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To compare the effect of pulsed electromagnetic field therapy vs. transcutaneous electrical stimulation to reduce pain, disability and increase Range of motion in knee osteoarthritis.

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ABSTRACT: Osteoarthritis is a dynamic but gradual, non-inflammatory, degenerative disease of cartilage and other joint tissue, particularly in the aged, interspersed with inflammatory phases. Pulsed Electromagnetic Field Therapy is the devices that utilize PEMF technology emit electromagnetic waves at different frequencies in order to stimulate and encourage your body's natural recovery process. Methods- Patients were divided into three groups, Group A (20 participants), Group B (20 participants) and Group C (20 participants). Group A patients were treated with Pulsed Electromagnetic Field Therapy and therapeutic exercise program, Group B 20 patients were treated with Transcutaneous Electrical Nerve Stimulation and therapeutic exercise program. Group C (Control Group) 20 patients were treated only with therapeutic exercise program. We measured the range of motion, pain and disability of knee at 0 day, 2^{nd} week and 4^{th} week. At the end of 4^{th} week analysis was done using paired and unpaired t-test and significant results were found. Result-The groups showed significant difference and improvement after treatment. However, greater magnitude of %improvement was observed in Group A than Group B. Conclusion- Pulsed Electromagnetic Field Therapy and therapeutic exercise program was significantly effective in improving pain, disability and range of motion in osteoarthritis patients.

KEYWORDS: Osteoarthritis, pulsed electromagnetic field therapy, TENS, WOMAC, VAS, Active ROM.

I. INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis and one of the leading causes of disability. This degenerative and progressive joint disease affects around 250 million people worldwide. Osteoarthritis is a degenerative disorder of synovial joints characterized by focal loss of articular cartilage with reactive changes in the subchondral and marginal bone, synovium, and para-articular structures. (Scott et al. 2010). Osteoarthritis is a disease which commonly affects the knee, often resulting in pain and disability. Lifetime risk of developing symptomatic knee osteoarthritis is as high as 45%, and although risk factors such as aging, obesity, and female gender are linked to an increased likelihood of developing knee osteoarthritis, the etiology is not entirely clear. (Murphy et al.2008).

OA is classified into two groups according to its etiology: primary (idiopathic or non-traumatic) and secondary (usually due to trauma or mechanical misalignment). The severity of the disease can also be graded according to the radio graphical findings by the Kellgren–Lawrence (KL) system described in 1957. and later accepted by WHO in 1961. Grade 0- no radiographic features of OA. Grade 1- Doubtful joint space narrowing and possible osteophytes lipping. Grades 2- Definite osteophytes and possible osteophytes and possible joint space narrowing on anterior-posterior weight bearing radiograph. Grade 3-Multiple osteophytes, definite joint space narrowing, sclerosis, possible bony deformity. Grade 4-Large osteophytes, marked joint space narrowing, severe sclerosis and definite bony deformity.

Conservative treatment includes various exercise methods and physical therapy modalities such as hot-therapy, Transcutaneous electrical nerve stimulation (TENS), Ultrasound (US), Acupuncture and Laser (Light amplification by stimulated emission of radiations). Exercise programs consist of active and passive ROM exercises, stretching exercises guided by a physiotherapy, self-stretching, manipulation and mobilisation techniques, strengthening exercises, patient education and home exercises. By applying appropriate treatment techniques in a creative and judicious manner, the physical therapist can do much to enhance the speed and degree of recovery from osteoarthritis. More controlled studies, however, are needed comparing the combined effects of different forms of treatment.

Pulsed Electromagnetic Field Therapy is the device that utilize PEMF technology emit electromagnetic waves at different frequencies in order to stimulate and encourage your body's natural recovery process. When cells become distressed from disease, trauma or toxins, they lose their ability to function efficiently. PEMF restores the positive and negative charges in the cell, enabling it to perform its natural function while speeding tissue. Pulsed electromagnetic fields (PEMFs) have received attention for the treatment of early OA. In vitro and in vivo studies have demonstrated that PEMFs have the ability to influence cartilage metabolism through pro-anabolic and anti-catabolic activities. It has been proven to be a successful method in fracture healing (non-union and delayed union), being placed almost at par with surgically invasive methods but with considerably less risk and cost. The term PEMF is restricted to time-varying magnetic field characteristics that induce voltage waveform patterns in the tissue it is supplied to, and these waveforms are similar to those resulting from dynamic mechanical deformation. Physical stress on bone causes the appearance of tiny currents (piezoelectric potentials) that are believed to promote tissue formation. These potentials occur due to movement of fluid containing electrolytes in channels of the bone containing organic constituents with fixed charges, generating "streaming potentials." Transcutaneous electrical nerve stimulation is the application of low frequency current in the form of pulsed rectangular current through surface electrodes. Transcutaneous electrical nerve stimulation is usually employed for pain relief. Transcutaneous electrical nerve stimulation is mostly applied as short pulses of around 50micro seconds at 40-150 Hertz, called as conventional transcutaneous electrical nerve stimulation, and is a high frequency, low intensity stimulation. These low intensity short pulses were used selectively to stimulate the large low threshold A Beta fibres and produce pain inhibition by pain gate mechanism, as proposed by Melzac and Wall, 1965.

Thus this study very much needed and it aimed to compare the efficacy of pulse electromagnetic field therapy and transcutaneous electrical nerve stimulation to reduce the pain and disability and to improve the ROM of the knee in patients with osteoarthritis.

II. MATERIALS AND METHOD

Patients were taken from the OPD of Dasmesh college of physiotherapy Faridkot and written informed consent was received from all patients enrolled in the study. Sixty patients between the ages 40 to 55 years were included, according to inclusion criteria i.e. 1.Subjects with symptomatic and radiological evidence of grade 2 or 3 knee osteoarthritis. 2. Subjects should have anterior knee pain and to some extent generalized knee pain and have difficulty in walking, using steps and stairs. 3. crepitus.

The patients were included in the 3 groups namely; Group A, Group B and Group C using simple random sampling method. The inclusion and exclusion criteria were strictly followed while enrolling the patients in the study group. The patient's demographic profile and detailed medical history was taken through individual interviewing.

PROCEDURE:

Group A: 20 patients with knee osteoarthritis were treated with pulsed electromagnetic field therapy and therapeutic exercise program. Pulsed Electromagnetic Field Therapy for 15 minutes at 50 Hz frequency twice a day. PEMF(Pulsed Electromagnetic Field Therapy) was delivered by OMI ring. The ring was placed around the knee.

Group B: 20 patients with knee osteoarthritis were treated with transcutaneous electrical nerve stimulation and therapeutic exercise program. The Transcutaneous electrical nerve stimulation was given using a frequency of 100 Hz, pulse width of 50 µs, intensity (mA) with two channels and four square, percutaneous electrodes set at the individual subject's sensorial threshold and a length of application of 20 minutes. The percutaneous electrodes for the electrical stimulation will place on the anterior, medial and lateral portions of the knee.

Group C: 20 patients with knee osteoarthritis were given therapeutic exercises program only same as in group A and B.

OUTCOME MEASURES:

Patients were assessed at baseline, 2nd week and 4th week by:

- Assessment of knee pain using Visual analog scale (VAS)
- Assessment of knee disability using Western Ontario and McMaster universities arthritis index (WOMAC) scale
- A standard plastic goniometer was used to measure Knee Range of Motion.

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III. RESULTS

STATISTICAL ANALYSIS:

The data was described as mean and standard deviation, for normally distributed data. Paired t test was used to compare between variables within each group, while student unpaired t test was used to compare between three groups. The p value was set at level less than 0.05.

GROUP A

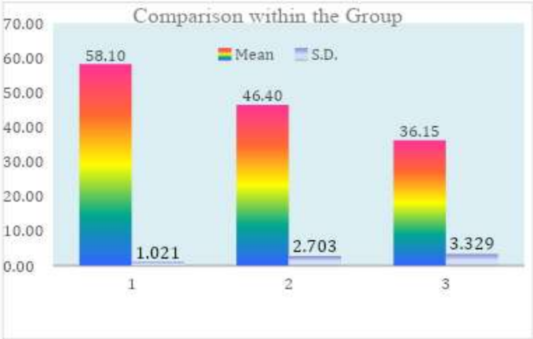

Table 1.1 shows Comparison of Pre intervention and Post Intervention values of WOMAC Scale within group A. Where Pre-interventions Mean ±SD of WOMAC Scale was 58.10±1.021 and that of Post-intervention was 36.15±3.329. The value of F Test as calculated was 741.510 which was statistically significant, at P<0.05.

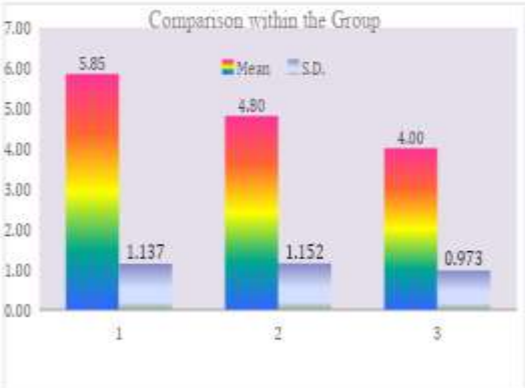

Table 1.2 shows Comparison of Pre intervention and Post Intervention values of Visual Analogue Scale within group A. Where Pre-interventions Mean ±SD of Visual Analogue Scale was 5.85±1.137 and that of Post-intervention was 4±0.973. The value of F Test as calculated was 104.960 which was statistically significant, at P<0.05.

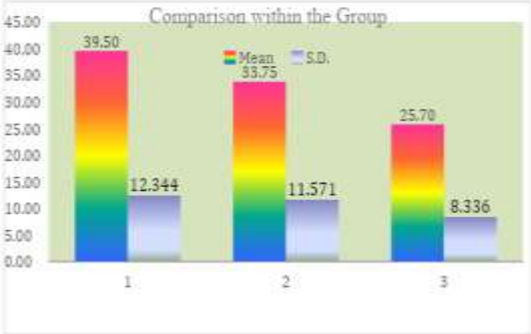

Table 1.3 shows Comparison of Pre intervention and Post Intervention values of Knee Range of Motion within group A. Where Pre-interventions Mean ±SD of Knee Range of motion was 39.50±12.344 and that of Post-intervention was 25.70±8.336. The value of F Test as calculated was 93.330 which was statistically significant, at P<0.05.

GROUP B

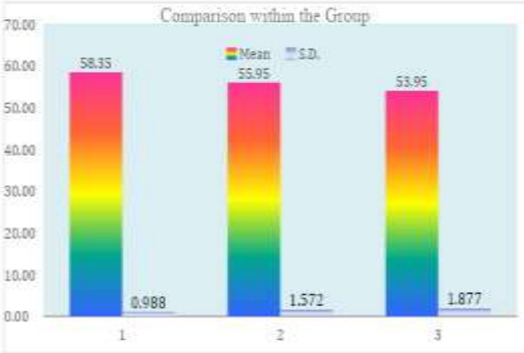

Table 2.1 shows Comparison of Pre intervention and Post Intervention values of WOMAC Scale within group B. Where Pre-interventions Mean ±SD of WOMAC Scale was 58.35±0.988 and that of Post-intervention was 53.95±1.877. The value of F Test as calculated was 123.500 which was statistically significant, at P<0.05.

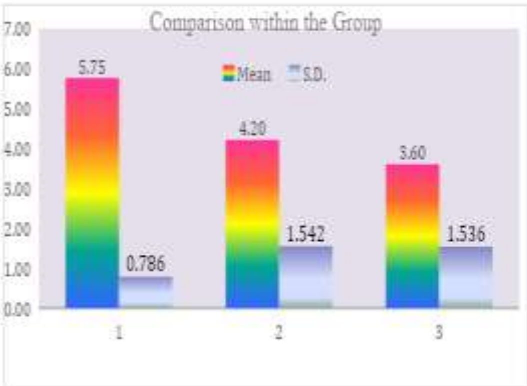

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Table 2.2 shows Comparison of Pre intervention and Post Intervention values of Visual Analogue Scale within group B. Where Pre-interventions Mean ±SD of Visual Analogue Scale was 5.75± 0.786 and that of Post-intervention was 3.60±1.536. The value of F Test as calculated was 31.080 which was statistically significant, at P<0.05.

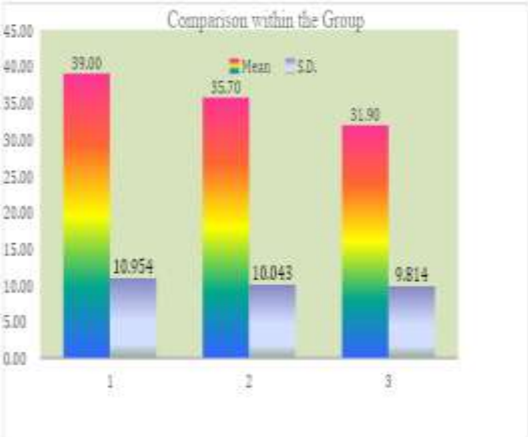

Table 2.3 shows Comparison of Pre intervention and Post Intervention values of Knee Range of Motion within group B. Where Pre-interventions Mean ±SD of Knee Range of motion was 39.00±10.954 and that of Post-intervention was 31.90±9.814. The value of F Test as calculated was 39.690 which was statistically significant, at P<0.05.

GROUP C

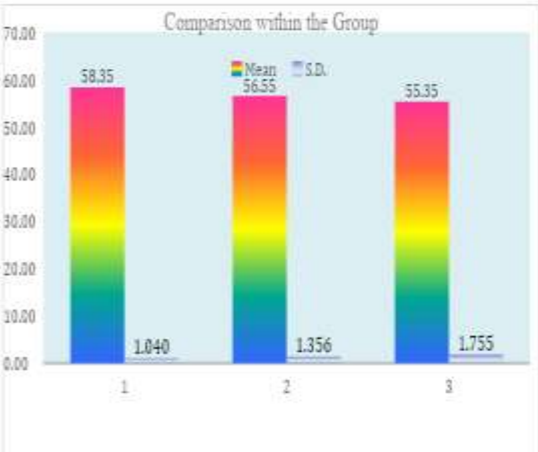

Table 3.1 shows Comparison of Pre intervention and Post Intervention values of WOMAC Scale within group C. Where Pre-interventions Mean ±SD of WOMAC Scale was 58.35±1.040 and that of Post-intervention was 55.35±1.755. The value of F Test as calculated was 38.680 which was statistically significant, at P<0.05.

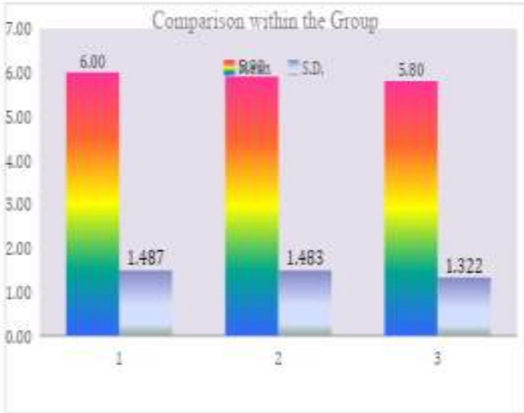

Table 3.2 shows Comparison of Pre intervention and Post Intervention values of Visual Analogue Scale within group C. Where Pre-interventions Mean ±SD of Visual Analogue Scale was 6.0±1.487 and that of Post-intervention was 5.80±1.322. The value of F Test as calculated was 1.540 which was statistically not significant, at P<0.05.

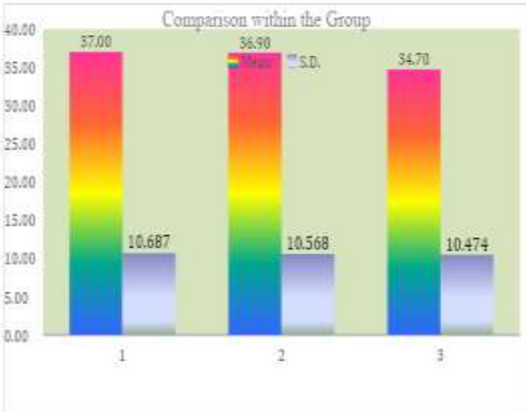

Table 3.3 shows Comparison of Pre intervention and Post Intervention values of Knee Range of Motion within group C. Where Pre-interventions Mean±SD of Visual Analogue Scale was 37.00±10.687 and that of Post-intervention was 34.70±10.474. The value of F Test as calculated was 181.750 which was statistically significant, at P<0.05.

INTERGROUP ANALYSIS

Table No.4.1 shows comparision values of pre intervention values of WOMAC Scale among Group A, Group B and Group C. Where Pre Intervention Mean±SD of WOMAC scale of Group A was 58.10±1.021, Group B was 58.35±0.988 and Group C was 58.35±1.040. The F test value 0.430, which is statistically not significant, at P<0.05. Where Post Intervention Mean±SD of WOMAC scale of Group A was 36.15±3.329, Group B was 53.95±1.877 and Group C was 55.35±1.755. The F test value is 388.673, which is statistically significant, at P<0.05.

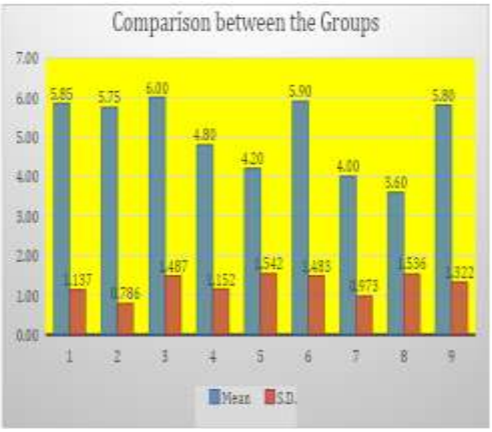

Table No. 4.2 shows comparison values of pre intervention values of visual analog Scale among Group A, Group B and Group C. Where Pre Intervention Mean±SD of visual analogue scale of Group A was 5.85±1.137, Group B was 5.75±0.786 and Group C was 6.00±1.487.The F test value 0.231, which is statistically not significant, at P<0.05. Where Post Intervention Mean±SD of visual analog scale of Group A was 4.00±0.973, Group B was 3.60±1.536 and Group C was 5.80±1.322.The F test value 16.308, which is statistically significant, at P<0.05.

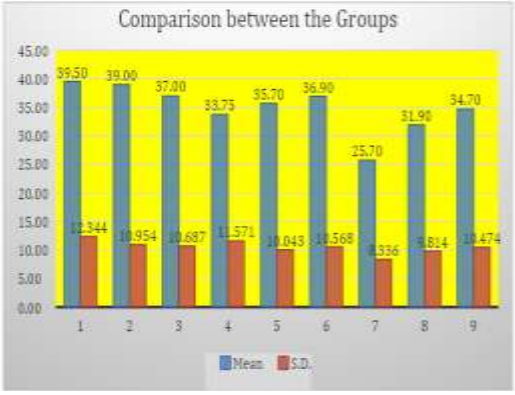

Table No. 4.3 shows comparision values of PRE and POST intervention values of Knee Range of Motion among Group A, Group B and Group C. Where Pre Intervention Mean ±SD of Knee range of motion of Group A was 39.50±12.344, Group B was 39.00±10.954 and Group C was 37.00±10.687.The F test value 0.272, which is statistically not significant, at P<0.05. Where the Post intervention Mean ±SD of Knee ROM of Group A was 25.70±8.336, Group B was 31.90±9.814 and Group C was 34.70±10.474. The F test value is 4.620, which is statistically significant at P<0.05.

IV. DISCUSSION

The present study was undertaken to compare the effect of Pulsed Electromagnetic Field Therapy vs s Transcutaneous Electrical Nerve Stimulation to reduce pain, disability and increase range of motion in knee osteoarthritis. Taking account of the need of present study the fact cannot be over ruled that there is paucity of literature on pulsed electromagnetic fields. A few studies have been conducted on efficacy of pulsed electromagnetic fields in reducing pain and improve functional ability in patients in knee osteoarthritis. But till date no research is available to compare the effect of pulsed electromagnetic field therapy vs. transcutaneous electrical nerve stimulation to reduce pain, disability and increasing range of motion in knee osteoarthritis.

Pulsed electromagnetic field (PEMF) is used to treat bone and joint disorders for over 30 years. Recent studies demonstrate a significant effect of PEMF on bone and cartilage proliferation, differentiation, synthesis of extracellular matrix (ECM) and production of growth factors. A systematic review based on 3 clinical studies which assessed effect of PEMF therapy for osteoarthritis of knee, incorporating factors like pain, physical function, patient assessment, joint imaging, health related quality of life and physician global assessment indicates that electrical stimulation therapy may be useful in OA of knee, but stresses the need for confirmation in future studies. Proteoglycan loss occurs in joint cartilage in OA and PEMF therapy has been shown to induce proteoglycans synthesis in-vivo and in-vitro. PEMF has also demonstrated to have positive effect on cellular proliferation and DNA synthesis through opening of voltage sensitive calcium channels.

Zorzi et al, (2007) in a randomized clinical trial evaluating the outcomes of arthroscopic chondro-abrasion or perforation followed by treatment with PEMF, showed that the treatment with PEMFs aided patient recovery after arthroscopic surgery, reducing the use of NSAIDs. The use of PEMFs was associated with improved functional outcomes with a long-term effect.

Patients with knee OA have significantly poorer quality of life compared with healthy controls, and this is related to functional disability and chronic pain. We assessed quality of life using the SF-36 v2 questionnaire, as a sensitive health status measure for clinical evaluation, and we found that physical health improved after the exposure to PEMF.

Gian (2015) conducted a study which concluded that OA patients treated with the PEMF device significantly reduced their intake of NSAIDs compared with the placebo group. Given that the factors influencing pain perception in each individual patient remain complex, an attempt to define the mechanisms of pain modulation of this form of therapy in relationship to previously described biological effects remains speculative.

Vavken et al. (2009) reported that PEMF did not alleviate knee pain, but improved knee function 310 weeks after the treatment initiation. The authors did not include four trials. However, considering that all trials were evaluated as low-quality trials in our study, the results of Vavken et al. are in good agreement with our findings on the improvement of knee function. Nevertheless, they are not consistent with the results of the present study on the efficacy of the PEMF therapy in reducing knee pain. Although the authors included several trials dealing with other OA sites in their review, this discrepancy may be explained by the fact that their analysis involved the use of different measurement units between trials. Indeed, for the calculation of the weighted mean difference, the authors combined data from the VAS (100 mm) and the WOMAC pain subscale (20 points) without prior transformation of the values. This flaw may have distorted the conclusions of their review.

On a macroscopic level, in vivo studies (2011) conducted on Dunkin Hartley guinea pigs showed that PEMFs was able to reduce tissue fibrillation, preserve cartilage thickness, and prevent the sclerosis of the subchondral bone in lateral and medial compartment of the knee. These preclinical data present the rationale for the clinical application of PEMFs as an alternative to the use of NSAIDs or intra-articular injections (steroids, hyaluronic acid, PRP) in the symptomatic treatment of early OA. Also, PEMF delivers energy that increases the spin of electrons, without generating heat or free radicals. It is believed that this increased spin allows mitochondria to generate more ATP at a faster rate thereby improving tissue function.

V. CONCLUSION

Based on our study though both groups showed significant reduction in pain and improvement in functional status and Range of motion, but group A showed more improvement in the reduction pain and functional status on mean values as compared to the group B. Hence, alternate hypothesis is accepted and null hypothesis is rejected.

Thus we conclude pulsed electromagnetic field therapy with therapeutic exercises is more beneficial line of treatment compared to transcutaneous electrical nerve stimulation with therapeutic exercises in patients with osteoarthritis of knee. This study has shown that pulsed electromagnetic field therapy with therapeutic exercises, it is possible to reduce pain and improve range of motion and functional capacity with Osteoarthritis of knee. The results indicate that pulsed electromagnetic field therapy with therapeutic exercises has better influence on the reduction of pain and improve functional capacity and range of motion of the patients. The study also shows that pulsed electromagnetic field therapy is safe, effective and well tolerated by patients with osteoarthritis knee.

Thus this study proposes that pulsed electromagnetic field therapy with therapeutic exercises, is effective and can be applied individually in osteoarthritis knee for immediate effects of pain relief and improved mobility and function.

Looking back on this project, the overall outcome of results to be observed. This can be evaluated by looking at how well our objectives were met. Our first objective is to control the engine valve of an engine, select a linear actuator that meets specifications, and construct an electronic control system, deal with the design aspect of our project and were all almost achieved. More specifically, next objective, the electronic control system we constructed is able to read engine speeds from 0 to 3600 rpm and vary the valve timing depending on engine speed and operator inputs. However, our final objective, to obtain gains in horsepower, torque, and efficiency of 2% was not met because of not setting up in an engine but theoretically it should be done. We are confident though that this objective of installing in an engine can be met if more time for testing and facilities is given. There is a lot we could say about the need for variable valve timing. This design is very realistic for the future of the automotive industry as well as our education.

LIMITATIONS OF THE STUDY

1. The study sample size was relatively small.
2. This study subjects physical function, emotional function and Social levels were not considered.
3. Confounding Variables like functional limitation and environmental factors were not considered.
4. The study was limited to assess only the pain intensity by using visual analogue scale, goniometer for range of motion and Western Ontario and McMaster Universities Arthritis Index.

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