was insufficient evidence from randomized controlled trials to draw conclusions on the effectiveness of interventions used to prevent hamstring injuries in people participating in football or other high-risk activities. The findings for manual therapy needed confirmation.

A. Silder et al., (2010) investigated whether bilateral differences in strength, neuromuscular patterns, and musculotendon kinematics during sprinting were present in individuals with a history of unilateral hamstring injury, and whether such differences were linked to the presence of scar tissue. Eighteen subjects with a previous hamstring injury (>5 months prior) participated in a magnetic resonance (MR) imaging exam, isokinetic strength testing, and a biomechanical assessment of treadmill sprinting. Bilateral comparisons were made for peak knee flexion torque, angle of peak torque, and the hamstrings:quadriceps strength ratio, as well as muscle activations and peak hamstring stretch during sprinting. MR images were used to measure the volumes of the proximal tendon/aponeurosis of the biceps femoris, with asymmetries considered
indicative of scar tissue. A significantly enlarged proximal biceps femoris tendon volume was measured on the side of prior injury. However, no significant differences between the previously injured and uninjured limbs were found in strength measures, peak hamstring stretch, or muscle activation patterns. Further, the degree of asymmetry in tendon volume was not correlated to any of the functional measures.

_Hoskins. W. and Pollard. H._(2010) documented the usage of a sports chiropractic manual therapy intervention within a RCT by identifying the type, amount, frequency, location and reason for treatment provided. This information is useful for the uptake of the intervention into clinical settings and to allow clinicians to better understand a role that sports chiropractors offer. All treatments rendered to 29 semi-elite Australian Rules footballers in the sports chiropractic intervention group of an 8 month RCT investigating hamstring and lower-limb injury prevention were recorded. Treatment was pragmatically and individually determined and could consist of high-velocity, low-amplitude (HVLA) manipulation, mobilization and/or supporting soft tissue therapies. Descriptive statistics recorded the treatment rendered for symptomatic or asymptomatic benefit, delivered to joint or soft tissue structures and categorized into body regions. For the joint therapy, it was recorded whether treatment consisted of HVLA manipulation, HVLA manipulation and mobilization, or mobilization only. Breakdown of the HVLA technique was performed. A total of 487 treatments were provided (mean 16.8 consultations/player) with 64% of treatment for asymptomatic benefit (73% joint therapies, 57% soft tissue therapies). Treatment was delivered to approximately 4 soft tissue and 4 joint regions each consultation. The most common asymptomatic regions treated with joint therapies were thoracic (22%), knee (20%), hip (19%), sacroiliac joint (13%) and lumbar (11%). For soft tissue therapies it was gluteal (22%), hip flexor (14%), knee (12%) and lumbar (11%). The
most common symptomatic regions treated with joint therapies were lumbar (25%), thoracic (15%) and hip (14%). For soft tissue therapies it was gluteal (22%), lumbar (15%) and posterior thigh (8%). Of the joint therapy, 56% was HVLA manipulation only, 36% high-HVLA and mobilization and 9% mobilization only. Of the HVLA manipulation, 63% was manually performed and 37% mechanically assisted. The intervention applied was multimodal and multi-regional. Most treatment was for asymptomatic benefit, particularly for joint based therapies, which consisted largely of HVLA manipulation techniques. Most treatment was applied to non-local hamstring structures, in particular the knee, hip, pelvis and spine.

M. Bleakley et al., (2010) compared an accelerated intervention incorporating early therapeutic exercise after acute ankle sprains with a standard protection, rest, ice, compression, and elevation intervention. Randomized controlled trial with blinded outcome assessor. Accident and emergency department and university based sports injury clinic. 101 patients with an acute grade 1 or 2 ankle sprain were selected Participants were randomized to an accelerated intervention with early therapeutic exercise (exercise group) or a standard protection, rest, ice, compression, and elevation intervention (standard group). The primary outcome was subjective ankle function (lower extremity functional scale). Secondary outcomes were pain at rest and on activity, swelling, and physical activity at baseline and at one, two, three, and four weeks after injury. Ankle function and rate of re-injury were assessed at 16 weeks. An overall treatment effect was in favour of the exercise group (P=0.0077); this was significant at both week 1 (baseline adjusted difference in treatment 5.28, 98.75% confidence interval 0.31 to 10.26; P=0.008) and week 2 (4.92, 0.27 to 9.57; P=0.0083). Activity level was significantly higher in the exercise group as measured by time spent walking (1.2 hours, 95% confidence interval 0.9 to 1.4 v 1.6, 1.3 to 1.9), step count
(5621 steps, 95% confidence interval 4399 to 6843 v 7886, 6357 to 9416), and time spent in light intensity activity (53 minutes, 95% confidence interval 44 to 60 v 76, 58 to 95). The groups did not differ at any other time point for pain at rest, pain on activity, or swelling. The reinjury rate was 4% (two in each group). An accelerated exercise protocol during the first week after ankle sprain improved ankle function; the group receiving this intervention was more active during that week than the group receiving standard care.

R. Aliyev (2009) evaluated of the effects of the therapy method deep oscillation in immediate therapy and after-care of different sports injuries in addition to usual care (complex physical and medical therapy). Two soccer teams were supported by a sports medicine section of a rehabilitation hospital. In n = 14 people (mean age 23.9 years) 49 sports injuries of different kind were treated. Subjective rating of the symptoms by VAS improved significant (p = 0.001) from 8.7 (baseline) to 2.1 points (post-treatment). Objective rating by the attending physician according to different clinically relevant parameters led to "very good" or "good" results in 90 % of the patients. In conclusion it could be stated that therapy method deep oscillation was an easy to use and comparably cost effective adjuvant therapy option. They already had good experience with it in other indications concerning reabsorption of oedema, reducing pain, anti-inflammatory effect, promotion of motoricity, promotion of wound healing, anti-fibrotic effect and improvement in trophicity and quality of the tissue. All these mentioned effects could be confirmed in the treatment of patients with acute sports injury and trauma. The soft mode of action was the reason that in contrast to other electric and mechanical therapies it was no contraindication in immediate therapy. In general they noted no side effects; patients were highly compliant and rated this therapy as very good.
J. Brummitt (2008) identified current literature relating to sports massage and its role in effecting an athlete's psychological readiness, in enhancing sports performance, in recovery from exercise and competition, and in the treatment of sports related musculoskeletal injuries. Electronic databases were used to identify papers relevant to this review. The following keywords were searched: massage, sports injuries, athletic injuries, physical therapy, rehabilitation, delayed onset muscle soreness, sports psychology, sports performance, sports massage, sports recovery, soft tissue mobilization, deep transverse friction massage, pre-event, and post exercise. Research studies pertaining to the following general categories were identified and reviewed: pre-event (physiological and psychological variables), sports performance, recovery, and rehabilitation. Despite the fact that clinical research had been performed, a poor appreciation existed for the appropriate clinical use of sports massage. Additional studies examining the physiological and psychological effects of sports massage were thought to be necessary in order to assist the sports physical therapist in developing and implementing clinically significant evidence based programmes or treatments.

A. Arnason, et al., (2008) reported that eccentric strength training using Nordic hamstring lowers would be an effective way to reduce the risk of hamstring injury among soccer players. Flexibility training alone did not appear to have any preventative effect.

R. Arabaci (2008) examined the acute effects of pre-performance lower limb massage after warm-up on explosive and high-speed motor capacities and flexibility. Twenty-four physically active healthy Caucasian male subjects volunteered to participate in this study. All subjects were from a Physical Education and Sport Department in a large university in Turkey. The study had a counterbalanced crossover
design. Each of the subjects applied the following intervention protocols in a randomised order; (a) massage, (b) stretching, and (c) rest. Before (pre) and after (post) each of the interventions, the 10 meter acceleration (AS), flying start 20 meter sprint (FS), 30 meter sprint from standing position (TS), leg reaction time (LR), vertical jump (VJ) and sit & reach (SR) tests were performed. A Wilcoxon’s signed rank test was used to compare before and after test values within the three interventions (massage, stretching and rest). The data showed a significant worsening, after massage and stretching interventions, in the VJ, LR (only in stretching intervention), AS and TS tests (p < 0.05), and significant improvement in the SR test (p < 0.05). In contrast, the rest intervention led only to a significant decrement in TS performance (p < 0.05). In conclusion, the findings suggested that performing 10 minute posterior and 5 minute anterior lower limb Swedish massage had an adverse effect on vertical jump, speed, and reaction time, and a positive effect on sit and reach test results.

*P. Haakana (2008)* determined the correlations between subcutaneous tissue and rectus femoris muscle thickness and muscle tone. The differences on muscle tone between groups that received massage immediately or one day after the resistance training were examined. The effects of massage on perceived recovery were monitored immediately and day after massage. Ten subjects completed the study, five in each group. The thickness of subcutaneous and muscle tissue, and pennation angle was measured from rectus femoris muscle prior to the training session. Both groups had the same pre measurements and training session, with three sets at 70% of 1 RM squat until exhaustion on a Smith machine. Muscle tone was measured before and after the training and massage sessions, and a day after massage. Subjects filled in questionnaires of their state of perceived recovery each time the muscle tone was measured after the training. Massage was applied for group 1 immediately after the
training and for group 2 one day after the training. Massage, 10 minutes per leg, was performed with effleurage and petrissage techniques by the same therapist for each subject. A significant decrease in muscle tone was found in group 1 immediately after training. Following the massage the tone increased. There was no effect of training or massage on group 2. This might be due lack of subjects and the control group, insufficient training session, incapability of subjects to totally relax during the muscle tone measurement or other factors such as elevated muscle tone due to activities prior to the measurements.

R. Ogai et al., (2008) studied the effect of petrissage on cycle ergometer pedaling performance. It was applied between consecutive bouts of supramaximal exercise performed by the lower leg muscle. The subjects were 11 healthy female students actively engaged in sports. Exercise bouts of ergometer cycling at loads determined individually (0.075 kp x body weight (kg)) for 5 s repeated eight times at intervals of 20 s had to be performed twice on an experimental day with 35 min intermittent bed rest. Each subject was investigated on two occasions with a minimum interval of 1 week, once without (control, CO) and once with 10 min petrissage (massage, MA) of the exercising lower leg during the bed rest phase. Effects of exercise bouts on blood lactate, muscle stiffness and perceived lower limb fatigue and their recovery before and after the second exercise bout were determined. For the first exercise bouts total power did not differ between MA and CO. Courses of blood lactate did not differ between MA and CO. However, recovery from measured muscle stiffness (p<0.05) and perceived lower limb fatigue (p<0.05) were more pronounced and total power during the second exercise bout was enhanced (p<0.01) in MA as compared with CO subjects. Petrissage improved cycle ergometer pedalling performance independent of blood lactate but in correlation with improved recovery from muscle stiffness.
A.H. Jarvinen et al., (2007) stated that rehabilitation programme should be built around progressive agility and trunk stabilization exercises, as these exercises seem to yield better outcome for injured skeletal muscle than programmes based exclusively on stretching and strengthening of the injured muscle.

JHM Brooks et al., (2006) suggested that the two recent trials indicated that strength training programmes based on eccentric exercises indeed seem to reduce hamstring injuries significantly more than do conventional strengthening programmes.

George J et al., (2006) found out that the hamstring strain remains an essential sympathy toward restoration experts as they result in an incapacitating harm portrayed by intense loss of utilitarian execution, delayed times of recuperation, and resultant expanded occurrence of repeat. Enhanced flexibility has for some time been viewed as important part of preventive treatment of musculotendinous strain. Expanding hamstring flexibility can assume an essential part in averting lower limit overuse injuries.

M.A Sherry and T.M. Best (2004) compared the effectiveness of 2 rehabilitation programmes for acute hamstring strain by evaluating time needed to return to sports and reinjury rate during the first 2 weeks and the first year after return to sport. A third objective was to investigate the relationship between functional testing performance and time to return to sports and reinjury rates after return to sport. Hamstring muscle strains are common in sports and often result in chronic pain, recurrent hamstring strains, and reduced sports performance. Current rehabilitation programmes are primarily developed anatomically and lack support from prospective, randomized research. Twenty-four athletes with an acute hamstring strain were randomly assigned to 1 of 2 rehabilitation groups. Eleven athletes were assigned to a protocol consisting of static stretching, isolated progressive hamstring resistance

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exercise, and icing (STST group). Thirteen athletes were assigned to a programme consisting of progressive agility and trunk stabilization exercises and icing (PATS group). The number of days for full return to sports, injury recurrence within the first 2 weeks, injury recurrence within the first year of returning to sports, and lower-extremity functional evaluations were collected for all subjects and compared between groups. The average (+/- SD) time required to return to sports for athletes in the STST group was 37.4 +/- 27.6 days, while the average time for athletes in the PATS group was 22.2 +/- 8.3 days. This difference was not statistically significant (P = .2455). In the first 2 weeks after return to sports, reinjury rate was significantly greater (P = .00343, Fisher's exact test) in the STST group, where 6 of 11 athletes (54.5%) suffered a recurrent hamstring strain after completing the stretching and strengthening programme, as compared to none of the 13 athletes (0%) in the PATS group. After 1 year of return to sports, reinjury rate was significantly greater (P = .0059, Fisher's exact test) in the STST group. Seven of 10 athletes (70%) who completed the hamstring stretching and strengthening programme, as compared to only 1 of the 13 athletes (7.7%) who completed the progressive agility and trunk stabilization program, suffered a recurrent hamstring strain during that 1-year period. A rehabilitation programme consisting of progressive agility and trunk stabilization exercises is more effective than a programme emphasizing isolated hamstring stretching and strengthening in promoting return to sports and preventing injury recurrence in athletes suffering an acute hamstring strain. Future randomized clinical trials should investigate the potential for progressive agility and trunk stabilization programmes in the prevention of hamstring strain injury during sports.

* A. Marc (2004) conducted a study on comparison of 2 rehabilitation programmes in the treatment of acute hamstring strain on variables of time to return to
sports and reinjury recurrences. For this 23 athletes were divided to in 2 groups. Group-I with isolated stretching and strengthening and 2nd group with PATS group among 11 in each. The experimentation was done for the first 2 weeks to check the time to return to the sports and until 1 year for recurrences. The result of this study indicated that PATS technique was more effective when compared with isolated stretching and strengthening.

*S. Neilson et al., (2004)* conducted a study “Eccentric Training and static stretching to improve hamstring flexibility of High School Males”, to determine if the flexibility of high school aged males would improve after 6 week eccentric exercises programme. It improved the changes in the hamstring flexibility. They used a test retest control group design in a laboratory setting. Subjects were assigned randomly to 1 of 3 groups eccentric training, static stretching (or) control to 1 of 3 groups. A total of 69 subjects with a mean age of 16.45 – 0.96 years and with limited hamstring flexibility (defined as 20° loss of knee extension measured with the thigh held at 90° of hip flexion) were reemitted for this study. Hamstring flexibility was measured using passive 90/90 test before and after the 6-week programme. Differences were significant for test and for the test by group interaction. Follow-up analysis indicated significant differences between the control group (gain – 1.67) and both the eccentric – training – 12.05) groups. No difference was found between the eccentric and static – stretching groups. The gains achieved in range of motion of knee extension (indicating improvement in hamstring flexibility) with eccentric training were equal to those made by statically stretching the hamstring flexibility.

*G. Dawson et al., (2004)* evaluated the potential for repeated massage therapy interventions to influence recovery of quadriceps and hamstring muscle soreness, recovery of quadriceps and hamstring muscle strength and reduction of upper leg
muscle swelling over a two week recovery period following an actual road running race. Twelve adult recreational runners (8 male, 4 female) completed a half marathon (21.1 km) road race. On days 1, 4, 8, and 11 post-race, subjects received 30 minutes of standardized massage therapy performed by a registered massage therapist on a randomly assigned massage treatment leg, while the other (control) leg received no massage treatment. Two days prior to the race (baseline) and preceding the treatments on post-race days 1, 4, 8, and 11 the following measures were conducted on each of the massage and control legs: strength of quadriceps and hamstring muscles, leg swelling, and soreness perception. On day 1, post-race quadriceps peak torque was significantly reduced (p < 0.05), and soreness and leg circumference significantly elevated (p < 0.05) relative to pre-race values with no difference between legs. This suggested that exercise-induced muscle disruption did occur. Comparing the rate of return to baseline measures between the massaged and control legs, revealed no significant differences (p > 0.05). All measures had returned to baseline on day 11. Massage did not affect the recovery of muscles in terms of physiological measures of strength, swelling, or soreness. However, questionnaires revealed that 7 of the 12 participants perceived that the massaged leg felt better upon recovery.

A. Robertson et al., (2004) examined the effects of leg massage compared with passive recovery on lactate clearance, muscular power output, and fatigue characteristics after repeated high intensity cycling exercise, with the conditions before the intervention controlled and standardized. Nine male games players participated. They attended the laboratory on two occasions one week apart and at the same time of day. Dietary intake and activity were replicated for the two preceding days on each occasion. After baseline measurement of heart rate and blood lactate concentration, subjects performed a standardised warm up on the cycle ergometer. This was followed
by six standardised 30 second high intensity exercise bouts, interspersed with 30 seconds of active recovery. After five minutes of active recovery and either 20 minutes of leg massage or supine passive rest, the subjects performed a second standardised warm up and a 30 second Wingate test. Capillary blood samples were drawn at intervals, and heart rate, peak power, mean power, and fatigue index were recorded. There were no significant differences in the mean power during the initial high intensity exercise bouts (p =0.92). No major effect of massage was observed on blood lactate.

A. Barlow et al., (2004) investigated if a single massage of the hamstring muscle group would alter the performance of the sit and reach test. Before treatment, each of 11 male subjects performed the sit and reach test. The treatment consisted of either massage of the hamstring muscle group (both legs, total time about 15 minutes) or supine rest with no massage. Performance of the sit and reach test was repeated after treatment. Each subject returned the subsequent week to perform the tests again, receiving the alternative treatment relative to their initial visit. Mean percentage changes in sit and reach scores after treatment were calculated for the massage and no massage treatments, and analysed using Student’s t tests. Mean (SD) percentage changes in sit and reach scores after massage and no massage were small (6.0 (4.3)% and 4.6 (4.8)% respectively) and not significantly different for subjects with relatively high (15 cm and above) values before treatment. Mean percentage changes in sit and reach scores for subjects with relatively low values before treatment (below 15 cm) were large (18.2 (8.2)% and 15.5 (16.2)% respectively), but no significant differences were found between the massage and no massage groups. A single massage of the hamstring muscle group was not associated with any significant increase in sit and reach performance immediately after treatment in physically active young men.
B. Hemmings et al., (2000) investigated the effect of massage on perceived recovery and blood lactate removal, and also to examine massage effects on repeated boxing performance. Eight amateur boxers completed two performances on a boxing ergometer on two occasions in a counterbalanced design. Boxers initially completed performance 1, after which they received a massage or passive rest intervention. Each boxer then gave perceived recovery ratings before completing a second performance, which was a repeated simulation of the first. Heart rates and blood lactate and glucose levels were also assessed before, during, and after all performances. A repeated measures analysis of variance showed no significant group differences for either performance, although a main effect was found showing a decrement in punching force from performance 1 to performance 2 (p<0.05). A Wilcoxon matched pairs test showed that the massage intervention significantly increased perceptions of recovery (p<0.01) compared with the passive rest intervention. A doubly multivariate multiple analysis of variance showed no differences in blood lactate or glucose following massage or passive rest interventions, although the blood lactate concentration after the second performance was significantly higher following massage (p<0.05). These findings provide some support for the psychological benefits of massage, but raise questions about the benefit of massage for physiological restoration and repeated sports performance.

S. O’ Reilly et al., (1999) conducted a study focused on isometric strengthening of quadriceps and hamstrings muscles in a home based exercise programme. They had enrolled 191 patients with knee pain having aged 40-90 years. Experimental group regularly performed strengthening exercises for six month and control group had not received any treatment. Exercise therapy results showed 22.5% reduction in WOMAC index pain score and 6.2% in
control group. Score of physical function of WOMAC index reduced up to 17.4% in exercise group and remained unchanged in control group.

P. Holmich et al.,(1999), demonstrated that individuals with longstanding adductor pain had less pain and improved sports performance after undergoing an active rehabilitation programme that aimed at improving strength and coordination of the muscles acting on the pelvis, as compared with individuals who completed a rehabilitation programme consisting of modalities and stretching. Progressive agility and trunk stabilization drills do involve a combination of concentric, eccentric, and isometric contractions of the hamstring muscles in various length-tension positions. Although isokinetic testing was not carried out in their study, it was possible that early initiation (phase 1) of concentric, eccentric, and isometric contractions in the PATS group helped to prevent reduction in strength or muscle imbalances without adversely affecting the scar tissue. The STST group did not start eccentric contractions (non-weight-bearing foot catches) until phase 2.

2.2. Summary of Literature reviewed

In this chapter the reviews and related previous studies were presented. A serious review of literature helped the scholar from the methodological point of view too. It was learnt that most of the research studies cited in this chapter on analysis as the appropriate methods for finding out suitable remedy. The present study may serve as a foundation and main ingredient for future research to enhance the physical fitness variables and reduce hamstring strain.