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Editor-in-Chief: Prof. (Dr.) S.K. Verma

I am happy that the Volume 7, No. 2 issue of **Journal of Exercise Science and Physiotherapy (JESP)** is ready for the readers. This issue of JESP contains seven articles on different important aspects of exercise science. **Jagga et al from Punjab** presents a review of Occupation and its association with Carpal Tunnel syndrome. In summary, they conclude from the studies reviewed that a useful body of research now supports and extends previous conclusions that certain occupations involving wrist activities materially increases the risk of carpal tunnel syndrome. Through the results of their study, they further advise and emphasize that prolonged exposure to highly repetitive flexion and extension of the wrist should be avoided. De et al, from West Bengal in their study on the "Effect of Body Posture on Hand Grip Strength in Adult Bengalee Population" concluded that male subjects demonstrate greater grip strength compared to that of female subjects and the maximum achievable grip strength was recorded in standing posture with elbow angle of 90° in both adult male and female subjects. They recommend that the grip strength of Bengalee population should be measured in standing posture with elbow angle of 90° , shoulder angle of 180° , and the trunk and wrist in neutral positions to provide maximum force. Nidhi et al from Dehradun, in their study entitled "*Effect of Spinal Stimulation on Monosynaptic Reflex by Medium Frequency Current*" used Premodular IFC & Russian current by surface spinal stimulation at T-12 & L-1 regions to explain how surface spinal stimulation by two medium frequency currents influences on monosynaptic reflex. They conclude that spinal stimulation with medium frequency current result in a significant effect on monosynaptic reflex as revealed by significant effect on H-latency and H-amplitude, however Premodular IFC produced greater effect than the Russian current. **Soodan & Kumar from Patiala**, Punjab investigated the motor nerve conduction velocity of selected nerves of both the upper and lower extremities in sprinters and distance runners. They observed significant differences in motor nerve conduction velocities between dominant and non-dominant limbs in each group. They concluded that motor nerve conduction velocity of ulnar nerve was found to be higher in sprinters as compared to the distance runners, and the MNCV for Common Peroneal Nerve is higher in distance runners as compared to sprinters. The MNCV of ulnar and CPN were higher in dominant limbs (i.e. arms & legs) of both sides of the body as compared to non dominant limbs. The diabetes mellitus is becoming more and more prevalent in Indian society. In India, it is estimated that approximately 2% of the population, 15 million people have diabetes and WHO has declared India as the "Diabetic Capital of the World". Chronic hyperglycemia is associated with significant long-term complications, particularly damage to the nerves, heart, blood vessels, eyes and kidneys. **Singh & Kumar from Punjab** studied the relationship among glycated haemoglobin (HbA1c) and lipid profile in male type 2 diabetics of Punjabi population. They concluded from the results of their study that HbA1c can also be used as a predictor of dyslipidaemia in type 2 diabetics in addition to as a glycemic control parameter. Thus, early diagnosis of dyslipidaemia can be used as a preventive measure for the development of cardiovascular disease (CVD) in type 2 diabetics. **Multani et al from Punjab** concluded that sportspersons possess higher bone mineral density than their non- sports cohort and sportspersons involved in high impact sports possess substantially higher bone mineral density than sportspersons involved in moderate impact sports. Clinically, this information is important, as it can be utilized while designing preventive and treatment plans for osteopenic and osteoporotic individuals respectively. Dental injuries are a major problem for players from the pain stand point, aesthetic standpoint and economics stand point. Depending on the extent and the types of injury, some injuries can be managed at the sporting event site, with the athlete resuming play immediately. The study by **Verma from Chandigarh** discusses various treatment options available for different types of fractures to the teeth. The paper presents a case study of a 17 year old athletic player with a chief complaint of broken upper front teeth while playing hockey. A Treatment plan that was divided into two parts i.e. (i) treatment for left and right central incisor with enamel /dentin fracture and (ii) treatment for left lateral incisor with enamel/dentin /pulp were adopted. The study discusses various treatment options available for different types of fractures to the teeth. The paper also enlightens the sportsperson to deal with dental trauma met by them while playing games.

S.K. Verma

Occupation and its association with Carpal Tunnel syndrome- A Review

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Abstract

Carpal tunnel syndrome (CTS) is a common problem with estimated annual incidence rate of 0.5-5.1 per 1000. Its incidence in the workplace has reached epidemic proportions, comprising 40.8 percent of all upper extremity repetitive motion. Certain occupational activities also carry an increased risk of CTS. A number of etiological factors have been suggested to be potentially etiologic for CTS. These include repetitive prolonged hand intensive activities, forceful exertions awkward or static posture, vibration, temperature extremes and localized mechanical stress. Referred literature was collected up to June 2011 mentioning carpal tunnel syndrome and occupation and textbook of orthopaedic physiotherapy third edition by Robert Donateli and Wooden. Most of the articles dealt with prevalence, diagnosis, and description of carpal tunnel syndrome. Various articles from the collected data were based on occupational studies. The references were further supplemented by systematic search on Pubmed, Google and Pedro with keywords occupation, incidence, and prevalence with carpal tunnel syndrome. Several specific occupational studies that had been reviewed in these were found to deal with meat, cut metal workers, supermarket workers, meat industry workers, slaughter house, assembly line workers, meat and fish process, manufacturing, construction and agriculture workers, musicians, ski manufacturing, frozen food factory employees, repetitive industrial work groups, poultry processing workers, heavy wrist movements and heavy manual workers, packaging industry workers, footwear factory, grocery store workers etc. These studies were included in the review. In summary, a useful body of research now supports and extends previous conclusions that certain occupations involving wrist activities materially increases the risk of carpal tunnel syndrome. Prolonged exposure to highly repetitive flexion and extension of the wrist should be avoided.

KEY WORDS: Carpal Tunnel Syndrome, Occupation, Repetitive Flexion, Repetitive Extension

Introduction

Carpal tunnel syndrome (CTS) is defined as a complex of symptoms arising from compression of the median nerve at the carpal tunnel. Symptoms of median nerve compression include pain, numbness, or tingling on the anterior surface of the index, middle, or radial half of the ring finger. It is often associated with weakness of hand grip or nocturnal symptoms including hand or arm pain and numbness. Provocative physical examination techniques such as Tinel's sign, Phalen's sign, and a two point discrimination test have been used to

support the diagnosis of this condition. Median nerve entrapment is the pathological process that causes symptoms of CTS.

Carpal tunnel syndrome is a common problem with estimated annual incidence rate of 0.5-5.1 per 1000. Its incidence in the workplace has reached epidemic proportions, comprising 40.8 percent of all upper extremity repetitive motion disorders as reported by the *Bureau of Labor Statistics* in 1994. It was first discovered in 1947 that CTS was related to occupation, when *Brian et al (1947)* reported approximately 6 cases of work –

related CTS in repetitive work. Occupational CTS is a major cause of lost work days and workers compensation costs. It is characterized by sensory and less commonly motor symptoms and signs in the peripheral distribution of median nerve. The known causes of CTS include Trauma, Diabetes, Rheumatoid Arthritis, Acromegaly, Hypothyroidism and Pregnancy. The association of CTS with work related risk factors is a recurring theme of causation among workers, ergonomists, lawyers and physicians. The majority of the literature that tries to establish this as a casual association fails to meet the appropriate standards of epidemiologic validity.

Certain occupational activities also carry an increased risk of CTS. A study by *Yves Roouelaurs et al (2008)* provides high quality information on occupational association of CTS. High prevalence were observed in manufacturing (42-93 % for both sexes), Construction (66% for men) and personal service industries (66% for women) and in the trade and commerce sectors (49% for women). A systemic review done by *Keith et al. in 2007* identified 38 primary reports that provided information that regular and prolonged use of hand vibrating tools increases risk of CTS more than 2 folds and found substantial evidence for similar or even higher risks from prolonged and highly repetitious flexion and extension of wrist specially when associated with forceful grip. In an another study done by *Joon Youn Kim et al (2004)* it was concluded that frequency of CTS occurrence is more in high risk industry jobs. A number of etiological factors have been suggested to be potentially etiologic for CTS. These include repetitive

prolonged hand intensive activities, forceful exertions awkward or static posture, vibration, temperature extremes and localized mechanical stress.

Material & Methods

Referred literature was collected up to June 2011 mentioning carpal tunnel syndrome and occupation and textbook of orthopaedic physiotherapy third edition by Robert Donateli and Wooden. Most of the articles dealt with prevalence, diagnosis, and description of carpal tunnel syndrome. Various articles from our collected data were based on occupational studies. The references were further supplemented by systematic search on Pubmed, Google and Pedro with keywords occupation, incidence, and prevalence with carpal tunnel syndrome. Several specific occupational studies that had been reviewed in these were found to deal with meat, cut metal workers, supermarket workers, meat industry workers, slaughter house, assembly line workers, meat and fish process, manufacturing, construction and agriculture workers, musicians, ski manufacturing, frozen food factory employees, repetitive industrial work groups, poultry processing workers, heavy wrist movements and heavy manual workers, packaging industry workers, footwear factory, grocery store workers etc. These studies were included in the review. The search was further refined by restricting attention to English language publications and to papers that included specified epidemiological terms. Titles, articles and abstracts were studied duplicates and obviously irrelevant references were eliminated by the researchers.

Results

In the research of literature reviewed up to June 2011, 60 papers were identified. The evidence on carpal tunnel syndrome and different occupations are considered under the following subheadings:

1. *Vibration exposed workers*
2. *Assembly line workers*
3. *Food processing, Slaughter house & Frozen food factory workers*
4. *Grocery store workers*
5. *Manufacturing unit or Industrial workers*
6. *Textile workers*
7. *Computer users.*

Vibration exposed workers: Strong evidence is shown in many researches that decreasing the acceleration level of a handheld vibrating tool has a positive relationship with the prevalence of HAVS (Hand arm vibration syndrome). In a study of Finnish forestry workers using chain saws, *Koskimies et al (1992)* found that the prevalence of HAVS symptoms declined from a peak of 40% to 5% after the introduction of light-weight, low-vibration chain saws with reduced acceleration from 14 to 2 m/s². Likewise, a study of similar workers in Japan by *Futatsuka and Uneno (1985, 1986)* found that the prevalence of vascular symptoms among chain saw operators who began their jobs before the introduction of various engineering and administrative controls peaked at 63%. (Vibration acceleration levels for chain saws used during this period ranged from 111 to 304 m/s²). In contrast, the peak prevalence for chain saw operators who began working after the introduction of anti-vibration

chain saws (acceleration level: 10-33 m/s²) and exposure duration limits (2 hrs/day) was only 2%. According to *Gemme et al (1993)*, the absorption of vibration energy by the hand is influenced by the vibration intensity, as well as by frequency, transmission direction, grip and feed forces, hand-arm postures, and anthropometric factors. Several studies reviewed found relationships between prevalence of HAVS and duration of vibration exposed work [*Bovenzi, 1994; Bovenzi et al, 1995; Letz et al, 1992; Nilsson et al, 1989*]. One cross-sectional study reported no association with duration of exposure (*Musson et al, 1989*). However *Sandén et al (2010)* observed no differences in distal latencies between subjects exposed to hand-arm vibration and unexposed subjects, neither in the sensory conduction latencies of the median nerve, nor in the motor conduction latencies of the median and ulnar nerves. Seven subjects (9%) in the exposed group and three subjects (12%) in the unexposed group had both pathological sensory nerve conduction at the wrist and symptoms suggestive of carpal tunnel syndrome.

Assembly line workers: With regard to assembly work, a greater than doubling of risk was reported by *Abbas et al (2001)* who studied personal and work related risk factors associated with carpal tunnel syndrome in electronic assembly and clerical workers in Egypt. They observed that electronics assembly workers were more likely to report CTS (odds ratio {OR} = 11.41) whose jobs involved a precision (pinch) grip and frequent repetition. *Barnhart et al (1991)* found that in ski assembly workers employed for an average of 5.1 years in jobs that entailed 'repeated and/or sustained' flexion, extension or ulnar or radial

deviation of the wrist, Carpal tunnel syndrome was observed in either or both hands in 15.4% of those workers with repetitive jobs, but only in 3.1% of those workers with non-repetitive jobs. The conclusion was drawn that carpal tunnel syndrome is associated with jobs requiring frequent and sustained hand work (OR 4.0). *Bystrom et al (1995)* & *Michael Spallek et al (2010)* revealed that in automobile assembly workers OR is 2.9, but with wide confidence limits. *Leclerc et al (1998)* did study on workers assembling small electrical appliances, motor vehicles and ski accessories (OR 4.5). *Cannon and co-workers (1981)* did a case-control study of 30 subjects in an aircraft engine assembly plant who were identified as having the carpal tunnel syndrome. Three variables were found to be predictive of the development of the carpal tunnel syndrome: using vibrating hand tools.

Food processing, Slaughter house & Frozen food factory workers: In the food-processing and food-packing industries, excess risks were reported by the following people: (i) *Schottland et al (1991)* in poultry workers (OR 2.9); (ii) *Frost et al (1998)* in slaughterhouse workers stated 5.1% of the non-deboning slaughterhouse workers [prevalence ratio (PR) 3.23, 95% confidence interval (95% CI) 1.3-7.99] and 7.8% of the deboning slaughterhouse workers (PR 4.91, 95% CI 2.03-11.81) had CTS & conclude daily high-velocity and high-force manual work is a risk factor for CTS; (OR 3.3–5.5); (iii) *Kim et al (2004)* in their study on meat and fish processing plant workers, observed that fifty-one (73.9%) workers in the experimental group had findings compatible to the NIOSH definition of

Work-Related CTS. The prevalence of CTS in a meat and fish processing plant was much higher. Therefore *Chiang et al (1990)* was of the view that the jobs in the frozen-food factory should be considered as high-risk jobs. They studied three groups of workers. Group I (with subjects involved in little exposure to cold and low repetitive movements of the wrist) served as the internal standard. In group II (subjects having no local exposure to cold, but a high degree of repetitiveness) and group III (had those subjects who had a combination of local exposure to cold and a high degree of repetitiveness). They observed that the risk of CTS for group II + III was 14.39 times higher than that of group I. Group III still had a higher risk of CTS than group II. Repetitiveness as well as hands' local exposure to cold was found to be contributing factors leading to CTS (OR 11.7).

Osorio et al. in 1994 studied 56 supermarket workers. Exposure to repetitive and forceful wrist motions was rated as high, moderate, or low, following observation of job tasks. The CTS case definition was based on symptoms and nerve conduction studies. CTS-like symptoms occurred more often (OR 8.3, 95% CI 2.6–26.4) among workers in the high exposure group compared to the low exposed group. The odds of meeting the symptom and NCS-based CTS case definition among the high exposure group were 6.7 (95% CI 0.8–52.9), compared to the low exposure group. *Baron et al. in 1991* studied CTS in 124 grocery store checkers and 157 other grocery store workers who were not checkers. The CTS case definition required symptoms that met pre-determined criteria on a standardized questionnaire and physical

examinations. The OR for CTS among checkers was 3.7 (95% CI 0.7–16.7), in a model that included age, hobbies, second jobs, systemic disease, and obesity. Participation rates at the work sites were higher among the exposed group (checkers: 85% participation, non-checkers: 55% participation). After telephone interviews in which 85% of the non-checkers completed questionnaires, investigators reported that the proportion of non-checkers meeting the case definition did not increase. *Morgenstern et al. in 1991* mailed questionnaires to 1,345 union grocery checkers and a general population group. Exposure was based on self-reported time working as a checker. Symptoms of CTS were significantly associated with age and the use of diuretics, and non-significantly associated with average hours worked per week, and years worked as a checker. A positive CTS outcome was based on the presence of all four symptoms: pain in the hands or wrist, nocturnal pain, tingling in the hands or fingers, or numbness. The estimated attributable fraction of CTS symptoms to working as a checker was about 60%, using both a general population comparison group and a low exposed checker group. The limitations of this study are: (i) the use of an overly sensitive health outcome measure, for example, 32% of the surveyed population reported numbness; and (ii) the use of self-reported exposure. The survey with the questionnaire reported that 12 % to 62.5 % of supermarket checkers were somewhat affected by CTS. The NCS found that 20% of workers using vibratory tools including chain saw, 5.5 % of instrument players and 6.4% of dentists had CTS.

Roquelaure et al in 2002 in shoe factory stated that on the basis of

prevalence data, three types of work situation were detected to be at high risk of MSDs: cutting, sewing, and assembly preparation. The three types of work situations identified on the basis of incidence data (sewing preparation, mechanized assembling, and finishing) were different from those identified by prevalence data. At least one recognised risk factor for MSDs was identified for all groups of work situations. The ergonomic risk could be considered as serious for the four types of work situation having the highest ergonomic scores (sewing, assembly preparation, pasting, and cutting). *Silverstein et al. in 1987* studied 652 workers in 39 jobs from 7 different plants (electronics, appliance, apparel, and bearing manufacturing; metal casting, and an iron foundry). Investigators divided jobs into high or low repetitiveness categories, based on analysis of videotaped job tasks of 3 representative workers in each job. High repetitiveness was defined as cycle time less than 30 seconds or at least 50% of the work cycle spent performing the same fundamental movements. Jobs were also divided into high or low force categories based on EMGs of representative workers' forearm flexor muscles while they performed their usual tasks. EMG measurements were averaged within each work group to characterize the force requirements of the job. High force was defined as a mean adjusted force >6 kg. Jobs were then classified into 4 groups: low force/low repetitiveness, high force/low repetitiveness, low force/high repetitiveness, and high force/high repetitiveness. Fourteen cases (2.1% prevalence) of CTS were diagnosed based on standardized physical examinations and structured interviews. *Hagberg.M et al, in 1992* studied 15 cross-sectional

studies involving 32 occupational or exposure groups and six case-referent studies. The prevalence of CTS in the different occupational groups varied between 0.6 and 61%. The highest prevalence was noted for grinders, butchers, grocery store workers, frozen food factory workers, platers, and workers with high-force, high-repetitive manual movements & concluded that exposure to physical work load factors, such as repetitive and forceful gripping, is probably a major risk factor for CTS in several types of worker populations. However, *Gedizlioglu. M et al, in 2008* in steel industry has found no cases of CTS in heavy manual workers, but sub clinical involvement of peripheral nerves. The key point of the study is that in this group of manual workers, manual work was not a risk factor for the development of clinical CTS;

McCormack et al. in 1990 studied 1,579 textile production workers and compared them to 468 other non-office workers, a comparison group that included machine maintenance workers, transportation workers, cleaners, and sweepers. The textile production workers were divided into four broad job categories based on similarity of upper extremity exertions. formal exposure assessment was conducted. Health assessment included a questionnaire and screening physical examination followed by a diagnostic physical examination. CTS was diagnosed using predetermined clinical criteria. The severity of cases was also reported as mild, moderate, or severe. The overall prevalence for CTS was 1.1%, with 0.7% in boarding, 1.2% in sewing, 0.9% in knitting, 0.5% in packaging/folding, and 1.3% in the

comparison group. None of the differences were statistically significant. A statistical model that also included age, gender, race, and years of employment showed that CTS occurred more often among women in this study ($p<0.05$). Interpretation of these data, especially with a low prevalence disorder like CTS, is difficult since gender varied with job (94% of boarding workers were female, compared to 56% in the comparison group), and the comparison group (machine maintenance workers, transportation workers, cleaners and sweepers) may have also been exposed to upper extremity exertions. Interactions among potential confounders were not addressed, but they are suspected because of significant associations between race and three MSDs.

Andersen et al in 2003 in computer workers conclude that self-reported prevalence of tingling/numbness in the right hand at baseline was 10.9%. The interview confirmed that prevalence of tingling/ numbness in the median nerve was 4.8%, of which about one third, corresponding to a prevalence of 1.4%, experienced symptoms at night. Onset of new symptoms in the 1-year follow-up was 5.5%. In the cross-sectional comparisons and in the follow-up analyses, there was an association between use of a mouse device for more than 20 h/wk and risk of possible CTS but no statistically significant association with keyboard use. The occurrence of possible CTS in the right hand was low. The study emphasizes that computer use does not pose a severe occupational hazard for developing symptoms of CTS. A survey was done by *J. Clarke Stevens et al in 2001* of employees who were identified as

frequent computer users. Although 29.6% of the employees reported hand paraesthesia, only 27 employees (10.5%) met clinical criteria for carpal tunnel syndrome, and in 9 (3.5%) the syndrome was confirmed by nerve conduction studies. Affected and unaffected employees had similar occupations, years using a computer, and time using the computer during the day. The frequency of carpal tunnel syndrome in computer users is similar to that in the general population.

In most of the studies diagnosis of CTS was based on a combination of signs, symptoms and electrophysiological findings, but the exact criteria applied varied between investigations. For example, some required the demonstration of abnormal conduction in the median nerve as a condition for inclusion, whereas others accepted positive physical signs as an alternative. A few studies took a reported or documented medical diagnosis of CTS as their case definition, and others defined cases on the basis only of symptoms.

Repeated flexion and extension of the wrist (defined in various ways) more than doubled the risk of physician-confirmed CTS was found in many studies, three studies point to wrist flexion or extension for at least half the working day as carrying a particularly high risk. In the study by (i) *Silverstein et al. in 1987* in a well-known and careful survey that spanned several industries and included videotaped job analysis, reported associations both with repetitive and with forceful hand-wrist work. For repetitive work (hand-wrist flexion and extension), defined by a cycle time of .30 s or .50% of cycle time involved in performing the same fundamental activities, the OR was

2.7 (95% CI 0.3–28) in low-force jobs (hand force ,1 kg) and 15.5 (95% CI 1.7–142) in high-force jobs (hand force .4 kg). (ii) *de Krom et al. in 1990* found that risks were elevated 5- to 8-fold when the self-reported time spent in activities with the wrist flexed or extended was 20 h/week, while in the study by Nordstrom et al. the OR for CTS was more than doubled for those estimating that they bent/twisted their wrists for 3.5 h/day versus 0 h/day. A study by (iii) *Wieslander et al. in 1989* suggested that risk may double after 1 year in a job involving ‘repetitive wrist movement’, while another by *Tanaka et al.* found that risks were increased nearly 6-fold in workers bending/twisting the hand or wrist ‘many times per hour’. Two other studies, by *Leclerc et al. in 1998 & 2001* and *Roquelaure et al. in 1997*, found associations with assembly work that involved a short elemental cycle time (10 s per repetition, RRs 1.9 and 8.8).

Discussion

The carpal tunnel syndrome is felt to be induced or aggravated by any process that compresses the median nerve as it passes through the narrow confined space of the carpal tunnel. Repetitive flexion and extension of the wrist and grasping motions of the hand are thought to repeatedly compress the median nerve between the tendons and carpal bones, leading to injury to the median nerve. These motions also place a person at risk for the development of tendonitis and the accompanying swelling of the synovial sheath within the carpal tunnel with secondary compression of the median nerve.

Reasonable evidence was found that repetitive work increases the risk of carpal tunnel syndrome. There were three different studies reporting association 1)

high repetition and high force in the hands 2) vibration exposure 3) occupation. A study by *Roquelaure et al (2008)* and *Joon youn kim et al (2004)* supported this evidence. Another review done by *Keith et al (2006)* also supported that repetitive prolonged hand intensive activities, forceful exertions awkward or static posture, vibration and localized mechanical stress are associated with carpal tunnel syndrome.

There was surprising consistency of observed effects across the different studies. Occupational tasks or job titles associated with vibration exposure repetitive hand movements and forceful grips were reported in most of the studies as risk factor for carpal tunnel syndrome. Vibration exposure and packaging is probably an indicator of exposure to forceful repetitive gripping. In the study *Leclerc et al* studied that carpal tunnel syndrome is present in one or both hands in 11.8% workers in repetitive work and frequency was high in packaging (16.2%), In an another study *Kim et al in 2004* found that the prevalence of CTS in a meat and fish processing plant that involve repetitive working was much higher. *Keith et al in 2006* identified 38 primary reports that provided higher quality information that regular and prolonged use of hand held vibratory tools increase the risk of carpal tunnel syndrome more than 2 fold and found substantial evidence for similar or even higher risks from prolonged and highly repetitious flexion and extension of the wrist especially when allied with a forceful grip.

One inconsistency was noted *Viikari-juntura in 1999* reported only 1% prevalence with repetitive work involving

job title cutter. *Juntunen et al in 1983* also questioned the association between vibration exposure and carpal tunnel syndrome claiming that patients with neuropathic diatheses, who are at greater risk for CTS tend to be selected into group of patients with vibration syndrome. IF so the frequency of carpal tunnel syndrome would be higher among exposed workers because of earlier diagnosis or detection in this group. However this detection bias was not present in the studies in which the same diagnostic procedures were used for the study.

In summary, a useful body of research now supports and extends previous conclusions that certain occupation having wrist activities materially increases the risk of carpal tunnel syndrome. Prolonged exposure to highly repetitive flexion and extension of the wrist should be avoided.

References

- Abbas, M.F., Faris, R.H., Harber, P.I. 2001. Worksite and personal factors associated with carpal tunnel syndrome in an Egyptian electronics assembly factory. *Int. J. Occup. Environ. Health*, 7: 31–36.
- Andersen, J.H. 2003. Computer Use and Carpal Tunnel Syndrome A 1-Year Follow-up Study. *JAMA*, 289(22): 2963-2969
- Armstrong, T.J., Chaffin, D.B. 1979. Carpal tunnel syndrome and selected personal attributes. *Occup. Med.* 21: 481-6.
- Aroori, S., Roy, A. Spence, J. 2008. Carpal tunnel syndrome. *Ulster. Med. J.* 77(1): 6-17.
- Barnhart, S., Demers, P.A., Miller, M., Longstreth, W.T.J., Rosenstock, L. 1991. Carpal tunnel syndrome among ski manufacturing workers. *Scand. J. Work Environ. Health.* 17: 46–52.
- Baron, S., Milliron, M., Habes, D., Fidler, A. 1991. Hazard evaluation and technical assistance report: Shoprite Supermarkets, New Jersey—New York. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National

- Institute for Occupational Safety and Health, NIOSH Report No. **HHHE 88**–344, 2092.
- Bonfiglioli, R., Mattioli, S., Spagnolo, M.R., Violante, F.S. 2006. Course of symptoms and median nerve conduction values in workers performing repetitive jobs at risk for carpal tunnel syndrome. *Occup. Med. (Lond)*. **56(2)**: 115-21.
- Bovenzi, M. 1994. Hand-arm vibration syndrome and dose-response relation for vibration-induced white finger among quarry drillers and stone-carvers. *Occup. Env. Med.* **51(9)**: 603–611.
- Bovenzi, M., Franzinelli, A., Mancini, R., Cannava, M.G., Maiorano, M., Ceccarelli, F. 1995. Dose-response relation for vascular disorders induced by vibration in the fingers of forestry workers. *Occup. Env. Med.* **52**: 722–730.
- Brian, R.W., Wright, A.D. and Wilkinson, M., 1947. Spontaneous compression of both median nerves in the carpal tunnel syndrome. *Lancet* **1**: 277-282
- Butcher, F. and Rosenfalck, A. 1966. Evoked action potentials and conduction velocity in human sensory nerves. *Brain. Res.* **3**: 1.
- Bystrom, S., Hall, C., Welander, T., Kilbom, A. 1995. Clinical disorders and pressure-pain threshold of the forearm and hand among automobile assembly line workers. *J. Hand. Surg. (Br)* **20**:782–790.
- Campbell, W.W, Ward, L.C and Swift, T.R. 1980. Nerve conduction velocity varies inversely with height. *Muscle Nerve.* **3**: 436.
- Cannon, L.J., Bernacki, E.J., Walter, S.D. 1981. Personal and occupational factors associated with carpal tunnel syndrome. *J. Occup. Med.* **23**: 255-258
- Chiang, H.C., Chen, S.S., Yu, H.S., Ko, Y.C. 1990. The occurrence of carpal tunnel syndrome in frozen food factory employees. *Gaoxiang Yi. Xue. Ke. Xue. Za. Zhi.* **6**: 73–80.
- Croft, P. 1993. Soft tissue rheumatism. *Epidemiology of the Rheumatic Diseases* (Oxford University Press In: Silman AJ and Hochberg MC (Eds.), Oxford. 399–408.
- de Krom, M.C., Kester, A.D., Knipschild PG, Spaans F. 1990. Risk factors for carpal tunnel syndrome. *Am. J. Epidem.* **132**: 1102–1110.
- Frost, P., Andersen, J.H., Nielsen, V.K. 1998. Occurrence of carpal tunnel syndrome among slaughterhouse workers. *Scand. J. Work. Environ. Health.* **24**: 285–292.
- Futatsuka, M., Uneno, T. 1985. Vibration exposure and vibration induced white finger due to chain saw operation. *J. Occup. Med.* **27**: 257–264.
- Futatsuka, M., Uneno, T. 1986. A followup study of vibrationinduced white finger due to chain saw operation. *Scand. J. Work. Environ. Health.* **12(4)**: 304–306
- Gamstorp, I. 1963. Normal conduction velocity of ulnar, median and peroneal nerves in infancy, childhood and adolescence. *Acta. Paed.* **68**: 146.
- Gedizlioglu, M. 2008. Carpal tunnel syndrome in the Turkish steel industry. *Occup. Med.* **58**: 212–214
- Gemne, G., Lundström, R., Hansson, J. 1993. Disorders induced by work with hand-held vibrating tools: a review of current knowledge for criteria documentation. *Arbete. Och. Hals.* **6**: 1–83.
- Hagberg, M., Morgenstern, H., Kelsh, M. 1992. Impact of occupations and job tasks on the prevalence of carpal tunnel syndrome. *Scand. J. Work. Env. Health.* **18**: 337–345.
- Halar, M., DeLisa, J.A., Soine, T.L. 1983. Nerve conduction in upper extremities: Skin temperature correlation. *Arch. Phys. Med. Rehab.* **64**: 142.
- Juntunen, J., Matikainen, E., Seppalainen, A.M, Laine A. 1983. Peripheral neuropathy and vibration syndrome. *Int. Arch. Occup. Environ. Health.* **52**: 17-24.
- Kim, J.Y., Kim, J.I., Son, J.E., Yun, S.K. 2004. Prevalence of carpal tunnel syndrome in meat and fish processing plants. *J. Occup. Health.* **46**: 230–234.
- Koskimies, K., Pyykko, I., Starck, J., Inaba, R. 1992. Vibration syndrome among Finnish forest workers between 1972 and 1990. *Int. Arch. Occup. Environ. Health.* **64(4)**: 251-6
- Kuorinka, I. and Forcier, L. 1995. *Work-Related Musculoskeletal Disorders (WMSDs): A Reference Book for Prevention* (Taylor and Francis, London).
- Leclerc, A., Franchi, P., Cristofari, M.F. 1998. Carpal tunnel syndrome and work organisation in repetitive work: a cross sectional study in France. Study Group on Repetitive Work. *Occup. Env. Med.* **55**: 180–187.
- Leclerc, A., Landre, M.F., Chastang, J.F., Niedhammer, I., Roquelaure, Y. 2001. Study Group on Repetitive Work. Upper-limb disorders in repetitive work. *Scand. J. Work. Environ Health.* **27**: 268–278.
- Lee, H.J. Delisa, J.A and Bach J.R.1999. The effect of temperature on antidromic median sensory

- conduction. *Electromyogram Clin. Neurophysiology*. **3**: 33,125.
- Letz, R., Chemiack, M.G., Gerr, F., Hershman, D., Pace, P. 1992. A cross-sectional epidemiological survey of shipyard workers exposed to hand-arm vibration. *Br. J. Ind. Med.* **49(1)**: 53–62.
- McCormack, R.R. Jr., Inman, R.D., Wells, A., Berntsen, C., Imbus, H.R. 1990. Prevalence of tendinitis and related disorders of the upper extremity in a manufacturing workforce. *J. Rheumatology*. **17**: 958–964.
- Misra, U.K. and Kalita, J. 2008. Clinical Neurophysiology - Nerve conduction Electromyography and Evoked Potentials. Reed Elsevier India Pvt Ltd, New Delhi, India.
- Morgenstern, H., Kelsh, M., Kraus, J., Margolis, W. 1991. A cross-sectional study of hand/wrist symptoms in female grocery checkers. *Am. J. Ind. Med.* **20(2)**: 209–218.
- Musson, Y., Burdorf, A., van Drimmelen, D. 1989. Exposure to shock and vibration and symptoms in workers using impact power tools. *Ann. Occup. Hyg.* **33(1)**: 85–96.
- Nathan, P.A., Keniston, R.C., Myers, L.D., Mekadows, K.D. 1992. Longitudinal study of median nerve sensory conduction in industry: relationship to age, gender, hand dominance, occupational hand use, and clinical diagnosis. *J. Hand Surg. (Am)* **17**: 850–857.
- National Institute for Occupational Health and Safety. 1997. *Musculoskeletal Disorders and Workplace Factors. A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back* (US Department of Health and Human Sciences/NIOSH, Cincinnati, OH) Publication no. 97–141.
- Nilsson, T., Burström, L., Hagberg, M. 1989. Risk assessment of vibration exposure and white fingers among platers. *Int. Arch. Occup. Environ. Health*. **61(7)**: 473–481.
- Norris, A.H., Shock, N.W. and Wagman, I. H. 1953. Age changes in the maximum conduction velocity of motor fibers of human nerves. *J. Applied Physiology*, **5**: 598.
- Nordstrom, D.L., Vierkant, R.A., Layde, P.M., Smith, M.J. 1998. Comparison of self-reported and expert-observed physical activities at work in a general population. *Am. J. Ind. Med.* **34**: 29–35.
- Orosio, A.M., Ames, R.G., Jones, J., Castorina, J., Rempel, D., Estrin, W., 1994. Carpal tunnel syndrome among grocery store workers. *Am. J. Ind. Med.* **25(2)**: 229–245.
- Palmer, K.T., Harris, E.C., Coggon, D. 2007. Carpal tunnel syndrome and its relation to occupation: a systematic literature review. *Occup. Med. (Lond)*. **57(1)**: 57–66.
- Roquelaure, Y., Mechali, S., Dano, C., Fanello, S., Benetti, F., Bureau, D., Mariel, J., Martin, Y.H., Derriennic, F., Penneau-Fontbonne, D. 1997. Occupational and personal risk factors for carpal tunnel syndrome in industrial workers. *Scand. J. Work Environ. Health*. **23**: 364–369.
- Roquelaure, Y., Mariel, J., Fanello, S., Boissière, J.C., Chiron, H., Dano, C., Bureau, D., Penneau-Fontbonne, D. 2002. Active epidemiological surveillance of musculoskeletal disorders in a shoe factory. *Occup. Environ. Med.* **59**: 452–458.
- Rosignol, M., Patry, L., Sacks, S. 1998. Carpal tunnel syndrome: validation of an interview questionnaire on occupational exposure. *Am. J. Ind. Med.* **33(3)**: 224–31.
- Ross, A., Leveritt, M. and Riek, S. 2001. Neural influences on sprint running training adaptations and acute responses. School of Human Movement Studies, University of Queensland, Brisbane, Australia.
- Sandén, H., 2010. Nerve conduction in relation to vibration exposure - a non-positive cohort study. *J. Occup. Med. Toxicol.*, **5**: 21
- Schottland, J.R., Kirschberg, G.J., Fillingim, R., Davis, V.P., Hogg, F. 1991. Median nerve latencies in poultry processing workers: an approach to resolving the role of industrial 'cumulative trauma' in the development of carpal tunnel syndrome. *J. Occup. Med.* **33**: 627–631.
- Silverstein, B.A., Fine, L.J., Armstrong, T.J. 1987. Occupational factors and carpal tunnel syndrome. *Am. J. Ind. Med.* **11**: 343–358.
- Spallek, M., Kuhn, W., Uibel, S., Mark, Anke van Quarcoo, D. 2010. Work-related musculoskeletal disorders in the automotive industry due to repetitive work -implications for rehabilitation. *J. Occup. Med. Toxicol.*, **5**: 6.
- Stetson, D.S., Albers, J.W. and Silverstein, B.A. 1992. Effects of age, sex and anthropometric factors on nerve conduction measures. *Muscle and Nerve* **15**: 1095–1104.
- Stetson, D.S., Silverstein, B.A., Keyserling, W.M., Wolfe, R.A., Albers, J.W. 1993. Median sensory distal amplitude and latency:

- Comparison between non exposed managerial/ Professional employees and industrial workers. *Am. J. Ind. Med.* **24(2)**: 175-89.
- Stevens, J.C, Witt, J.C, Smith, B.E, and Weaver, A.L. 2001. The frequency of carpal tunnel syndrome in computer users at a medical facility. *Neur.* **56 (11)**: 1568-1570.
- Sullivan, S.B. and Schmitz, T.J. 2001. Physical Rehabilitation Assessment and Treatment. Jaypee Brothers, New Delhi, India.
- Tanaka, S., Wild, D.K., Cameron, L.L., Freund, E. 1997. Association of occupational and non-occupational risk factors with the prevalence of self-reported carpal tunnel syndrome in a national survey of the working population. *Am. J. Ind. Med.*, **32**: 550-556.
- Viikari-Juntura, E., Silverstein, B. 1999. Role of physical load factors in carpal tunnel syndrome. *Scand. J. Work. Environ. Health* **25**: 163-185.
- Werner, R.A., Franzblau, A. 1996. Hand dominance effect on median and ulnar sensory evoked amplitude and latency in asymptomatic workers. *Arch. Phys. Med. Rehabil.* **77(5)**: 473-6.
- Wieslander, G., Norback, D., Gothe, C.J., Juhlin, L. 1989. Carpal tunnel syndrome (CTS) and exposure to vibration, repetitive wrist movements, and heavy manual work: a case-referent study. *Br. J. Ind. Med.* **46**: 43-47.



Effect of Body Posture on Hand Grip Strength in Adult Bengalee Population

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Abstract

Objectives: The present work was aimed to assess the variation of grip strength with the changes of posture and body joint angles and to establish an optimal body posture and joint angle for the maximum grip strength for adult Bengalee population. **Methods:** Adult male (n=156) and female (n=224) were involved in this study. The hand grip strength was measured by using Lafayette hand grip dynamometer. **Results:** The results revealed that male subjects had a significantly greater ($p<0.001$) grip strength compared to that of female subjects and the highest grip strength was found in standing posture with elbow angle of 90° in both adult male and female subjects. **Conclusions:** From the results it may be recommended that the grip strength of Bengalee population may be measured in standing posture with elbow angle of 90° , shoulder angle of 180° , and the trunk and wrist in neutral positions to provide maximum force.

Key words: Grip strength, Standing posture, Body joint angle, Bengalee (Indian) population

Introduction

Reliable and valid evaluation of hand strength can provide an objective index of general upper body strength. The power grip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions. The synergistic action of flexor and extensor muscles and the interplay of muscle groups is an important factor in the strength of the resulting grip. Many factors influence the strength of the grip, including muscle strength, fatigue, time of the day, age, nutritional status, restricted motion, and pain. Grip strength is often used in medicine as a specific type of hand strength. The purpose of this testing is diverse, including to diagnose diseases, to evaluate and compare treatments, to document progression of muscle strength,

and to provide feedback during the rehabilitation process as a measure indicating the level of hand function. It can be used as a measure of fatigue. It is also able to predict a decline in function in old age (Rantanen et al, 1999).

Wang et al (2005) suggested for evaluating grip strength as a nutritional marker. Handgrip strength not only is a marker of body lean muscle mass but also may be used in conjunction with serum albumin as a nutrition-monitoring tool in patients. People are generally limited by their strength when exerting force. Strength is a muscle's capacity to exert maximal effort or resist maximal opposing force. Grip strength is correlated with the strength of the upper extremity, general strength of the body and some anthropometric measurements (Rantanen et al, 1994) and therefore is often adopted in clinical practice as an objective

measure of upper extremity function (Balogun *et al*, 1991). It is used in a wide range of clinical settings, e.g., to evaluate the extent of upper limb impairment (Swanson, 1995), in a musculoskeletal (Agnew and Maas, 1991) or neurological/stroke (Heller *et al*, 1987) setting. Grip strength is measured using a number of different measurement tools, e.g., the Oxford Muscle Scale, and various instruments such as Strain Gauges, e.g., MIE Digital Pinch/Grip Analyser (Sunderland *et al*, 1989), Mechanical Instruments such as the Smedley or Stoelting dynamometer (Bagi *et al*, 2011) or hydraulic instruments such as Jamar Dynamometer (Richards *et al*, 1996). Similarly there is a wide variation in the patients testing position, which may lead to discrepancies in result interpretation. The hand grip strength may be influenced by different factors including dominance of the hand. The difference of grip strength between dominant and non-dominant has been reported by Schmidt and Toews (1970). Beside handedness the grip strength may vary with the change of body postures (Balogun *et al*, 1991). The strength may also be vary with the change of body positions when different joint angles, e.g., shoulder, wrist, elbow etc. are changed (Mathiowetz *et al*, 1985a; Lamorean and Hotler, 1995). Grip strength may be altered due to wrist angle deviation in different directions (Richards *et al*, 1996; Imrhan, 1991; Duque *et al*, 1995; Dempsey and Ayoub, 1996; Halpern and Fernandez, 1996).

In 1992, the ASHT (*American Society of Hand Therapists, 1992*) produced a revised standardized protocol for grip strength testing, requiring the elbow to be held in 90 degrees of flexion. Therefore, using the ASHT standards,

Richards (1997) adopted this protocol to examine grip strength, finding no significant difference in grip strength between sitting and supine. Yasou *et al* (2005) found grip strength had a significant correlation with the muscle strength of 45 degrees shoulder abduction and external rotation in the affected (injured) side. Dopsaj *et al* (2007) confirmed that men showed significantly greater maximal hand grip force in both dominant and non-dominant hands than women. A number of studies have shown that hand grip strength is both a highly sexually dimorphic and a lateralized anthropometric measurement (Mathiowetz *et al*, 1985b; Petersen *et al*, 1989; Kamarul *et al*, 2006). The aim of the present study was to assess the variation of grip strength with the changes of postures among adult male and female subjects in Bengalee (Indian) population and to suggest a standard posture for measuring hand grip strength for the said population.

Materials and Methods

Selection of site and subject

The subjects were selected randomly from different districts, i.e. Paschim Medinipur, Purba Medinipur, and Purulia of West Bengal state, India. The study was conducted on 380 adult subjects (156 male and 224 female) having the age range of 20 years to 60 years. The present study was approved by the Human Ethical Committee of the institution, and the experiment was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration. All the subjects volunteered for the present study. From all the subjects consents were taken according to the rules of the institution.

Measurement of Hand grip strength

The static grip strength measurement has been performed by having the subjects' maximal grip by using Lafayette (USA) hand grip dynamometer. This hand grip dynamometer features a dual pointer system to retain the maximum effort. The testing range on a dual scale is (0-100) kg / (0-220) lb. The subject was asked to squeeze the dynamometer as hard as possible without moving the rest of the body. Reading was taken from the dynamometer scale, when the pointer no longer moved (*Dhara et al, 2009*) and thus the grip strength were measured for both the hands.

Measurement of hand grip strength in different body posture:

The grip strength was evaluated with the variation of posture as well as body joint angles. Experiments were performed on three main postures, viz., standing, sitting, and lying as well as in different arm positions and during adopting forwarding bend posture. In sitting posture the grip strength was measured in two different conditions:

- a. Sitting without elbow rest: Seated in a chair with elbows unsupported forming an angle of 90°.
- b. Sitting with elbow rest: Seated with elbow supported on the armrest of a chair. The arm was rested comfortably with elbow at 90° flexion.

The arms positions and bend posture was defined by joint angle as explained below:

- a. The arm was hanging normally beside the body with an elbow angle of 180° approximately.
- b. The upper arm was hanging normally beside the body with fore arm forming an angle of 90° at elbow.
- c. The arm was extended horizontally with a shoulder angle of 90°.
- d. The arm was extended upward with a shoulder angle of 180°.
- e. The wrist was remaining neutrally.
- f. The wrist was abducted with maximum ulnar deviation.
- g. The hip was remaining neutrally (normal standing).
- h. The body was bent forward with a hip angle of 130° to 150°.

The grip strength was tested for both the right and left hands.

Three readings were taken in each position with a time gap of 1 minute. A rest of 5 minutes was given between two postures while recording the strength. Three trials were given on both the hands. The maximum value was taken in kilogram. The average value was not taken because problem could arise due to fatigue of the muscle (*Haidar et al, 2004*).

Statistical Analysis

Data were summarized into mean and standard deviation values using Microsoft Excel. The level of significance of difference between group means was determined performing t-tests (*Das and Das, 2004*). The ANOVA study and post-hoc analysis were made by the use of ORIGIN 6.1 software.

Results & Discussion

Table 1: Mean ± SD of grip strength (Kg) of right and left hand among male and female subjects during adopting different postures

Different Posture	Male (n= 133)		Female (n= 156)	
	Right Hand	Left Hand	Right Hand	Left Hand
Standing	28.32 ± 8.11	26.77 ± 7.93	15.33±4.95 ###	13.68±4.70** ###
Sitting with elbow rest	26.95 ± 8.19	26.00 ± 7.86	14.42±4.88 ###	13.14 ± 4.76*###
Sitting without elbow rest	27.81 ± 8.29	25.89 ± 7.48*	14.85±5.24 ###	13.50 ± 5.05*###
Lying condition (supine)	27.46 ± 8.05	25.95 ± 8.10	14.52±4.82 ###	13.12 ± 4.80*###
F-value	0.66	0.37	1.05	0.51

w. r. t. right hand **p<0.01 *p<0.05; w. r. t. male subject ###p<0.00

The grip strength values recorded in different postures have been presented in Table 1. It has been noted that in case of adult male subjects there was no significant difference in grip strength between right hand and left hand in four different postures except in sitting without elbow rest condition. In case of female subjects there were significant differences (p<0.05 or higher) in grip strength between right and left hand in all the postures. This result also showed that the hand grip strength was significantly higher (p<0.001) in adult male subjects than that of the adult female subjects in both right and left hand.

From the result of ANOVA it has been noted that there was no significant difference in hand grip strength among the four different postures in case of both male and female subjects (Table-1). However, the tendency of the results exhibited that the grip strength was slightly higher (1.3% to 5.9%) in standing posture than the other postures in both male and female subjects.

The variation of hand grip strength with the different arm postures has been presented in Table 2.

Table 2: Mean ± SD of grip strength (Kg) of right and left hand among male and female subjects in different body joint angles

Different body joint angle	Male (n=156)			Female (n=224)		
	Right Hand	Left Hand	% dif.	Right Hand	Left Hand	% dif.
Elbow 90°	30.29 ± 7.24	28.83 ± 7.18	4.82	16.80 ±4.91 ###	15.31 ±5.10 **###	8.87
Elbow 180°	29.98 ± 7.85	28.58 ± 7.58	4.67	16.35 ±4.89 ###	14.79 ±4.92 **###	9.54
Shoulder 90°	29.25 ± 7.51	28.16 ± 7.61	3.73	15.63 ±4.72 ###	14.58 ± 4.84* ###	6.72
Shoulder 180°	29.44 ± 7.61	28.75 ± 7.88	2.34	16.35 ±5.08 ###	15.10 ± 4.92** ###	7.65
Wrist neutral	28.72 ± 7.57	27.25 ± 7.74	5.12	15.35 ±5.23 ###	13.52 ±4.81 **###	11.92
Wrist ulnar deviation	24.37 ± 7.43	22.42 ±6.89*	8.00	12.36 ±4.58 ###	10.65 ±4.33 **###	13.84
Trunk neutral	29.06 ± 7.81	27.92 ± 7.26	3.92	15.87 ±4.63 ###	14.42 ±4.75 **###	9.14
Trunk flexion	26.81 ± 6.96	26.24 ± 7.24	2.13	14.30 ±4.91 ###	13.29 ± 4.94*###	7.06
F-value	10.98***	13.00***	-	19.49***	21.87***	-

w. r. t right hand ***p<0.001 **p<0.01 *p<0.05 w. r. t male subject ###p<0.001 ##p<0.01 p<0.05

It has been noted that in the case of male subjects there was no significant difference in grip strength between the right and left hand in different body postures except in wrist ulnar deviation. However, in female subjects there were significant differences in grip strength between the right and left hand in different arm postures. The adult male subjects had significantly higher grip strength values (p<0.001) in different arm postures than that of the female subjects in both left and right hand. It is also observed that in wrist neutral condition the grip strength of the right hand was higher by 5.12% in male and 11.92% in female than that of the left hand (Table-2). In wrist ulnar deviation it was greater in the right hand by 8.00% in male and 13.84% in female when compared to the left hand.

From the ANOVA results, it has been noted that the hand grip strength was significantly different ($p < 0.001$) among the different body joint angles in male and female subjects (Table 2). The highest value of hand grip strength was noted when the male and female subjects formed an angle of 90° at the elbow.

Table 3: Comparison of hand grip strength (kg) of right and left hand among the different body joint angle in male and female subject

Analysis	Male (n=156)		Female (n=224)	
	Right Hand	Left Hand	Right Hand	Left Hand
Elbow 90° and Elbow 180°				
% difference	1.02	0.87	2.68	3.40
t-value	0.359	0.299	0.976	1.086
Shoulder 90° and Shoulder 180°				
% difference	0.65	2.10	4.61	3.57
t-value	0.217	0.672	1.555	1.344
Wrist neutral and Wrist ulnar deviation				
% difference	15.15	17.72	19.87	21.23
t-value	5.125***	5.824***	6.421***	6.613***
Trunk neutral and Trunk flexion				
% difference	7.74	6.02	9.89	7.84
t-value	2.818**	2.046*	3.484***	2.474*

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

The strength measured in two different positions in each joint angle was compared and t test was performed to find the level of significance in difference between them (Table 3). From the results it has been noted that there was no significant difference in hand grip strength between two angles of elbow joints, i.e., 90° and 180° in both male and female subjects and the magnitude of variation between them was also little (0.9% to 3.4%). The similar trends of results were observed in between two angles at shoulder joints (90° and 180°). The percentage difference of grip strength between those shoulder angles varied from 0.7% to 4.6% only. However, in both the sexes the grip strength showed

significantly higher value ($p < 0.001$) in wrist neutral position than that in the wrist ulnar deviation. There was an appreciable variation (15% to 21%) in strength between two positions of the wrist. Similarly, in trunk neutral position the grip strength was significantly higher ($p < 0.001$) in both right and left hand than that of the trunk in flexed condition. The percentage of difference between two trunk positions varied from 6.0% to 9.9%.

Discussion

Variation of strength in two hands

The mean value of the hand grip strength of adult male and female subject was higher in the right hand in comparison to left hand in different postures and in different body joint angles. As the right hand of the subjects was the dominant hand, the subjects showed greater grip strength in that hand than that in the non-dominant hand, which might be because of difference in muscle strength between two hands. *Incel et al (2002)* also reported that the hand grip strength is to be higher in dominant hand with right handed subjects, but no such significant differences between sides could be documented for left handed people. However, *Bagi et al (2011)* noted greater grip strength in the dominant hand both in cases of right hander and left handers. *Kamarul (2003)* found that although the right hand is approximately 10% stronger than the left (12.1% in male and 11.0% in female) there is a variance of between 9.1 to 9.6% in different individuals. A general rule is often used to suggest that dominant hand is about 10% stronger than the non-dominant hand (*Petersen et al, 1989; Armstrong and Oldham, 1999*). Our findings were also

supported by the work of *O'Driscoll et al. (1992)*, and *Richards et al (1996)*. They reported higher grip strength values in the dominant hand compared to the non-dominant hand. However, there was a disagreement with above finding with that of the work done by *Reikeras (1983)* and *Harkonen et al (1993)* who reported that there was no significant difference in grip strength of dominant hand and non dominant hand. According to *Rabergs and Roberts (1997)*, one explanation for the differences in grip strength may be due to the use of more muscle and muscular hypertrophy in the dominant hand which leads to increased strength.

Effect of gender:

The result of this study indicated that grip strength of adult males in different postures and different body joint angles was significantly greater ($p < 0.001$) than the grip strength of adult female in both right and left hands. One possible explanation for this finding was the difference in the type of activity of each gender. Male are more active than female and perform more physical work. Sometimes males are involved in more weight handling than their female counterpart. The differences in body composition may be another factor. Strength variations between men and women may be mainly related to the smaller amount of absolute muscle mass (about 60% of men) and a higher body fat percentage in women (*Janssen et al, 2000*). Besides genetic effects this might be caused by a weaker affinity to strength-demanding tasks in women. It must be taken into account that women are 40% to 60% weaker in the upper body and about 25% to 30% in the lower body than men (*Shephard, 2000; Kraemer et al, 2001*). These regional differences occur

due to different muscle mass distributions and different day-to-day activities (*Janssen et al, 2000; Miller et al, 1993*). *Leyk and co-workers (2006)* investigated some 2000 age-matched young men and women with regard to their maximum handgrip strength. 90% of the female subjects produced maximal handgrip forces smaller than 95% of their male counterparts.

Effect of posture:

The results regarding the effect of posture on grip strength in male and female subjects indicated that there was no significant difference of grip strength among different postures. However, the mean grip strength was slightly higher in standing posture than that in the other postures. *Teraoka (1979)*, who studied the effects of different body positions on grip strength, also found that grip strength measured in standing was the strongest, whereas grip strength measured in supine was the weakest. *Balogun et al (1991)* also demonstrated that grip strength was greater in standing posture as compared to the supine and sitting positions. *Richards (1997)* found no difference in grip strength measured in either sitting or supine postures. Similar findings were also evident in the present study and therefore support the findings of the above researchers.

Effect of body joint angle

Variation of body joint angles had some effects on grip strength in adult male and female. The mean value of the hand grip strength in elbow 90 degree angle of adult male and female subjects was higher, although non-significantly, in both right and left hand. A possible reason may be that the grip strength is directly related to forearm muscle (flexor muscle).

Flexor muscle originates from lower part of the humerus which is above the elbow joint. So, the elbow position may have significant effect on grip strength (*Su et al, 1994a*). Earlier, *Mathiowetz et al (1985)* also studied the effect of elbow position on grip strength and found it to be higher with the elbow flexed at 90° while *Su et al (1994b)* found that the highest mean grip strength score was obtained with the elbow fully extended.

In the present study, although no significant difference in grip strength with the variation of shoulder positions was observed, yet it was slightly observed to be higher in shoulder 180° position. *Su et al (1994b)* compared the grip strength at 0° , 90° and 180° of shoulder flexion in standing. They found that the strongest grip was produced when the shoulder was in 180° of flexion with elbow fully extended whereas the weakest grip was associated with 0° of shoulder flexion. Coincidentally, 0° of shoulder flexion with 90° of elbow flexion was the recommended testing position by the American Society of Hand Therapists for grip strength measurement (*Fess and Moran, 1981*). Contrary to the above findings, *Mathiowetz et al (1985)* demonstrated that grip strength was significantly stronger at 90° of elbow flexion than at full extension. This finding was supported by a report that grip strength was greater at 90° of elbow flexion than at either full extension or 120° of flexion (*Fan et al, 1999*). *Kumar et al (2008)* suggested that grip endurance training can be undertaken with the elbow in 90° of flexion or full extension.

A wrist position also affects grip strength. It was observed in the present study that the wrist neutral position

showed significantly higher grip strength than that of ulnar deviation. *Ridan et al (2000)* stated that higher values of strength were noted in such configuration of the upper limb where the elbow joint was straight. On the other hand grip reduction in grip force was reported with wrist flexion (*Halpern and Fernandez, 1996; Kattel et al, 1996; Claudon, 1998*). *Lamoreau and Hotler (1995)* also observed that radial and ulnar deviation caused a reduction in grip strength. Pronation of the forearm has also been shown to reduce grip force, but the effects of supination are less clear (*De Smet et al, 1998; Mogk and Keir, 2003*). Slightly different observations were noted by other workers. *Fong and Ng (2001)* and *Barr et al (2001)* reported that grip strength is the highest with the wrist in 15° or 30° of extension and 0° of ulnar deviation. However, *Pryce (1998)* found no significant differences between any combination of 0° or 15° of wrist extension and ulnar deviation. *Mogk and Keir (2010)* demonstrated that the forearm posture only affected grip force when the wrist was flexed.

A significant variation in grip strength was observed between trunk neutral and trunk flexion positions. Similar variation was also noted by other groups of workers. *Debeliso et al (2004)* showed that trunk extension strength was significantly greater than trunk flexion strength. The trunk flexion strength of both women and men with bent working postures of the back was 98% of the strength of those who had no bent postures at work. The trunk extension strength on the other hand was 92% for women and 98% for men of the strength of those in the groups with bent back

postures compared to those who had no bent back postures (Nygard *et al*, 1988). Significant differences in trunk strength (isometric torque) were found between males and females, at various sagittal plane trunk postures, and between flexion and extension tasks (Keller and Roy, 2002).

Conclusions

Grip strength measured at standing posture was higher than that of other postures. Although there was no significant difference in hand grip strength between two angles of elbow joints, i.e., 90° and 180°, yet it was higher at the elbow joint angle of 90°. Similarly the grip strength of right and left hand showed slightly higher value at the shoulder joint angle of 180° although there was no significant difference between two shoulder joints angles (90° and 180°). However, the hand grip strength was significantly higher in wrist neutral position and trunk neutral position than that of wrist unlar deviation and trunk flexion respectively. From our study it may be recommended that for Bengalee (Indian) population the hand grip strength should be measured in the following standardized posture: the subjects should adopt standing posture with an angle of 90 degree at elbow joint and 180 degree at shoulder joint and the trunk and wrist should be at neutral positions. These findings highlight the importance for clinicians to adopt a standard testing position to assess grip strength in adult Bengalee population. This study also possesses important application in the use of grip strength during operation of different instruments in different postures and arm positions.

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References

- Agnew, P.J., Maas, F. 1991. Jamar dynamometer and adapted sphygmomanometer for measuring grip strength in patients with rheumatoid arthritis. *Occup. Ther. J. Res.*, **11(S)**: 259- 270.
- American Society of Hand Therapists, 1992. Clinical Assessment Recommendations. 2nd Ed. Chicago: *Am. Soc. Hand Therap.*
- Armstrong, C.A., Oldham, J.A. 1999. A comparison of dominant and non dominant hand strength. *J. Hand Surg.*, **24B (4)**: 421-5.
- Bagi, J.C., Kundachi, P.S., Goudar, S.S. 2011. Influence of motor task on handedness. *Al. Ameen J. Med. Sci.*, **4(1)**: 87 -91.
- Balogun, J.A., Akomalafe, C.T., Amusa, L.O. 1991. Grip strength: Effect of testing posture and elbow position. *Arch. Phys. Med. Rehab.*, **72**: 280-3.
- Barr, A.E., Goldsheyder, D., Ozkaya, N., Nordin, M. 2001. Testing apparatus and experimental procedure for position specific normalization of electromyographic measurements of distal upper extremity musculature. *Clin. Biom. (Bristol, Avon)*, **16**: 576-585.
- Claudon, L.1998. Evaluation of grip force using electromyograms in isometric isotonic conditions. *Int. J. Occup. Safety & Ergo.*, **4(2)**: 169-184.
- Das, D., Das, A. 2004. *Statistics in biology and psychology*. Academic Publishers, Calcutta. pp. 105.
- De, Smet, L., Tirez, B., Stappaerts, K. 1998. Effect of forearm rotation on grip strength. *Acta Orthop. Belgica*, **64(4)**: 360-362.
- Debeliso, M., O'shea, J.P., Harris, C., Adams, K.J., Climstein, M. 2004. The Relation between Trunk Strength Measures and Lumbar Disc Deformation during Stoop Type Lifting. *J. Exer. Physiol. online*, **7(6)**: 16-26.
- Dempsey, P.G., Ayoub, M.M. 1996. The influences of gender, grasp type, pinch width and wrist position on sustained pinch strength. *Int. J. Ind. Erg.*, **17**: 259-273.
- Dhara, P.C., De, S., Pal, A., Sengupta, P., Roy, S. 2009. Assessment of Hand Grip Strength of Orthopedically Challenged Persons Affected with Upper Extremity. *J. Life Scien.*, **1(2)**: 121-127.

- Dopsaj, M., Koroponovski, N., Vuckovic, G., Blagojevic, M., Marinkovic, B., Milijus, D. 2007. Maximal isometric hand grip force in well-trained university students in Serbia: descriptive, functional and sexual dimorphic model. *Serb. J. Sports Sci.*, **1(4)**: 138-147.
- Duque, J., Masset, D., Malchaire, J. 1995. Evaluation of hand grip force from EMG measurements. *Appl. Erg.*, **26(1)**: 61-66.
- Fan, A.C.C., Ng, G.Y.F. 1999. Effect of elbow position on hand grip strength development and repeatability of measurement. *Proceedings of the Hong Kong Physiotherapy Association Limited Annual Congress*, pp. 60.
- Fess, E.E., Moran, C.A. 1981. Clinical assessment recommendations. Chicago: American Society of Hand Therapists.
- Fong, P.W., Ng, G.Y. 2001. Effect of wrist positioning on the repeatability and strength of power grip. *Am. J. Occup. Ther.*, **55**: 212-216.
- Haidar, S.G., Kumar, D., Bassi R.S., Deshmukh, S.C. 2004. Average Versus Maximum Grip Strength: Which is More Consistent? *J. Hand Surg. (Brit. & Europ. Volume)*, **29B**: 82-84.
- Halpern, C.A., Fernandez, J.E. 1996. The effect of wrist and arm postures on peak pinch strength. *J. Hum. Ecol.*, **25**: 115-130.
- Harkonen, R., Piirtomaa, M. Alaranta, H. 1993. Strength and hand position of the Dynamometer in 204 Finnish Adults. *J. Hand Surg (British Volume)*, **18(1)**:129-132.
- Heller, A., Wade, D.T., Wood, V.A., Sunderland, A., Hower, R., Ward, E. 1987. Arm function after stroke: measurement and recovery over the first three months. *J. Neurol, Neurosurg. & Psycht.*, **50(6)**: 714- 719.
- Imrhan, S.N. 1991. The influence of wrist position on different types of pinch strength. *Appl. Ergonom.*, **22**: 379-384.
- Incel, N.A., Ceceli, E., Durukan, P.B., Erdem, H.R., Yorgancioglu, Z.R. 2002. Grip strength: Effect of hand dominance. *Singap. Med. J.*, **43(5)**: 234-237.
- Janssen, I., Heymsfield, S.B., Wang, Z.M., Ross, R. 2000. Skeletal muscle mass and distribution in 468 men and women aged 18 – 88 yr. *J. Appl. Physiol.*, **89(1)**: 81-88.
- Kamarul, T. 2003. Hand grip strength pattern in the adult Malaysian population. *Scientific report written for Masters of Orthopaedic Surgery*, Department of Orthopaedic Surgery University Malaya.
- Kamarul, T., Ahmad, T.S., Loh, W.Y.C. 2006. Hand gripstrength in the adult Malaysian population. *J.Orthop. Surg.*, **14(2)**: 172-177.
- Kattel, B.P., Fredericks, T.K., Fernandez, J.E., Lee, D.C. 1996. The effect of upper extremity posture on maximum grip strength. *International J. Indust. Ergon.*, **18(6)**: 423-429.
- Keller, T.S., Roy, A.L. 2002. Posture-dependent isometric trunk extension and flexion strength in normal male and female subjects. *J. Spin. Disord. & Tech.*, **15(4)**: 312-8.
- Kraemer, W.J., Mazzetti, S.A., Nindl, B.C., Gotshalk, L.A., Volek, J.S., Bush, J.A., 2001. Effect of resistance training on women's strength/power and occupational performances. *Med. & Scien. Sports & Exer.* **33(6)**: 1011-1025.
- Kumar, A.J.S., Parmar, V., Ahmed, S. 2008. A study of grip endurance and strength in different elbow positions. *J. Orthop. Traumat.*, **9**: 209-211.
- Lamorean and Hotler. 1995. *Rehabilitation of the hand: Surgery and therapy*. Mosby, Missouri. Pp.101: 223-4.
- Leyk, D., Rohde, U., Erley, O., Gorges, W., Wunderlich, M., Rütger, T. Essfeld, D. 2006. Recovery of hand grip strength and hand steadiness after exhausting manual stretcher carriage. *Europ. J. Appl. Physiol.*, **96(5)**: 593-599.
- Mathiowetz, V., Rennells, C., Donahoe, L. 1985a. Effect of elbow position on grip and key pinch strength. *Journal of Hand Surgery*, **10**: 694-7.
- Mathiowetz, V., Kashman, N., Volland, G., Weber, K., Dowe, M. 1985b. A Grip and pinch strength normative data for adults. *Archiv. Phys. Med. Rehab.*, **66**: 69- 72.
- Miller, A.E.J., MacDougall, J.D., Trarnopolky, M.A., Sale, D.G. 1993. Gender differences in strength and muscle fiber characteristics. *Europ. J. Appl. Physiol.*, **66**: 254-262.
- Mogk, J., Keir, P. 2010. The effects of posture on forearm muscle loading during gripping. *Ergonomics*, **46(9)**: 956-975.
- Mogk, J.P.M., keir, P.J. 2003. Crosstalk in surface electromyography of the proximal forearm with forearm rotation during gripping tasks. *J. Electromyog. & Kines.*, **13(1)**: 63-71.
- Nygaard, C.H., Luopajarvi, T., Suurnakki, T., Ilmarinen, J. 1988. Muscle strength and muscle endurance of middle-aged women and men associated to type, duration and

- intensity of muscular load at work. *Int. Arch. Occup. Env. Health*, **60**:291-297.
- O'Driscoll, S.W., Horii, E., Ness, R., Cahalan, T.D., Recharls, R.R. An KN. 1992. The relationship between wrist positions, grasp size and grip strength. *J. Hand Surg. (American Volume)*, **17**(1): 169-177.
- Petersen, P., Petrick, M., Connor, H., Conklin, D. 1989. Gripstrength and hand dominance challenging the 10% rule. *Am. J. Occup. Therapy*, **43**(7): 444 – 447.
- Pryce, J.C. 1980. Wrist position between neutral and ulnar deviation that facilitates maximum power grip strength. *J. Biomech.*, **13**: 505-11.
- Rabergs, G., Roberts, L. 1997. Effect of handedness on grip strength. *Archv. Phys. Med. Rehab.*, **76**: 410-414.
- Rantanen, T., Guralnik, J.M., Foley, D. 1999. Midlife hand grip strength as a predictor of old age disability. *The J. Am Med. Asso.*, **281**: 558–560.
- Rantanen, T., P. Era, E. Heikkinen. 1994. Maximal isometric strength and mobility among 75-year-old men and women. *Age Ageing*, **23**: 132–137.
- Reikeras, O. 1983. Bilateral difference of normal hand strength. *Archv Orthop. Trauma Surgery*, **101**: 223-224.
- Richards, L.G. 1997. Posture effects on grip strength. *Archv. Phys. Med. Rehab.*, **78**: 1154–1156.
- Richards, L.G., Olson, B. Palmiter-Thomas, P. 1996. How Forearm Position Affects Grip Strength. *Am. J. Occup. Therap.*, **50**(2):133-138.
- Ridan, T., Pieniżek, M., Cieřlar, G., Berwecki, A., Janusz, M., Kilar, Z. 2003. Influence of Number of Trials, Grip Breadth and Elbow Position on the Maximal Grip Strength. *J. Hum. Kinet.*, **3**: 73-91.
- Schmidt, R.T., Toews, J.V. 1970. Grip strength as measured by the Jaymar dynamometer. *Archv. Phys. Med. Rehab.*, **51**: 321-327.
- Shephard, R.J. 2000. Exercise and training in women, Part I: influence of gender on exercise and training Responses. *Canad. J. Appl. Physiol.*, **25**: 19-34.
- Su, C.Y., Lin, J.H., Cheng, K.F., Chien, T.H., Sung, Y.T. 1994a. Grip strength: relationship to shoulder position in normal subjects. *Archv. Phys. Med. Rehab.*, **7**: 812-5.
- Su, C.Y., Lin, J.H., Chien, T.H., Cheng, K.F., Sung, Y.T. 1994b. Grip strength in different positions of elbow and shoulder. *Archv. Phys. Med. Rehab.*, **75**: 812-5.
- Sunderland, A., Tinson, D., Bradley, L., Hewer, R. 1989. Arm function after stroke. An evaluation of grip strength as a measure of recovery and a prognostic indicator. *J. Neurol., Neurosurg. & Psychiatry*, **52**(11): 1267-72.
- Swanson, A. 1995. Pathomechanics of deformities in hand and wrist. In: *Rehabilitation of the hand*. Ed. Hunter, J.M., Mackin, E.J., and Callahan, A.D., St.Louis: Mosby year book, 1315-1328.
- Teraoka, T. 1979. Studies on the peculiarity of grip strength in relation to body positions and aging. *Kobe J. Med. Scien.*, **25**: 1–17.
- Wang, A.Y., Sea, M.M., Ho, Z.S., Lui, S., Li, P. K., Woo, J. 2005. Evaluation of handgrip strength as a nutritional marker and prognostic indicator in peritoneal dialysis patients. *Am. J. Clin. Nutr.*, **81**: 79-86.
- Yasuo, G., Daisaku, T., Nariyuki, M., Jun'ya, S., Toshihiko, O., Masahiko, M., Yoshiyuki, M. 2005. Relationship Between Grip Strength and Surgical Results in Rotator Cuff Tears. *Shoulder Joint*, **29**(3):559-562.



Effect of Spinal Stimulation on Monosynaptic Reflex by Medium Frequency Current

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Abstract:

Surface spinal stimulation with electrical stimulation plays a major role in the management of various neurological disorders and also reduces the spasticity. There are many previous studies where surface spinal stimulation had been used in various neurological disorders and purposes and mostly in these studies low frequency current are used but still there is no study to explain how surface spinal stimulation by two medium frequency currents influences on monosynaptic reflex. In present study Premodular IFC & Russian current by surface spinal stimulation has been used at T-12 & L-1 for 45 minutes to see how it influence on monosynaptic reflex by taking Pre & post readings. The mean, standard deviations were calculated for all variables. After that ANOVA was applied between pre & post reading of all variables after medium frequency currents and after that two currents were compared by paired t- value for all the parameters of monosynaptic reflex. It was concluded that spinal stimulation with medium frequency current resulted in a significant effect on monosynaptic reflex as there was significant effect on H-latency and H-amplitude, however there was non significant effect on H/M ratio & Premodular IFC produced greater effect than the Russian current.

Key words: Monosynaptic reflex, Surface Spinal Stimulation, Medium frequency currents

Introduction

Electrotherapy is the treatment of patients by electrical means; in this electrical forces are applied to the body through which physiological changes occur for therapeutic purposes. Electrical stimulation helps in reducing spasticity in case of SCI, Cerebral palsy and Multiple sclerosis patients along with improvement in bladder function, respiratory function volitional control; active and passive movement and mood state with carry over effects lasting from 30 minutes to 24 hours (Hazelewood et al, 1994). American Physical Therapy Association acknowledges the use of electrotherapy in various fields such as pain management, tone management, treatment of neuromuscular dysfunction, improves

range of joint mobility, tissue repair, acute and chronic edema, peripheral blood flow, iontophoresis, Urine and fecal incontinence (Alon et al, 2005).

Surface Spinal Stimulation is delivered by pulses that are generated from amplitude modulated alternating current of a carrier frequency of 2500 Hz, and modulated to deliver beat at a frequency of 20 Hz. For application, an electrode is placed on each side of the spine (5cm apart) over the paravertebral skin at the twelfth thoracic and first lumbar vertebral levels. The self-adhesive electrodes of rectangular shape and size of 5×9cm are used. The stimulation amplitude is adjusted for each subject to produce only sensory stimulation and it is

applied continuously for 45 minutes (Wang et al., 2000).

Surface spinal stimulation through Tens also produces a significant effect on monosynaptic reflex. (Arsenault, 1993). In the present study attempt has been made to find physiological reasoning how surface spinal stimulation influences the monosynaptic stretch reflex in 30 normal adolescents and its physiological changes takes place through surface spinal stimulation and how different medium frequency currents produce effects on monosynaptic reflex.

Methods

Study was performed on 30 female subjects taken from the SBSPGI, Dehradun under the age group of 20-25 years. It was an experimental study which was performed in the Department of Physiotherapy. Study was performed in accordance with the ethical considerations of the institute and the consent of the subjects was taken prior to the study.

Before beginning with the procedure, the subjects were selected on the basis of convenient sampling by applying inclusion criteria and were explained the entire procedure in detail. The inclusion criteria were (i) female subjects of age 20 to 25 years, (ii) with normal BMI between 19 to 25 kg/m² and with (iii) height 165-190 cm are included. The body temperature ranged between 36-37°C, leg length from 27-49 cm and absence of any systemic, physical or neurological problem. The Exclusion Criteria was any sensory or motor impairment, space occupying lesion, upper motor neuron or lower motor neuron symptoms, mixed symptom rigidity, flaccidity and spasticity, any neurological and cognitive deficit, any

radiculopathy and neuropathy, any recent surgery on back, hip, knee, height below 165cm or above 190cm, leg length less than 27-cm or more than 49-cm and subjects with BMI more than 25 or less than 19.

Of all the 30 subjects, H-reflex was recorded maintaining room temperature between 19-24°C on non-dominant side in prone lying. Recording and reference electrodes were placed at the soleus muscle and sub maximal stimulation was given at popliteal crease. Surface spinal stimulation with premodular IFC was then applied at T₁₂ & L₁ level with rectangular shaped electrodes of 4.5X9.5 cm for 45 minutes in prone lying and again 3 readings of H-reflex were recorded after 5 minutes, 10 minutes & 15 minutes of treatment. After that washout period of 30 minutes were given to the subject & again pre reading was taken & after that again Russian current was applied for 45 minutes & whole procedure was repeated & Pre and post stimulation values of latency of H-reflex (ms), H/M ratio and amplitude of H-wave (mV) were taken. The data was collected and analyzed.

Results

Table 1: Mean and SD of Age, Height & Weight

Demographic	MEAN	SD
Age	21.03	1.52
Height	5.24	0.14
Weight	51.7	0.14

Table 1 shows the mean and standard deviation values of age, height and weight of the subjects. The mean and standard deviation of age is 21.03±1.52 yrs. The mean height was 5.24±.14 ft and weight was 51.7±.14 kg and mean BMI was 20.56±1.78. Repeated measures ANOVA

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shows a significant difference in Latency & amplitude values across the time points. A simple contrast results represent statistical significant difference between the pre-value and 5-minutes (P<0.01), and 10-minutes (P<0.01, but not in 15-minutes amplitude values (P=0.714).

Table 2: Mean and SD of H-Latency, H/M and H amplitude at Pre and Post intervals after Premodular IFC & comparison of mean value pre & post values

		Mean	SD	F-value/P-value (repeated measures ANOVA)	Significance (Compared with pre-value)*
H-Latency	Pre-value	27.53	1.22		
	5-minutes	28.20	1.02	F= 11.448 (df=3,87) P=0.000	P=0.009
	10-minutes	28.34	1.06	(P<0.001)	P=0.000(P<0.001)
	15-minutes	28.30	0.99		P=0.000(P<0.001)
H-Amp	Pre-value	3.19	1.19		
	5-minutes	4.02	1.04	F= 27.131 (df=3,87) P=0.000	P=0.000(P<0.001)
	10-minutes	4.79	1.08	(P<0.001)	P=0.000(P<0.001)
	15-minutes	3.76	1.22		P=0.039
H/M Ratio	5-minutes	.139	.09	F= .710 (df=3,87) P=0.000(P<0.001)	
	10-minutes	.174	.146		P=0.548
	15minutes	.166	.097		P=0.548(P>.005)

Table 3: Mean and SD of H-Latency, H/M and H amplitude at Pre and Post intervals after Russian current & comparison of mean value pre & post values

		Mean	SD	F-value/P-value (repeated measures ANOVA)	Significance (Compared with pre-value)*
H-Latency	Pre-value	27.53	1.22		
	5-minutes	28.20	1.02		P=0.009
	10-minutes	28.34	1.06	F= 11.448 (df=3,87) P=0.000	P=0.000(P<0.001)
	15-minutes	28.30	0.99	(P<0.001)	P=0.000(P<0.001)
H-Amp	Pre-value	3.19	1.19		
	5-minutes	4.02	1.04		P=0.000(P<0.001)
	10-minutes	4.79	1.08	F= 27.131 (df=3,87) P=0.000	P=0.000(P<0.001)
	15-minutes	3.76	1.22	(P<0.001)	P=0.039
H/M ratio	5-minuts	.125	.082	F= .681 P=0.565(P<0.01)	
	10-minutes	.14	.13		P=0.565
	15-minutes	.14	.093		P=0.565(P<.005)

The mean value depicts an increase in amplitude value from baseline upto 10 minutes and then starts decreasing—.

Where as latency increases from baseline to 15. To compare the Pre H/M ratio with other time points ANOVAs was applied.

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Only 5-minutes value was found to be significant with pre value. While post values show a non significant result of H/M ratio.

Table 4: Comparison of both premodular IFC and Russian Current

		IFS		Russian		P-value
		Mean	SD	Mean	SD	(Paired t-test)
H-Latency	Pre-value	27.53	1.22	27.44	1.24	0.228
	5-minutes	28.20	1.02	27.90	1.33	0.195
	10-minutes	28.34	1.06	28.00	1.37	0.082
	15-minutes	28.30	0.99	28.08	1.59	0.355
H-Amp	Pre-value	3.19	1.19	3.16	1.18	0.661
	5-minutes	4.02	1.04	3.69	1.35	0.074
	10-minutes	4.79	1.08	4.05	1.23	0.008
	15-minutes	3.76	1.22	3.00	1.11	0.002
H/M Ratio	Pre-value	0.139	0.09	0.125	0.082	0.114
	5minutes	0.174	0.146	0.14	0.13	0.416
	10-minutes	0.166	0.097	0.14	0.093	0.22
	15minute	0.137	0.141	0.12	0.1005	0.488

The table 4 shows comparison of H amplitude between the Premodular IFC and Russian current. After spinal stimulation the pre readings were found to be (t- value 0.443, p value <0.05), after 5 minutes (t-value -1.734, p- value <0.05), after 10 minutes (t- value -2.869, p value <0.05) and after 15 minutes (t- value 3.319, p value < 0.05) were found to be non significant for pre reading and for 5 minutes and significant for 10 minutes and 15 minutes of treatment. While H-latency & H/M ratio show non-significant results.

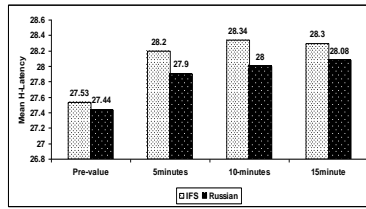


Figure 1: Comparison of H-latency of both premodular IFC & Russian current

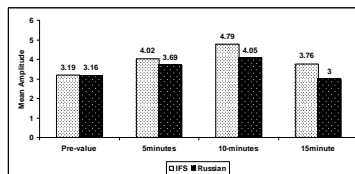


Figure 2: Comparison of Mean H-amplitude of both premodular IFC & Russian current

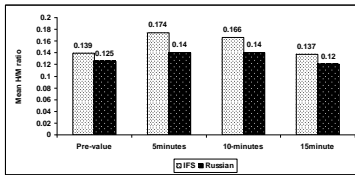


Figure 3: Comparison of Mean H/M Ratio of both premodular IFC & Russian current

Discussion

Electrical stimulation is well known technique that uses electrical currents for the management of various neurological disorders. Electrical stimulation is effective in the treatment of SCI patients as it reduces spasticity in them: (Lojze Vodovnik, 1984). Stimulation of spastic muscle itself is based on recurrent inhibition which is caused by Renshaw cell, which has a negative feedback loop to the motorneurons (Rothwell et al., 1994).

Surface spinal stimulation has pronounced effects in H-reflex, which is an electrically induced reflex analogous to mechanically induced spinal stretch reflex; its arc is similar to spinal stretch reflex except that it bypasses the muscle spindle, and therefore it is a valuable tool for assessing mono synaptic reflex activity in spinal cord. Thus, it is a reliable tool for the assessment of muscle tone through the excitability of alpha motor neuron (Palmieri et al., 2004).

In the present study, to find the effect of surface spinal stimulation in H-reflex, only female subjects were taken because the significant role of sex in H-reflex has already been elicited (Huang et al., 2009). H-reflex has also shown modifications due to variations in age and leg length (Robinson et al., 1988). So in

the present study, considering the age factor, subjects of age group 20-25 years and leg length in present study were controlled between 27 and 49 cm. H – reflex latency shows increase with cooling and decrease with warming (Riccardo et al, 2001). So, in the present study room temperature was monitored from 19-24°C. As Body Mass Index has also shown to influence the conduction changes (Buschbacher, 1998), the subjects with normal BMI (19-25 Kg/m²) were included in the study.

In the present study, surface spinal stimulation of carrier frequency of 2500 Hz and beat frequency 20 Hz was given through the surface electrodes of size 4.5 x-9 cm, which were placed 5 cm apart on each side of spine, as explained by Wang et al (2000).

The results revealed that there are changes in the nerve excitability, H amplitude and H-Latency and there is significant influence of Surface Spinal Stimulation on monosynaptic reflex. There is significant increase of H-latency and H amplitude; however there is elongation of H-/M ratio but not upto significant level. The results are in accordance with study done by Arsenault et al (1993) who also found a gradual increase of H-reflex amplitude upto 40% after 20 minutes regardless of whether the TENS is applied on L5 or S2. They further reported that increase in H-response value was accompanied by a shift of spectral content towards low frequencies, which occurred with a cooling of skin overlying the soleus muscle. The results of the study are also supported by the study done by Alireza (2009). They however used tripolar TENS with different intensities (1.5 ST and 1.25 ST) on T-11 vertebra which showed peak

to peak increase in amplitude as slow motor neurons were inhibited and fast motor neurons were facilitated.

Conclusion

Results of the present study suggests that spinal stimulation when done with medium frequency currents i.e Premodular IFC (3000Hz) and Russian current (2500Hz) produces a significant change in H-Latency and H-amplitude and it was also found out that Premodular IFC (3000Hz) produces more effect in various parameters of H-reflex such as H-Latency and H-amplitude as compared to Russian current.

References

- Alon G et al. Electrotherapeutic Terminology in Physical Therapy 2005. Section on Clinical Electrophysiology. Alexandria, VA: American Physical Therapy Association.
- Alireza, S., Firoozabadi, S.M.P., Torkaman, G., Fathollahi, Y. (2009). "The effect of vertebral column tripolar electrical stimulation with various intensities on soleus and gastrocnemius H-reflex and Mh Wave recruitment curve", *Physiology and Pharmacology*, **13**(2): 229-243.
- Arsenault, B., Belanger, A.Y., Durand, M.J., De Serres, S.J., Fortin, L., Kemp, F. 1993. Effect of TENS and topical anesthesia on soleus H-reflex and the concomitant influence of skin/muscle temperature, *Arch. Phys. Med. Rehabilitation-Rehab.* **74**(1): 48-53.
- Buschbacher, R. (1999). "Normal range for H-reflex recording from the calf muscle S.", *AMAm. J. Phys. Med. And Rehab.*, **77**: 6.
- Hazelwood, M. E., Brown, J. K., Rowe, P. J. (1994). "The use of therapeutic electrical stimulation in the treatment of hemiplegic cerebral palsy", *Dev. Med. Chil. Neurol.* **36**: 661-673.
- Huang, C.R., Chang, W.N., Chang, H.W., Tsai, N.W., and Lu, C. 2009. Effects of Age, Gender, Height and Weight on late responses and nerve conduction study parameters", *Acta Neurol Taiwan*, **18**: 242-249.
- Palmieri, R.M., Ingersoll, C.D. and Hoffman, M.A. 2004. The Hofmann Reflex: Methodologic considerations and applications for use in sports medicine and athletic training research, *J. Athl. Train.*, **39**(3): 268-77.
- Riccardo, M., Giovani, B.S., Aido, M., Vitaliano, F.M., Lucio, P. 2001. Recruitment curve of the Soleus H-reflex in chronic back pain and lumbosacral radiculopathy, *BMC Muscle Skeletal Disorders*, **4**: 11
- Robinson, C., Kett, N., Bolam, J. 1988. Spasticity in Spinal Cord injured patients: 2. Initial measures and long term effects of surface electrical stimulation. *Arch. Phys. Med. Rehabil.*, **69**: 862-8.
- Rothwell, J. 1994. Control of human voluntary movement, 2nd ed. London: Chapman & Hall.
- Vodovnik, L., Rebersek, S., Stefanovaska, A., Zidar, J. 1988. Electrical stimulation for the control of paralysis and therapy of abnormal movement. *Scand. J. Rehabil. Med.*, **17**: 91-7.
- Wang, R.Y., Chan, R.C., Tsai, M.W. 2000. Effect of thoraco-lumbas electric sensory stimulation on knee extensor spasticity of persons who survived cerebrovascular accident (CVA). *J. Rehabil. Res. Dev.*, **37**(1): 73-9.



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Motor Nerve Conduction Velocity of Sprinters & Long Distance Runners of Selected Nerves of both Upper and Lower Limbs

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Abstract

Background: The aim of this study was to describe motor nerve conduction velocity of selected nerves of both the upper and lower extremities in sportsmen. Thirty high-level sprinters (100mts & 200 mts) and thirty high level distance runners (3000mts) were volunteered to participate in the study. Method: Motor Nerve Conduction Velocities (MNCV) of Ulnar and Common Peroneal Nerve (CPN) were recorded with the help of computerized equipment -Neuroperfect (Medicaid Systems, India) with standard techniques of supramaximal percutaneous stimulation with constant current and surface electrodes. The anthropometric measurements taken were Body Height (cms), Age (yrs) and Body weight (kgs). The neurophysiological parameters taken were MNCV of Ulnar Nerve (upper extremity) and Common Peroneal Nerve (lower extremity) of both sides (i.e. dominant and non-dominant) of the body. The room temperature was maintained at 37 degree Celsius. Results: Significant differences in motor nerve conduction velocities were found between dominant and non-dominant limbs in each group. Ulnar nerve conduction velocity measured from above elbow to below elbow was significantly higher in the sprinters than long distance runners. The CPN nerve conduction velocity is significantly higher in distance runners as compared to sprinters. Conclusion: The motor nerve conduction velocity of ulnar nerve was found to be higher in sprinters as compared to the distance runners, and the MNCV for CPN is higher in distance runners as compared to sprinters. The MNCV of ulnar and CPN were higher in dominant limbs (i.e. arms & legs) of both sides of the body as compared to non dominant limbs.

Key words: Motor nerve conduction velocity, ulnar nerve, Common Peroneal Nerve

Introduction

The players are creating and breaking new records in today's competitive sports. Traditionally the motto of Olympic festival is faster, higher and stronger is still alive in the field of physical education and sports science. The level of physical fitness and motor ability is increasing day to day because of the development of science and technology.

The anthropometric and motor nerve conduction studies in sports are the measure of the analysis of relationship between anthropometric characteristics and neurophysiological functions. With the growth of athletic participation there has been a commensurate increase of sports-related neurological disorders. Prompt evaluation and treatment of the professional and recreational athletes enable an earlier return to competition (Payne and Morrow, 1993). Their technical advancement has developed

during the past 10years, and in addition to using the traditional anthropometric methods and the facilities to measure aerobic and anaerobic exercise performances as well as the exercise changes in neuro-physiological function has also witnessed progression. The modern coaching methods are prepared for the development of physical fitness, exercise neuro-physiological ability and sports anthropometrical assessments.

Most sports-related traumatic peripheral nerve injuries result in transient motor and sensory symptoms and motor nerve conduction studies can best evaluate and confirm the diagnosis and identification of the peripheral neurologic disorders. Absence of neurologic disorders may redirect the evaluation to alternative explanations for weakness or atrophy of the skeletal muscles (*Wilmore and Costil, 1994*).

Material and Methods

The study was conducted on a group of 60 male athletes comprised of 30 sprinters and 30 distance runners in the age range of 18 to 25 years. Each subject was screened for any sign or symptoms of either peripheral neuropathy or compression syndrome of both the extremities. Motor nerve conduction velocity (MNCV) of ulnar nerve (upper extremity) and Common Peroneal Nerve (lower extremity), was recorded by using computerized equipment -Neuroperfect (Medicaid Systems, India).

The anthropometric variables, including age (yrs), height (cm), weight (kg) were recorded for the study. Selected variables were expressed in mean and standard deviation (±SD) for comparison among sprinters (n=30), and distance runners (n=30), who underwent the same

testing procedures in the Exercise Science Laboratory of Department of Sports Science, Punjabi University Patiala.

The standard techniques of supramaximal stimulation with a constant current stimulator and surface electrode recording on both the upper and lower extremities of dominant and non dominant side of each subject i.e. right and left side, while the subject was lying in supine position was employed. The room temperature was kept at 37⁰C for all the subjects.

Results & Discussion

Table 1a: Mean ± SD of Anthropometric Variables and MNCV of Ulnar Nerve (Upper extremity) of Sprinters & Distance runners (N=30)

Anthropometric Variables					
Sprinters			Distance runners		
Age, yrs	Ht., cm	Wt., kg	Age, yr	Ht., cm	Wt., kg
23.0	170.3	72.6	24.06	170.1	72.63
7±1.7	±4.1	±7.4	±1.6	±4.1	±7.4

Table 1b: Mean ± SD of MNCV of Ulnar Nerve (Upper extremity) of Sprinters & Distance runners (N=30)

MNCV (m/sec)			
Upper Extremity (Sprinters)		Upper Extremity (Distance runners)	
Rt. Ulnar	Lt. Ulnar	Rt. Ulnar	Lt. Ulnar
47.95±12.3	43.89±5.7	42.26±7.17	41.4±7.4

In the present study, the mean age in case of sprinters is 23.07±1.77, the mean height is 170.3±4.1 & the mean weight is 72.6±7.4. For distance runners, the mean age is 24.06±1.6, the mean height is 170.1±4.1, the average weight (kg) is 72.63±7.4 respectively.

In neurophysiologic evaluation of upper extremities in sprinters, The MNCV of right ulnar is 47.95±12.39 m/s and the MNCV of left ulnar nerve is 43.89±5.7 m/s. In case of distance runners, the

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MNCV for right ulnar is 42.26±7.17 m/s, and the MNCV of left Ulnar nerve is 41.4±7.4 m/s. Thus, the value of MNCV of right & left ulnar nerve of sprinters in the present study is higher in sprinters as compared to the distance runners.

Table 2a: Mean ± SD of Anthropometric Variables of Right & Left CPN (Lower extremity) of Sprinters & Distance runners (N=30)

Anthropometric Variables					
Sprinters			Distance runners		
Age	Ht.	Wt.	Age	Ht.	Wt.
23.07±1.77	170.3±4.5	72.6±7.4	24.06±1.6	170.1±4.1	72.6±7.4

Table 2b: Mean ± SD of MNCV of Right & Left CPN (Lower extremity) of Sprinters & Distance runners (N=30)

MNCV (m/sec)			
Lower Extremity (Sprinters)		Lower Extremity (Distance runners)	
Rt. CPN	Lt. CPN	Rt. CPN	Lt. CPN
56.63±6.6	49.89±5.7	56.63±6.6	49.89±5.7

The results of the present study, the neurophysiological evaluation of lower extremity shows that the mean MNCV of right Common Peroneal Nerve (CPN) in Sprinters is 56.63±6.6m/s and the MNCV for left common peroneal nerve is 49.89±5.7 m/s respectively. In case of Distance runners, the MNCV of right CPN is 59.8±6.15 m/s and the MNCV of left CPN is 51.7±6.7 m/s, which are higher as compared to the MNCV of sprinters in lower extremities of both sides of the body. Thus, the value of MNCV of right common peroneal nerve (CPN) in the present study is higher in distance runners as compared to the sprinters.

Summary and Conclusions

In the present study, the mean MNCV of right Ulnar in sprinters is 47.95±12.3 m/s, and of left ulnar is

43.89±5.7 m/s and the MNCV of right common peroneal nerve (CPN) is 56.63±6.6 m/s and of left CPN is 49.89±5.7. Whereas, the MNCV of right ulnar in distance runners is 42.26±7.17 and for left Ulnar is 41.4±7.4 m/s, which is low as compared to MNCV of Ulnar nerve of sprinters on both sides of the body. Moreover, the MNCV of right CPN in distance runners is 59.8±6.15 m/s, and the MNCV of left CPN, is 51.7±6.7 m/s. whereas, the MNCV of sprinters for right CPN is 56.63±6.6 m/s, and MNCV of left CPN is 49.89±5.7 m/s. This is lower as compared to MNCV of right CPN & left CPN of distance runners of both sides of the body (right & left). It is also observed, that the MNCV in dominant limbs (Arms & Legs) was higher when compared with the non dominant limbs in both the groups i.e. Aerobic (distance runners) & Anaerobic (sprinters) groups. Thus the results of this study shows that a further research work will be needed to carry on a large number of subjects with additional nerves and variables of MNCV like Amplitude, latency etc. of extremities of both sides of the body of the subjects.

References

DeLisa, J.A., Mackenzie, K., Baran, E.M. 1994. Manual of Nerve Conduction Velocity and Clinical Neurophysiology. New York, NY: Raven Press.

Feinberg, J.H., Nadler, S.F., Krivickas, L.S. 1997. Peripheral nerve injuries in the athlete. *Sports Med.*, **24**: 385–408.

Payne, G., and Morrow, J. 1993. Exercise & VO2 max in children : A metaanalysis. *Medicine and Science in Sports and Exercise* **26**: 510-514.

Gilliatt, R.W. and Thomas, P.K. 1960. Changes in nerve conduction with ulnar lesions at the elbow. *J. Neurol. Neurosurg. Psychiat.* **23**: 312-320.

Hodes, R., Larrabee, M.G. and German, W. 1948. The human electromyogram in response to

- nerve stimulation and the conduction velocity of motor axons. *Arch. Neurol. Psychiat.* **60**: 240-365.
- Lenman J.A.R., Ritchie A.E. 1987. Clinical Electromyography. New York, NY: Churchill Livingstone,
- Rosenfalck, P., Rosenfalck, A. 1975. Electromyography-sensory and motor conduction. Findings in normal subjects. Lab of Clin Neurophysiology, Copenhagen. 1-49,
- Tasaki, I., Takeuchi, T. 1942. Weitere studien Uber den Aktionsstrom der markhaltigen Nervenfasern und uber die elektrosaltatorische Ubertragung des Nervenimpulses. *Pflug. Arch. Ges. Physiol.* **245**: 764-782,
- Treihaft Marc, M. 2000. Peripheral Nerve Disorders in Athletes. CNI (Colorado Neurological Institute) (online library), A Medical Review Journal, 11(1).
- Waxman, S.G. 1977. Conduction in myelinated, unmyelinated, and demyelinated fibers. *Arch. Neurol.* **34**: 585-589,
- Wilbourn, A.J. 1990. Electrodiagnostic testing of neurologic injuries in athletes. *Clin. Sports Med.*, **9**: 229-245.
- Wilmore, J.H. & Costill, D.L. 1994. Physiology of Sport and Exercise, Human Kinetics.



Relationship among HbA1c and Lipid Profile in Punjabi Type 2 Diabetic Population

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Abstract

This study was planned to evaluate the relationship among glycated haemoglobin (HbA1c) and lipid profile in type 2 diabetic males of Punjabi population. A total of 120 type 2 diabetics with an age ranged from 30 to 70 years volunteered to participate in this study. The glycated haemoglobin (HbA1c) & lipid profiles were recorded with standard procedure. The statistical analysis was done by using SPSS version 16.0. The mean HbA1c was $7.34 \pm 1.24\%$. There were 59% subjects with high total cholesterol (TC) levels and 98% were with raised LDL levels. The 65% of the subjects were having lower HDL level. HbA1c demonstrated significant positive relationship with total cholesterol, TC ($r=0.29$), triglyceride, TG ($r=0.26$), high density lipoprotein cholesterol, HDL-C ($r=0.19$) and with low density lipoprotein cholesterol, LDL-C ($r=0.5$). It was concluded from the results of this study that HbA1c can also be used as a predictor of dyslipidaemia in type 2 diabetics in addition to as a glycemic control parameter. Thus, early diagnosis of dyslipidaemia can be used as a preventive measure for the development of cardiovascular disease (CVD) in type 2 diabetics.

Keywords: Diabetes mellitus, Dyslipidemia, CVD.

Introduction:

The diabetes mellitus is becoming more and more prevalent in Indian society. In India, it is estimated that approximately 2% of the population, 15 million people have diabetes (Swami, 1984). The number of cases is said to be rising by 5%-6% each year and an estimated 300,000 people die from diabetes and its complication (Herman et al., 1984). There are about 3.5 crore diabetics in India and the figure will rise to about 5.2 crores by 2025. Every 5th patient visiting a consulting physician is a diabetic, and, every 7th patient visiting a family physician is a diabetic. Prevalence of diabetes is higher in Indian subcontinent & [H-it](#) is estimated that 20%

of global burden resides in South East Asia Region (SEAR) area, which will be tripled to 228 million by the year 2025 from the current 84 million (Park, 2007). Keeping in view the alarming increase in the incidence and prevalence of diabetics in India, WHO has declared India as the "Diabetic Capital of the World" (Gupta, 2002). Chronic hyperglycemia is associated with significant long-term complications, particularly damage to the nerves, heart, blood vessels, eyes and kidneys (Yki-Yarvinen, 1998). The abnormalities like insulin resistance, hyperinsulinemia, hyperglycemia, dyslipidemia, and hypertension in type 2 diabetics tend to cluster and are often referred to as the "metabolic syndrome (Grundy, 1998)." Elements of the

metabolic syndrome are strong risk factors for cardiovascular disease (Lamarche *et al.*, 1998 and Reaven & Law, 1994). An early intervention to normalize circulating lipids has been shown to reduce cardiovascular complications and mortality (Windler, 2005). The glycated haemoglobin (HbA1c) provides an index of a type 2 diabetics' average blood glucose level during the past 2–3 months and considered to be the most objective and reliable measure of long-term metabolic control of glucose (Nathan, 1984). American Diabetes Association (ADA) proposed the use of HbA1c in the definition of diabetes and the category of increased diabetes risk (which also includes impaired fasting glucose and impaired glucose tolerance) in 2010 (American Diabetes Association-*Diabetes Care*, 2010). Estimated risk of CVD has shown to be increased by 18% for each 1% increase in absolute HbA1c value in diabetic population (Selvin, 2004). Thus, the aim of this study was to observe the relationship among glycated haemoglobin (HbA1c) and lipid profile in male type 2 diabetics of Punjabi population.

Materials and methods

The present study was conducted on one hundred twenty type 2 diabetic male patients belong to Patiala district of Punjab after obtaining their informed written consent and selected them as subjects and their age ranged from 30-70 years. The study protocol was approved by the Ethics Committee of Punjabi University, Patiala. The Lipid Profile - total cholesterol (TC), high density lipoprotein (HDL), very low density lipoprotein (VLDL) & Triglycerides (TG)] of each subject was measured by using Erba Blood Analyzer. The low

density lipoprotein (LDL) was calculated by using Friedewald formula: LDL= TC – (TG/5) - HDL. The glycated haemoglobin (HbA1c) was estimated by appropriate standard kits. The data was analyzed with SPSS version 16.0. The mean, SD and correlation (Pearson's) test was used to interpret the results.

Results

The mean age, HbA1c, total cholesterol, triglycerides, high density lipoprotein, low density lipoprotein and very low density lipoprotein were 50.3± 11.8 years, 7.34±1.24%, 203.9 ±15.8 mg/dl, 151.1 ± 17.7 mg/dl, 37.7 ± 6.2 mg/dl, 124.4 ± 11.9 mg/dl and 32.3 ± 7.1 mg/dl respectively. According to NCEP-ATPIII guideline, hypercholesterolemia is defined as TC>200 mg/dl, high LDL-C when value >100 mg/dl, hypertriglyceridemia as TAG >150 mg/dl and low HDL-C when value <40 mg/dl. Dyslipidemia was defined by presence of one or more than one abnormal serum lipid concentration. Diabetes was defined as per American Diabetes Association (ADA) criteria. Results shows that 59% type 2 diabetics in this study had hypercholesterolemia, 53% Hypertriglyceridemia, 98% abnormal LDL levels and 65% of them the HDL was less than 40 mg/dl (Table 1).

Table 1: Mean ± SD of HbA1c & lipid profile of type 2 diabetics

Variables	Mean
Age (years)	50.3± 11.8
HbA1C (%)	7.34± 1.24
TC (mg/dl)	203.9±15.8
HDL (mg/dl)	37.7±6.2
LDL (mg/dl)	124.4±11.9
VLDL (mg/dl)	32.3±7.1
TG (mg/dl)	151.1±17.7

TC- total cholesterol, HDL- high density lipoproteins, LDL-low density lipoproteins, VLDL- very low density lipoproteins, TG- triglycerides

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Further, it was found that glycated haemoglobin (HbA1c) was positively and significantly related with total cholesterol (r=0.29), high density lipoproteins (r=0.19), triglycerides (r= 0.26) and very low density lipoproteins (r=0.16). However, low density lipoproteins (r=0.5) did not show any significant relationship with HbA1c.

Table 2. Correlation among HbA1c and lipid profile of type 2 diabetics

Variables	TC	HDL	LDL	VLDL	TG
HbA1C	.29**	.19**	.05	.16*	.26**
TC	-	.28**	.66**	.50**	.58**
HDL		-	.09	.20**	.44**
LDL			-	.39**	.32**
VLDL				-	.66**

**p<0.01; * p<0.05

HbA1c-glycated haemoglobin, TC- total cholesterol, HDL- high density lipoproteins, LDL-low density lipoproteins, VLDL- very low density lipoproteins, TG- triglycerides

Discussion

Results of this study show that the levels of LDL, HDL, TC and TG were significantly higher in type 2 diabetics. These findings were in agreement with the previous studies (Wexler et al., 2005). High prevalence of hypercholesterolemia, hypertriglyceridemia and high LDL and low HDL was found in type 2 diabetics in this study which are well known risk factors for cardiovascular diseases. Goldberg (1996) reported that the cause of dyslipidaemia in type 2 diabetes mellitus may be that insulin is not working properly which affects the liver apolipoprotein production. The apolipoprotein regulates the enzymatic activity of lipoprotein lipase (LpL) and Cholesterol ester transport protein

(Goldberg, 1996). A highly positive significant relationship of HbA1c with dyslipidemia was observed in the present study. Erciyas et al, (2004) also reported positive correlation of HbA1c level with TC and TG in diabetic patients. The Diabetes complications and control trial (DCCT) established HbA1c as the gold standard of glycemc control. The level of HbA1c value ≤7.0% was said to be appropriate for reducing the risk of cardiovascular complications. The diabetic patients with higher HbA1c value (value > 7.0%) can exhibit a significant increase in TC, LDL, TAG and HDL in comparison to patients with HbA1c value ≤7.0% (Rohlfing et al., 2002). Khan et al., (2007) also reported that severity of dyslipidaemia increases in patients with higher HbA1c value. As elevated HbA1c and dyslipidaemia are independent risk factors of CVD, diabetic patients with elevated HbA1c and dyslipidaemia can be considered as a very high risk group for CVD. Improving glycemc control can substantially reduce the risk of cardiovascular events in diabetics (Selvin et al, 2006). It has been reported that reducing the HbA1c level by 0.2% could lower the mortality by 10% (Khaw et al, 2001). Thus, the results of the present study suggest the importance of glycemc control in order to manage dyslipidaemia and risk for cardiovascular diseases in type 2 diabetics.

Conclusions

It was concluded from the results of this study that HbA1c can be used as a predictor of dyslipidaemia in type 2 diabetics in addition to as glycemc control parameter. Thus, early diagnosis of dyslipidaemia can be used as a preventive measure for the development

of cardiovascular disease (CVD) in type 2 diabetics.

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References

- American Diabetes Association. 2010. Diagnosis and classification of Diabetes Mellitus. *Diabetes Care* **33**: s6 2-s69.
- Erciyas, F., Taneli, F., Arslan, B., and Uslu, Y. 2004. Glycemic control, oxidative stress and lipid profile in children with type 1 Diabetes Mellitus. *Arch. Med. Res.* **35**: 134-140.
- Goldberg, I.J. 1996. Lipoprotein lipase and lipolysis: central roles in lipoprotein metabolism and atherogenesis. *J. Lipid Res.*, **37**: 693-707.
- Grundy, S.M. 1998. Multifactorial causation of obesity: implications for prevention. *Am J. Clin. Nutr.*, **67**: 563S-572S.
- Herman, W.H., Sinnock, P., Brenner, E., Brimberry, J.L., Langford, D., Nakashima, A., Sepe, S.J., Teutsch, S.M. and Mazze, R.S. 1984. An Epidemiologic model for diabetes mellitus: incidence, prevalence & mortality. *Diabetes Care* **7**: 367-371.
- Khan, H.A., Sobki, S.H. and Khan, S.A. 2007. Association between glycaemic control and serum lipids profile in type 2 diabetic patients: HbA1c predicts dyslipidaemia. *Clin. Exp. Med.*, **7**: 24-29.
- Khaw, K.T., Wareham, N., Luben, R., Bingham, S., Oakes, S., Welch, A., 2001. Glycated haemoglobin, diabetes, and mortality in men in Norfolk cohort of European Prospective Investigation of Cancer and Nutrition (EPIC-Norfolk). *Br. Med. J.* **322**: 15-18.
- Lamarche, B., Tchernof, A., Mauriege, P., Cantin, B., Dagenais, G.R., Despres, J.P. 1998. Fasting insulin and apolipoprotein B levels and low-density lipoprotein particle size as risk factors for ischemic heart disease. *JAMA.* **279**: 1955-1961.
- Nathan, D.M., Singer, D.E., Hurxthal, K., and Goodson, J.D. 1984. The clinical information value of the Glycosylated hemoglobin assay. *N. Engl. J. Med.* **310**: 341-346.
- Park K. 2007. *Park's Textbook of Preventive and Social Medicine*. 19th ed. Jabalpur: M/s Banarasidas Bhanot.
- Reaven, G.M. and Laws, A. 1994. Insulin resistance, compensatory hyperinsulinemia, and coronary heart disease. *Diabetologia.* **37**: 948-952.
- Rohlfing, C.L., Wiedmeyer, H.M., Little, R.R., England, J.D., Tennill, A. and Goldstein, D.E. 2002. Defining the relationship between plasma glucose and HbA1c: analysis of glucose profiles and HbA1c in the Diabetes Control and Complications trial. *Diabetes Care* **25**: 275-278.
- Selvin, E., Marinopoulos, S., Berkenblit, G., Rami, T., Brancati, F.L., Powe, N.R., 2004. Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. *Ann. Intern. Med.* **14**: 421-431.
- Selvin, E., Wattanakit, K., Steffes, M.W., Coresh, J. and Sharrett, A.R. 2006. HbA1c and peripheral arterial disease in diabetes: the Atherosclerosis Risk in Communities study. *Diabetes Care* **29**: 877-882.
- Swami Shankardevananda Saraswati. 1984. In: *Yogic management of asthma & diabetes*. Publisher: Bihar School of Yoga, Bihar, India
- Gupta, V 2002. Diabetes in Elderly Patients. *JK Practitioner*, **91**(4): 258-259.
- Wexler, D.J., Grant, R.W., Meigs, J.B., Nathan, D.M. and Cagliero, E. 2005. Sex disparities in treatment of cardiac risk factors in patients with type 2 diabetes. *Diabetes Care*, **28**: 514-520.
- Windler, E. 2005. What is the consequence of an abnormal lipid profile in patients with type 2 diabetes or the metabolic syndrome? *Atheroscler. Suppl* **6**: 11-14.
- Yki-Yarvinen, H. 1998. Toxicity of hyperglycaemia in type 2 diabetes. *Diabetes Metab Rev.* **14**(Suppl 1): S45-S50.



Impact of Sporting activities on Bone mineral density

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Abstract

It is known that participating in sports can have a beneficial effect on bone mass. However, it is not well established which type of sporting activity is more beneficial for increased bone mineral density. The objective of the study was to determine the relationship between impact of sporting activities and bone mineral density. As a part of study, bone mineral density of sportspersons was compared with age-matched non-sportspersons. Research design for present study was a cross-sectional design. A total of 70 subjects in the age group of 25-75 years participated in the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m²) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m²). Bone mineral density was measured by using Osteopro-ultrasound bone mineral density system. The results revealed statistically significant difference with t value of 4.2061 (**p<0.05**), indicating that sportspersons had higher bone mineral density than their non-sports cohort. A statistically significant positive relationship was exhibited (r = 0.463) between impact of sporting activities and bone mineral density which implies that sportspersons involved in high impact sports (basketball, football, and athletics) have greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). It is concluded that bone mineral density is higher in sportspersons than their non- sports cohort and sportspersons involved in high impact sports possess substantially higher bone mineral density than sportspersons involved in moderate impact sports.

Keywords: BMI, Bone Mineral Density, High Impact Activities, Low Impact Activities

Introduction

Bone mineral density is used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. There is a statistical association between poor bone density and higher probability of fracture. Fragility fractures, which result from a fall from no greater than standing height, are a significant public health problem leading to much medical cost, inability to live independently, and even risk of death. Bone density measurements are used to screen people for osteoporosis risk and to

identify those who might benefit from measures to improve bone strength. It is estimated that around 40% of US white women and 13% of US white men aged 50 years will experience at least one clinically apparent fragility fracture in their lifetime. At age 50, a white woman has a 17% chance of sustaining a hip fracture, 15% chance of vertebral fracture and 16% chance for forearm fracture, with comparable figures of 6%, 5% and 2.5% respectively, for fractures in white males (Cummings & Melton, 2002). The 1st year

total direct cost of osteoporotic fractures is estimated to be 25 billion Euros in Europe (Melton *et al*, 1992). The report of the European Commission (1998) estimates an increase in the incidence of hip fractures in Germany from 117,000 in the year 2000 to 240,000 in the year 2040 (Haussler *et al*, 2007). Thus, osteoporosis and osteoporotic fractures have become one of the major health problems in western countries (Kannus *et al*, 1999). Nevertheless, in Asia, Osteoporosis is greatly under-diagnosed and undertreated even in the most high risk patients who have already fractured. The problem is particularly acute in rural areas. In the most populous countries like China and India, the majority of the population lives in rural areas, where hip fractures are often treated conservatively at home instead of by surgical treatment in hospitals (International Osteoporosis Foundation, 2009).

In India, osteoporosis is highly prevalent, with an estimated 30 million women diagnosed to have osteoporosis (Shah & Savardekar, 2005). Expert groups peg the number of osteoporosis patients at approximately 26 million (2003 figures) with the numbers projected to increase to 36 million by 2013 (Osteoporosis Society of India, 2003). In a study among Indian women aged 30-60 years from low income groups, BMD at all the skeletal sites were much lower than the values reported from developed countries with a high prevalence of osteopenia (52%) and osteoporosis (29%) thought to be due to inadequate nutrition (Shatrugna *et al*, 2005). Thus, it is critically important to diagnose osteoporosis at the earliest. Currently, bone mineral density testing is the most objective method to diagnose osteoporosis in asymptomatic individuals (National

Osteoporosis Foundation, 1998). Because bone mineral density accounts for 70% of bone strength, low bone mineral density is the greatest predictor of risk for bone fractures (Follin & Hansen, 2003). Consequently, a better understanding of mechanisms leading to low bone mineral density is a crucial step in the identification of patients at risk of osteoporosis and for designing therapeutic and prevention programs. Bone mineral density peaks at 20-30 years of age in both women and men. Remodelling maintains bone mass and mechanical competence in the adult skeleton by replacing the damaged and degraded bone tissue with new tissue. With ageing and osteoporosis, however, the remodelling tends to remain uncoupled in that packets of bone removed during resorption are not completely replaced during bone formation, resulting in a net loss of bone (Suominen, 2004). Thus, bone is metabolically active tissue with continuous remodelling occurring throughout life. Accordingly, it is reasonable to believe that mechanical force exerted on skeleton is of critical importance to maintain and improve bone mineral density. Animal studies have demonstrated a significant relationship between mechanical loading and bone formation. In humans, physical exercise, especially weight bearing activity has been reported to have beneficial effects on the skeleton in both adolescent and the elderly (Scerpella *et al*, 2003). Bone mineral density has been demonstrated to be higher in male athletes than in less active individuals (Pettersson *et al*, 1999). Additionally, athletes especially those who are strength trained, generally have greater bone mineral density than non-athletes, and that maximum strength levels and muscle mass correlates with

bone mineral density (Chilibeck *et al*, 1999). A number of studies have demonstrated a beneficial effect of physical exercise and sport training on bone mineral density (Dalen & Olsson, 1971; Cooper *et al*, 1988; Snow *et al*, 1992; Yung *et al* 1994; Bennell *et al*, 1997; Blanchet *et al*, 2003).

Overall, these studies provide evidence that there is a protective effect of sporting activity on bone mineral density. However, whether there is a direct relationship between the impact of various sporting activities and bone mineral density is less clear. To examine this issue further, the present study was undertaken to investigate the relationship between sporting activity and bone mineral density. As a part of study bone mineral density of sportspersons was compared with age-matched non-sportspersons.

Material and Methods

Participants: This was a cross-sectional study, which was performed in the Department of Physiotherapy, Punjabi university, Patiala in accordance with ethical considerations of the Institute. A total of 70 subjects in the age group of 25-75 years participated in the study. Informed consent was taken from all the participants prior to the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m²) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m²). Males and females engaged in any sport were included in sportspersons group. Males and females less than 25 years and more than 75 years were excluded. Subjects with a previous history of bone disease, illness or drug use that could affect bone mass were excluded. All

the subjects underwent anthropometric measurement. The subject's vitals were examined and the detailed physical examination was done. The sportspersons were ranked from 1- 10 for moderate to high impact sports including table tennis, cycling, throwing, wrestling, badminton, gymnastics, athletics, handball, football and basketball respectively.

Bone mineral density: The subjects were then made to undergo, bone mineral density test. Bone mineral density was measured by using Osteopro - ultrasound bone mineral density system. The bone mineral density was measured in the form of T- score. The subjects were classified as normal if T-scores were ≥ -1 , osteopenic if the lowest T-score was between -1 and -2.5 and osteoporotic if either T-score was ≤ -2.5 .

Results

Table 1: Comparison of mean value for age, BMI and bone mineral density (BMD) between sportspersons and non-sportspersons

Variables	Sportspersons		Non-Sportspersons		T value	P value
	Mean	SD	Mean	SD		
Age (yrs)	48.05	15.23	48.14	14.71	0.02	P>0.05
BMI (Kg/m ²)	25.99	3.25	26.29	4.83	0.30	P>0.05
BMD (T-score)	-0.98	1.76	-2.56	1.36	4.21*	P<0.05

The data was analyzed with the help of SPSS 13 software. Initially mean and standard deviation were calculated of both sportspersons and non- sportspersons. Later on, unpaired t test was used to analyze the significant difference of variables between sportspersons and non-sportspersons. Pearson correlation was applied to establish the relationship between the impact of various sporting activities and bone mineral density. Significance level was set at 0.05. Table 1

describes, the Mean values and T values of Age, BMI and Bone mineral density (BMD) for the sportspersons and non-sportspersons. The t value of Age, BMI and BMD is 0.24, 0.30 and 4.21 respectively, which is statistically significant for bone mineral density (BMD) and non-significant for Age and BMI indicating that two groups are homogenous and bone mineral density of sportspersons is more than non-sportspersons.

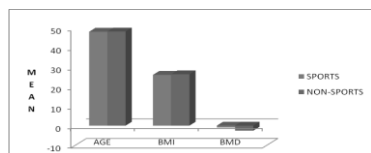


Figure 1: Comparison of mean value for Age, BMI and Bone mineral density (BMD) between sportspersons and non-sportspersons

Table 2: Description of the Mean and SD of bone mineral density for different sporting activities

Name of Sporting Activity	Bone Mineral Density (T-SCORE)	
	MEAN	SD
Table tennis	-2.373	0.546
Cycling	-2.473	1.67
Throwing	-2.03	1.668
Wrestling	0.515	0.219
Badminton	-0.72	1.33
Gymnastics	0.075	1.378
Athletics	0.078	2.105
Handball	-1.123	0.779
Football	-1.295	0.799
Basketball	0.232	2.014

Table 3 describes, about the correlation of impact of sporting activities with BMD. The correlation (r) of impact of sports with BMD is 0.463 which is statistically significant indicating that with an increase in impact of sporting activities, there is an increase in bone mineral density.

Table 3: Correlation of Bone mineral density (BMD) with impact of sporting activities

Variable	Pearson Correlation	N	Sig.
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BMD Vs Impact of sporting activities	0.463	35	P < 0.05
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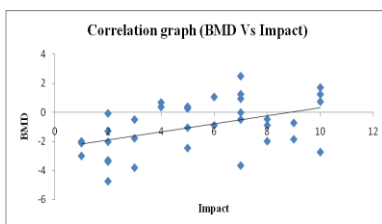


Figure 2: Correlation graph of Bone mineral density (BMD) Vs impact of sport

Discussion and Conclusion

Bone mineral density is the amount of mineral per square centimeter of bones, used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. The primary intent of the present study was to evaluate the impact of sporting activities on bone mineral density. To achieve this objective, the research work was carried out in two phases:

Phase I: Comparative study in which, bone mineral density of sportspersons was compared with that of non- sportspersons and

Phase II: Correlational study in which the relationship between the impact of different sporting activities and bone mineral density was investigated amongst sportspersons.

The results of the comparative study revealed statistically significant difference in the mean values of bone mineral density between sportspersons and non- sportspersons with t value 4.2061, indicating that sportspersons had significantly greater bone mineral density than their non-sports cohort. It is imperative here to mention that the difference in mean values of age and body

mass index between sportspersons and non-sportspersons was found to be statistically non-significant (t value=0.0240 and 0.3043 respectively), suggesting that the two groups in the present study, were homogenous in terms of age and body mass. These findings further suggest that sporting activity is a reasonable indicator of bone mineral density and may exert its effects independently of age and body mass.

Thus, findings of present study were suggestive of higher bone mineral density and therefore better bone strength in sportspersons when compared with age matched non-sportspersons. This is well in line with the study done by *Andreoli et al. (2001)* who stated that the athletes had significantly greater bone mineral density than the non-athletes of similar age. It appears that mechanical stress in the form of sporting activity may be a major factor in bone mineralization, though the physiological mechanisms involved in the response of bone cells to mechanical stress are still unclear. A possible explanation may be that osteocytes, acting as mechanoreceptors, respond and release chemical factor capable for promoting osteoblast proliferation at the local bone site. Thus, increased mechanical load is a contributory mechanism in sportspersons. However, it is possible that these beneficial effects of sporting activities on bone mineral density are impact reliant. Because the present study has demonstrated a significant relationship ($r = 0.463$) between impact of sporting activity and bone mineral density, indicating that with an increase in impact of sport, there is an increase in bone mineral density. The sportspersons included in the present study were athletes, throwers, wrestlers, gymnasts,

cyclists, basketball, football, handball, badminton and table tennis players. With all of them being the national level players, it was observed that athletes involved in high impact sports (basketball, football, and athletics) had greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). These findings suggest that sporting activities having higher impact and produce greater effects on bone remodelling than sporting activities with lower or moderate impact. This may be because of the application of strain magnitudes and rates of force development closer to the optimum for stimulating bone remodelling.

These findings of the present study support the previous reports of the positive effects of high impact activities on bone mineral density. The study done by *Block et al (1989)* has reported that weight bearing forms of vigorous exercise are associated with greater levels of bone mineral density. Another study done by *Lanyon et al (1989)* stated that physical activity involving high impact or weight bearing movements provides an osteogenic stimulus that may enhance bone mass at any age. *Heinonen et al (1993)* reported that the form of exercise has been shown to affect bone mineral density since weight bearing activities are associated with higher BMD while non-weight bearing exercises such as cycling and swimming do not seem to increase bone mineral density in young adults. *Barlet et al (1995)* have demonstrated the importance of weight bearing physical activity as well as mechanical loading for maintaining skeletal integrity. *Fehling et al (1995)* also demonstrated that a group of athletes who is engaged in a sport that loads the skeletal system with high

magnitude, short duration stimuli had greater BMD than athletes who participated in a sport that actively taxes their muscular system, but does not evoke ground reaction forces, suggesting that the type of mechanical loading regimen plays an integral part in influencing bone mineral density. Klesges et al., (1996) has also shown that training using loaded weight bearing exercises causes significant higher bone mineral density. Regular exercise, especially resistance and high impact activities, contributes to development of high peak bone mass and may reduce risk of falls and osteoporotic fracture in later life (Wallace & Ballard, 2000). It has been widely accepted that engaging in weight bearing activity can elicit significant positive bone mass adaptation (Blanchet et al., 2003).

On the whole, these studies, done over the period of last three decades, suggest that impact of physical exercise and sport training is an important factor in the acceleration and maintenance of bone mineral density. The present study has also demonstrated a significant correlation between the impact of sporting activity and bone mineral density. Furthermore, the study has revealed an osteogenic effect of sporting activity that is independent of age and body mass of an individual. In conclusion, present study analysis reveals that sporting activity has a positive effect on bone status and such a positive effect is increased by the higher impact of sporting activity that involves weight bearing loading. This implies that age-related loss in bone mineral density is preventable by the appropriate exercise program that includes increased mechanical loading with sporting activity of higher impact. Clinically, this information is important, as it can be utilized while designing preventive and

treatment plans for osteopenic and osteoporotic individuals respectively.

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References

- Andreoli, A., Monteleone, M., Loan, M. V., Promenzio, L., Tarantino, U., Lorenzo, A. 2001. Effects of different sports on BMD and muscle mass in highly trained athletes. *Official Journal of the American College of Sports Medicine*; **33**: 507-511.
- Barlet, J. P., Coxam, V., Davicco, M. J. 1995. Physical Exercise and the Skeleton. *Arch. Physiology Biochem*; 103:681– 698.
- Bennell, K. L., Malcolm, S. A., Kham, K. M. 1997. Bone mass and bone turnover in power athletes, endurance athletes, and controls: a 12-month longitudinal study. *J. Bone*, **20**: 477– 484
- Blanchet, C., Turcot-Lemay, L., Dumont, M. 2003. Leisure physical activity is associated with quantitative ultrasound measurements independently of bone mineral density in postmenopausal women. *Calcification Tissue International*, **73**: 339–49.
- Block, J.E., Friedlander A, Brooks G A, Steiger P, Stubbs H A, Genant H K. 1989. Determinants of Bone Density among Athletes Engaged In Weight-Bearing and Non-Weight-Bearing Activity. *J. Appl. Physiol.*, **67**: 1100 –1105.
- Chilibeck, P. D., Sale, J. T., Webber, J. C. 1999. Exercise and bone mineral density. *J. Sports Med.*, **19**: 103
- Cooper, C., Barker, D. P., Wickham, C. 1988. Physical activity, muscle strength and calcium intake in fracture of the proximal femur in Britain. *Brit. Med. J.*, **297**: 1433-46.
- Cummings, S. R., Melton, L. J. 2002. Epidemiology and outcomes of osteoporotic fractures. *Lancet*, **359**: 1761.
- Dalen, N., Olsson, K. E. 1971. Bone mineral content and physical activity. *Acta. Orthop. Scand.*, **45**: 170-174.
- Fehling, P. C., Alekel, L., Clasey, J., Rector, A., Stillman, R. A. 1995. Comparison of Bone

- Mineral Densities among Female. Athletes in Impact Loading and Active Loading Sports. *J. Bone*, **17**: 205-210.
- Follin, S. L., Hansen, L. B. 2003. Current approaches to the prevention and treatment of postmenopausal osteoporosis. *Am. J. Health Syst. Pharm.*, **60(9)**: 883-901; quiz 903-4
- Haussler, B., Gothe, H., Gol, D. 2007. Epidemiology, treatment and costs of osteoporosis in Germany-the Bone EVA Study. *Osteoporos Int.*; 18:77.
- Heinonen, A, Oja, P, Kannus, P, SievPnen, H., MHnttli, A., Vuoti. 1993. Bone mineral density of female athletes in different sports. *J. Bone Min.*, **23**: 1-14
- International Osteoporosis Foundation. 2009. The Asian Audit: Epidemiology, costs and burden of osteoporosis in Asia
- Kannus, P., Niemi, S., Parkkari, J., Palvanen, M., Vuori, I., Jarvinen, M. 1999. Hip fractures in Finland between 1970 and 1997 and predictions for the future. *J. Bone Min. Res.*, **353**: 802–805.
- Klesges, R. C., Ward, K. D., Shelton, M. L. 1996. Changes in bone mineral density in male athletes. Mechanism of action and intervention effects. *JAMA*, **17**: 226-30.
- Lanyon, L. E. 1989. The success and failure of the adaptive response to functional load-bearing in averting bone fracture. *J. Bone*, **13**: 17-21
- Melton, L. J., Chrischilles, E. A., Couper, C., Lane, A. W., Riggs, B. L. 1992. Perspective - How many women have osteoporosis? *J. of Bone Metab. Res.*, **9**: 1005-10.
- National Osteoporosis Foundation. Osteoporosis: 1998. Review of the evidence for prevention, diagnosis and treatment and cost-effective analysis. *Osteop. Int.*, **8(4)**: S1-S88.
- Osteoporosis Society of India. 2003. Action Plan Osteoporosis: Consensus statement of an expert group. New Delhi.
- Petterson U, Nordstrom P, Lorentzon R. 1999. A Comparison of Bone Mineral Density And Muscle Strength In Young Male Adults With Different Exercise Level. *Calcif. Tissue International*, **64**: 490–498.
- Scerpella, T. A., Davenport, M., Morganti, C. M. 2003. Dose related association of impact activity and bone mineral density in pre-pubertal girls. *Calcification Tissue Int.*, **72(1)**: 24–31.
- Shah, R. S., Savardekar, L. S. 2005. Post menopausal osteoporosis in India: Growing public Health concern. Symposium, Forum 9, Mumbai India 12-6.
- Shatrugna, V., Kulkarni, B., Kumar, P. A. 2005. Bone status of Indian women from a low-income group and its relationship to the nutritional status. *Osteop. Int.*, **16**: 1827.
- Snow, H. C., Whalen, R., Myburgh, K. L., Arnaud, S., Marcu, R. 1992. Bone mineral density, muscle strength, and recreational exercise in men. *J. Bone Min. Res.*, 1291-1296
- Suominen, H. 2004. Strength training for osteoporosis. Book of abstracts, 4th international conference on strength training. Aristotle University of Thessaloniki; 23-26.
- Wallace, L. S., Ballard, J. E. 2000. Osteoporosis coverage in selected women's magazines and newspapers. *J. Bone Miner. Res.*, **17**: 359-364.
- Yung, P. S., Lai, Y. M., Tung, P. M., Tsui, H. T., Wong, C. K., Hung, K. L., Qin, L. 2005. Effects of weight bearing and non-weight bearing exercises on bone properties using calcaneal quantitative ultrasound. *Brit. J. Sports Med.*, **39**: 547–551.



Maxillary Left Lateral Incisor Fracture with Pulpal Involvement - A Case Report

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Abstract

Vigorous physical activities as well as competitive athletics offer sports men and women a variety of healthful benefits. However, participating in such activities also places athletes at risk for injury, including trauma to the teeth and mouth. These injuries are most often due to direct hits with a ball or player-to-player contacts. The goal of present paper discusses a case of a 17 year old hockey player who met with a sports injury and reported to the dental clinic with the chief complaint of broken upper front teeth. The paper discusses various treatment options available for different types of fractures to the teeth. Simple fracture involving enamel/dentin requires composite build ups but complex fractures involving pulp and extensive loss of tooth structure requires root canal treatment followed by post and core and crowning of the fractured tooth with porcelain fused to metal.

KEYWORDS: Post and core, Root Canal, Crown

Introduction

A good athlete will devote endless hours to help him perform at the highest level possible. Strength, fitness, flexibility & endurance are crucial to their specific sport. All the systems of body are brought to their peak levels and this involves the assistance of coaches, trainers, physicians, nutritionists and other health care professionals. The most neglected area is dental health. These athletes represent the highest level of physical development but their dental health is either at or below average level of the general population. There are many reasons for this. The financial costs of proper dental care are not a priority within the athlete's limited budget. Secondly, athletes have not been educated in this regard that is about importance of good dental health to their performance.

The most serious problem arises when an athlete is unable to perform due to pain or swelling from

dental crises. Even if they are not forced to withdraw, the trauma of an unexpected dental problem can severely affect the level at which athlete is able to train or compete. Valuable time is lost when dental injury occurs.

Dental injuries are a major problem for players from the pain stand point, esthetic standpoint and economics stand point *Andreasen et al (1994)*. Depending on the extent and the types of injury, some injuries can be managed at the sporting event site, with the athlete resuming play immediately. Other injuries may demand transfer to an urgent care setting and management by a specialist. Proper initial assessment and management of injuries may prevent unfavorable long-term results and permanent facial deformities. The ultimate goals are for the athletes to recover functionally and aesthetically from the facial injury and to return to competition in a timely manner *Ranalli (2002)*. Dental injuries are common incidents and timely and suitable

management of these occurrences is crucial for the prospects of the involved tooth. Although different entities require different treatment approaches, it is paramount to determine the time frame of the incident, the vitality of the affected tooth, as well as set up a proper follow up scenario.

Case Report

A 17 year old athletic player reported to the clinics of Dr.H.S.Judge Institute of Dental Sciences Panjab Univeresity Chandigarh with a chief complaint of broken upper front teeth while playing hockey. Clinical and radiographic examinations were conducted. Clinical examination revealed fracture in the middle third of the crown of the maxillary left lateral incisor, exposing the pulp along with incisal fracture of maxillary right and left central incisor (Figure 1). There was no mobility or displacement. The remaining maxillary and mandibular anterior teeth were intact. Periapical radiograph was taken which confirmed pulpal involvement of maxillary left lateral incisor where as there was enamel /dentin fracture of left and right central incisors with no pulpal involvement. (Figure 2)

Treatment plan was divided into two parts

(1) Treatment for left and right central incisor with enamel /dentin fracture:

(2) Treatment for left lateral incisor with enamel/dentin /pulp fracture

(1) The treatment plan for left and right central incisors with enamel/dentin fracture was done by restoring them with composite restorations. Prior to giving composite restoration shade selection was done for better results. Shade guides was

used under proper natural light. The fractured surfaces of the tooth were prepared. Under rubber dam isolation etchant (phosphoric acid) was applied to the fractured surfaces for 15 seconds, washed, dried, and then bonding agent was applied. The restorative procedure was finished by incremental build up of composite. Finally the composite restoration was polished with composite polishing kit. (Figure 6)

(2) The treatment plan for left lateral incisor with pulal involvement was divided into

Step 1- endodontic phase

Step 2- adjustment of the post.

Step -3: Crown cutting of the restored tooth

Step 1: The Endodontic Phase

An infraorbital block was administered for left maxillary lateral incisor. The pulp chamber was opened using no.330 round carbide steel bur & working length determination IOPA was taken with a no. 10 K-file (Figure 3) .The pulp tissue was extirpated using no.10 – no.60 K-files. After irrigation with copious amounts of 2.5% NaOCl & Normal Saline, the root canal was dried using paper points. A thin mix of Zinc oxide eugenol paste was mixed and G.P points were coated with Zinc oxide eugenol paste and filled in the canal (Figure 4).

Step -2: Adjustment of post

The post space was prepared 1 week after the endodontic treatment was completed. The post space was created by

removing approximately 4mm of gutta percha points using gutta percha solvent. A prefabricated post was taken and inserted into the canal space to check for its proper adaptation. A periapical radiograph was taken which ensured that there was a minimum of 4 mm of gutta percha left in place to protect the apical seal and there was no gap between the post and the filling beneath. (Figure 5)

A total etch technique was used to bond the post and core. The prepared post space was then cleaned with saline, air-dried & acid – etched with 37% phosphoric acid for 15 seconds. This space was rinsed and air dried with oil-free compressed air. A light cured bonding agent was brushed on the etched surface & uniformly dispersed by a compressed air blast. It was then light cured with for 20 seconds. The prefabricated post was then cured for 20 seconds in order to gain rigidity, before insertion into the post space. Light cured flowable composite resin was then inserted into the canal chamber after which the post was inserted. The post & composite were then cured together for 60 seconds.

The coronal enamel was then etched for 20 seconds, rinsed with water & air dried followed by application of bonding agent – which was then light cured. The coronal post was then covered with the flowable composite for core build –up, followed by light curing it for 60 seconds and finally teeth were restored with hybrid composite. The final finishing & polishing was done with finishing burs. Occlusal interferences in normal & paranormal mandibular movements were removed.

Step -3: Crown cutting of the restored tooth

After root canal treatment and post adjustment of the fractured tooth, crown cutting of the teeth was done as shown in (Figure 5). After the crown cutting impression was taken and sent to the lab for the processing of Porcelain fused to metal crown. The crown was fixed with the help of luting cement i.e GIC TYPE I as shown in the (Figure 6).



Figure 1: fracture in the middle third of maxillary left lateral incisor along with incisal fracture of maxillary right and left central incisor



Figure 2: Periapical radiograph showing pulp involvement of maxillary left lateral incisor where as enamel /dentin fracture of left and right central incisors with no pulp involvement



Figure 3: Working length X-ray of left lateral incisor taken



FIGURE 4: IOPA showing obturation of left lateral incisor



FIGURE 5: IOPA showing prefabricated post adjustment



FIGURE 6: Final photograph of the patient with composite build ups in left and right central incisor and crown placement in left lateral incisor

Discussion

The paper discusses various treatment options available for different types of fractures to the teeth. Simple fracture involving enamel/dentin requires composite build ups but complex fractures involving pulp and extensive loss of tooth structure requires root canal treatment followed by post and core and crowning of the fractured tooth with porcelain fused to metal.

When there is severe loss of coronal tooth structure, the use of posts placed inside the canal after endodontic treatment will give retention, provide stability to the reconstructed crown, and withstand masticatory forces in function *Mouradian (2001)*.

The objective of a post and core buildup is primarily to replace missing coronal tooth structure sufficiently to provide adequate retention and resistance for the crown that will eventually restore the function and esthetics of the tooth *Freedman (2002)*. There are a variety of root posts used in dentistry A resin composite post building up directly, resin composite short post placement, alpha or omega shaped orthodontic wires, stainless steel pre fabricated posts, nickel-chromium cast posts with macro retentive elements, natural teeth from a tooth bank or reinforced fibers. Prefabricated posts are fast, cheap and easy to use; therefore they are the most widely used posts in the dental clinics.

Hence, this paper helps to develop dental trauma management awareness in sportspersons which can help deal with everyday teeth trauma in most appropriate way

Conclusion

In conclusion, the study discusses various treatment options available for different types of fractures to the teeth. The paper also enlightens the sportsperson to deal with dental trauma met by them while playing games.

References

Andreasen, J.O., Andreasen, F.M. Sjöström, O., Eriksson, B. (eds) 1994. Textbook and color atlas of traumatic injuries to the

teeth 3rd edition Copenhagen: Munksgaard

Ranalli, D.N. 2002. Sports dentistry and dental traumatology. *Dental Traumat.*, **18**(5): 231-236.

Mouradian, W.E. 2001. The face of a child: children's oral health and dental education. *J. Dent. Educ.*, **65**: 821-31.

Freedman, G. 2002. A look at post and cores. *Dent Today*, **7**: 118-119



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Journal Article in press:

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Thesis:

Özyener, F. 2000. *Effects of work intensity on dynamics of pulmonary gas exchange during exercise in humans*. Doctoral thesis, University of London, London. 79.

Thesis not in English:

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