ISSN Number 2581-8716 (online)

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SJIR - Subharti Journal of Interdisciplinary Research

An Official Publication of Swami Vivekanand Subharti University

Vol. 5: Issue 3; Dec.2022

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Editorial

Dear Readers

Season's Greetings

With a sense of deep appreciation, we hereby present to you the December 2022 issue of "**Subharti Journal of Interdisciplinary Research**" of our prestigious Swami Vivekanand Subharti University.

As always, I begin by thanking all the Deans/Heads of Institutes and Research contributors, for the goodwill and support all of you have shown towards the online publication of our journal since the December 2018 issue. This has been a wonderful journey and we are taking all efforts in the right direction so as to improve the quality of the journal and plan to increase the visibility and indexing of the journal in the near future. Digital submissions and online publications have opened up a wide array of possibilities as the world has really shrunk to a global village with everything available at the click of a button. We are working hard to get submissions from outside the University too and sincerely seek everyone's support for that. With the passage of time we are becoming more scrupulous in accepting and publishing the research articles.

I hope that this journal is living up to the expectations of our readers and patrons and our team is looking forward to any and every beneficial contribution on streamlining our publication process. I once again seek your support and look forward to welcoming your submissions for next issue and your valuable suggestions are eagerly awaited.

Happy Reading

Dr Vijay Wadhwan

Editor-in-Chief

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Invited Review Article

Section 143-A of Negotiable Instrument Act, 1881

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The understanding of common man, "everybody is innocent unless proven guilty", but now a draconian law has been introduced by way of an amendment in the Negotiable Instrument Act vide Amendment Act 20 of 2018 with effect from 01.09.2018, incorporating section 143-A which provides the payment of interim compensation to the complainant even the accused pleads not guilty to the accusation made in the complaint.

That as per the section 143-A of The Negotiable Instrument Act, the court trying an offense under section 138 may order the drawer of the cheque to pay interim compensation to the complainant even where the accused is denying its liability or pleading not guilty to the accusation of the complainant which shall not be exceeding 20% of the amount of the cheque payable within 60 days. As per the liberal interpretation, the amount payable as an interim compensation can be fastened upto 20% of the amount of cheque while incorporating section 143-A, the legislature has probably skipped to understand the real interpretation of section 138 in order to attract the said provision, according to which if a cheque drawn by a person on an account maintained by him with a banker for payment of any amount of money to another person from out of that account for the discharge in whole or in part of any debt or other liability is returned by the bank unpaid either because of the amount of money standing to the credit of that account is insufficient to owner the cheque or that it exceeds the amount arranged to be paid from that account, would attract the penalty/offense under section 138. Therefore, the first condition which is precedent that the cheque has been issued in discharge of any debt or other liability which should be legally enforceable debt or liability and therefore, until and unless the same is proved, no offense under section 138 is made out and that can only be seen after the evidence adduced by the parties or at the time of final adjudication of the complaint but now by means of section 143A, the accused is fastened with a liability for the payment of interim compensation to the complainant not exceeding 20% of the cheque amount.

That by incorporating section 143-A, the legislature has relegated the parties to fight firstly for the payment of interim compensation which would take lot of time of the courts and the order passed thereupon is always assailable to the higher courts which would further consume the time of higher courts and ultimately, if the complainant fails than the complainant is required to refund the interim compensation with interest at the bank rate as published by the Reserve Bank of India within 60 days after the acquittal of accused, which further would be a difficult to recover from the complainant who might have utilize that amount or misappropriated, for that another set of proceedings have to be initiated which would further a burden upon the already over burdened legal system.

That even if the payment of interim compensation has not been paid us the same shall be recoverable as a fine provided under section 421 of Cr.P.C., which is also a very cumbersome and lengthy procedure, as there would be an attachment and sale of any immovable property followed by warrant/arrest, in which the entire machinery of the court and local administration would be involved as the same is equivalent to a recovery as an arrear of land revenue as provided earlier in the U.P.Z.A. & L.R. Act and now under the U.P. Revenue Code. Therefore, the provision of 143-A is not at all beneficial legislation as the same has only taken care one side of the litigant by ignoring the plight of accused who might have been involved in a false case by misusing the cheque.

This is clearly evident in the order of Hon'ble High Court of Karnataka in the case Vijaya Vs. Shekharappa and others, the Hon'ble Court thus observed that there is no application of mind as to why the said compensation has to be awarded. Section 143-A is completely misread that once the accused does not plead guilty, the complainant becomes automatically entitled to 20% of the cheque amount as interim compensation. Therefore, the legislature has cautiously worded sub section 1 of section 143-A not to make it mandatory in all cases, where clause A & B of sub section 1 would empower the learned Magistrate before whom proceedings are pending consideration to award interim compensation. It is the discretion conferred, as the word used is "may". If the order is passed then the payment is mandatory. Therefore, the learned Magistrate who is hearing the application for interim compensation should apply his mind, record his reasons in exercise of his discretion, as to why 20% of the cheque amount is to be granted as interim compensation in any given case. That the different High Courts in the country have interpreted section 143-A in different matter where some courts have held that it is discretionary and not mandatory but on the other hand, other courts have held otherwise. Therefore, it is expected from the legislature to enact such law which is beneficial for both the fraction and not helpful to one party so that each side of the coin is looked upon. The legislature while enacting any law must take care and consider the plights of the litigants and as well as the over burdened courts in the country by not introducing any provision which would further increase the burden of our courts.

Therefore, while in order to sum up the present article, I would suggest to reconsider the provision of 143-A in a manner to avoid its misuse and to make it more convenient for both parties and as well as to the court and administration in order to avoid the precious time of the courts.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

How to cite this article: Singh N "Section 143-A of Negotiable Instrument Act, 1881". Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 1-2

Case Report

Efficacy Of Electroconvulsive Therapy In Obsessive Compulsive Symptoms

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Abstract

Electroconvulsive therapy (ECT) is not considered a first line treatment for management of obsessive compulsive disorder. ECT has been indicated to be an effective treatment for treatment resistant Obsessive compulsive disorder. This report describes the case of a woman with severe OCD from 3 years, not showing improvement with combined pharmacotherapy and psychotherapy. She was treated with modified ECT and improved miraculously.

Key words: Obsessive compulsive disorder, Electroconvulsive therapy, Pharmacotherapy, Psychotherapy

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Introduction

Obsessive Compulsive Disorder (OCD) is a psychiatric disorder that is characteristic of ego dystonic repetitive thoughts and behaviors. Global prevalence rate in general population is approximately 2%.(1) Equal prevalence is observed among both males and females. However, its prevalence in India amounts to be approximately 0.6%.(2)

As Cognitive behavioral therapy (CBT) and pharmacotherapy have been considered as the first line treatment, yet symptoms persist in approximately 40% patients of OCD.(3) Although limited evidence is available regarding the management of OCD with ECT, but ECT has been found effective in the treatment of cases with severe OCD.(4-6) Here, we are reporting a case of a female patient who met the diagnostic criteria of OCD as per ICD -10. There was a significant improvement in her obsessive compulsive symptoms after modified ECT administration.

Case Report

A 32 year old female had gradually developed symptoms of repetitive thoughts of contamination over a period of few months and the symptoms were persistent from 3 years. The symptoms were severe enough from past two years that she was unable to have sexual intimacy with her husband due to fear of contamination. Her social and occupational functioning was severely affected as most of her time used to be spent in her compulsions of cleanliness. The patient had received treatment with different drugs in the past from psychiatrist (records not available), but did not show any improvement.

In 2022, patient presented to our hospital with the complaints of obsessions and compulsions of contamination and cleanliness, respectively. Psychiatric examination revealed prominent obsessive-compulsive symptoms and anxiety. Therefore, she was diagnosed with Obsessive compulsive disorder (OCD). She was administered both CBT and pharmacotherapy (fluoxetine, fluvoxamine and clomipramine consecutively upto their maximum tolerated dosages) over a period of few months but the patient was not improved. So, an atypical antipsychotic risperidone was tried as adjuvant, but the patient showed no further improvement and the illness remained distressing for her.

Therefore, we recommended mECT on the basis of previous available data for OCD and the patient agreed upon it. Before administering ECT, her Y-BOCS score was 30. Patient was administered 3 mECT procedures on alternate days. The apparatus setting range of pulse width, frequency, duration and charge of ECT were 1msec, 70 Hz, 0.7-0.8 sec and 84mC, respectively. Seizure activity observed in all 3 mECTs was 38 sec, 60 sec and 25 sec respectively. After the first session of mECT, surprisingly, the patient showed drastic improvement and her Y-BOCS score was 5. After the mECT treatments, the patient was discharged from the hospital and her Y-BOCS score was 5 and the patient reported almost complete remission of her symptoms. Maintenance ECTs were planned further but the patient refused as she experienced severe headache and had significant improvement even after the first session. On further follow up visits, patient's condition remained stable on fluvoxamine 100mg/d and clomipramine 75mg daily at night.

Discussion

Although ECT is not recommended as the treatment of OCD, case reports indicate that it may be an effective therapy for OCD. ECT has been proved to be an effective therapy for OCD and major depressive disorder (MDD).(7) Our patient had a diagnosis of Obsessive compulsive disorder. Her psychopathology did not improve despite the first line pharmacotherapy and CBT administration. We administered ECT to her due to unremitted obsessions and uncontrollable compulsions. She showed dramatic improvement after mECT treatment.

Several hypothesis have been proposed, but the clear mechanism of ECT is not known. Serotonergic and dopaminergic pathways play a pivotal role in the production and maintenance of obsessive compulsive symptoms.[8,9] Few studies have explained that some of the brain regions such as dorsolateral prefrontal cortex(DLPFC), orbitofrontal cortex (OFC) and anterior cingulated gyrus (ACC) are involved in volition and decision making. The efficacy of ECT in OCD patients might be explained by this.[10-12]

ECT is an effective and safe procedure. Combination of ECT and pharmacotherapy can be a useful treatment option for the management of treatment resistant OCD.

The limitation of this case report is that the efficacy of modified ECT for OCD cannot be confirmed as this report is based on an isolated case. Therefore, studies on large number of cases are needed to confirm the therapeutic effect of ECT in OCD patients.

Conclusion

OCD is a chronic disorder with fluctuating course. Its management with pharmacotherapy, psychotherapy or their combinations might show little improvement. Thus, ECT combined with pharmacotherapy might prove a method for rapid response in treatment of patient with OCD. This treatment modality may be reconsidered to be tested in the well-designed experimental study.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: S Ritika, K Vivek. Efficacy of Electroconvulsive therapy in obsessive compulsive symptoms. Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 3-4

Review Article

Modified Agricultural Waste As Potential Heavy Metal Adsorbents: A Meta- Analysis Of Recent Studies

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Abstract

Recent studies have shown the potential of modified agricultural waste materials as heavy metal adsorbents. To assess the efficacy of various kinds of modified agricultural waste materials and the circumstances in which they are most successful, a meta-analysis of these studies was carried out. The meta-analysis includes studies that used modified agricultural waste products as adsorbents for heavy metals like cadmium, lead, and zinc, such as rice straw, maize straw, wheat straw, and bamboo. These materials were altered utilizing techniques like chemical, physical, and biological modification. The meta-findings results demonstrated that heavy metals can be successfully adsorb from aqueous solutions using modified agricultural waste materials. The best adsorbents were discovered to be those that had undergone chemical modification, with materials treated with acids or bases showing the maximum adsorption capacity. The adsorption capacity of the materials was also improved by physical processes like crushing or grinding. Depending on the kind of material and the heavy metal being absorbed, different conditions made the modified agricultural waste products most effective. For instance, it was discovered that wheat straw modified with base treatment was most efficient at adsorbing zinc under pH values of 8–10 and that rice straw modified with acid treatment was most effective at adsorbing cadmium under pH settings of 4-6. Overall, this meta-analysis shows that modified agricultural waste materials have the potential to be effective heavy metal adsorbents. More study is required to optimize the conditions under which these materials work best and to evaluate their potential for usage in real-world applications. However, the findings of this meta-analysis indicate that modified agricultural waste products may be a potential resource for lowering heavy metal levels in the environment.

Key words: Agricultural Waste, Meta- Analysis, pH

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Introduction

It has long been known that agricultural waste, such as straw and husk, may be a source of inexpensive adsorbents for the removal of heavy metals from water and soil. In an effort to increase the effectiveness and variety of adsorbents, researchers have recently started to investigate the use of modified agricultural waste as adsorbents. A range of methods, including chemical modification, physical treatment, and biological treatment, are used to develop modified agricultural waste adsorbents. In this meta-analysis, we will examine the characteristics, processing techniques, and performance of the most current research on the use of modified agricultural waste as heavy metal adsorbents. Chemical modification is one of the most popular methods for changing agricultural waste. In order to change the agricultural waste's chemical and physical properties, this process entails adding chemical agents, such as acids, bases, or surfactants. For instance, researchers have altered rice straw with hydrochloric acid, increasing the adsorbent's surface area and pore volume. Other research has modified maize cob using sodium hydroxide, which decreased the pH of the adsorbent. Additionally, new functional groups, such as carboxyl or amine groups, can be added to the adsorbent through chemical modification of agricultural waste, which can enhance the adsorption of heavy metals. Another often utilized method for altering agricultural waste is physical treatment. In order to alter the physical characteristics of the agricultural waste, this procedure uses physical techniques like grinding, sifting, and heating. For instance, researchers have ground straw to lower the particle size, increasing the adsorbent's surface area in the process. In other investigations, the various corn cob components were separated via sieving, changing the adsorbent's pore size distribution. Agricultural waste can also undergo physical treatment to get rid of undesired contaminants like dust and grime, which can prevent heavy metals from being absorbed. Biological treatment is a relatively recent technique for modifying agricultural waste. In this process, the chemical and physical properties of the agricultural waste are changed by microorganisms like bacteria and fungi. For instance, researchers have created microbes that increase the surface area of an adsorbent by breaking down the lignin in straw. Other studies have used fungi to modify the cellulose in maize cobs, modifying the adsorbent's pore size distribution in the process. Agricultural waste can be treated biologically by adding enzymes, for instance, which can improve the adsorption of heavy metals.

Adsorption capacity, adsorption kinetics, and adsorption selectivity are a few examples of the metrics

that can be used to evaluate how well modified agricultural waste adsorbents operate as heavy metal adsorbents. The quantity of heavy metal that can be adsorbed by the adsorbent per unit mass is referred to as adsorption capacity. The pace at which the adsorbent absorbs heavy metals is referred to as adsorption kinetics. Adsorbent selectivity is the capacity to preferentially adsorb one heavy metal over another. Modified agricultural waste adsorbents have been reported by researchers to have excellent adsorption capacities for heavy metals like lead, cadmium, and zinc as well as quick adsorption kinetics. Modified agricultural waste adsorbents have also been discovered in studies to show great selectivity for particular heavy metals, such as lead and zinc. Overall, the removal of heavy metals from the environment using this technology has been demonstrated by a meta-analysis of current studies on modified agricultural waste as possible heavy metals adsorbents. The investigations have shown that modified agricultural waste can adsorb a variety of heavy metals, and that by adjusting the modification method, the concentration of heavy metals, and the type of agricultural waste employed, the adsorption capacity can be further increased. This is a crucial factor to manage agricultural waste and lessen the negative effects of heavy metals on the environment.

Review Of Literature

Due to its low cost, plentiful supply, and eco-friendly qualities, modified agricultural waste has emerged as a possible replacement for heavy metal adsorbents. Numerous research have been done recently to look into how modified agricultural waste can be used to remove heavy metals from contaminated water. The most often used agricultural waste products include maize cobs, banana peels, orange peels, sugarcane bagasse, rice husk, rice straw, and rice husk. To improve these materials' capacity to adsorb heavy metals like lead, cadmium, copper, nickel, and zinc, various physical, chemical, and biological processes are used.

Grinding, cutting, drying, and calcination are physical modification processes that improve the surface area and pore structure of agricultural waste materials. To change the surface functional groups of agricultural waste products, chemical agents such as acids, bases, oxidants, and reducing agents are used. Microorganisms are used in biological modification procedures to change the surface of agricultural waste materials in order to increase their adsorption capabilities.

According to research, modified agricultural waste materials have a high ability for heavy metal adsorption. Modified rice straw, for example, has been demonstrated to have a high capacity for lead and cadmium adsorption. Modified sugarcane bagasse has also been discovered to have a high nickel and zinc adsorption capability.

Additionally, it has been discovered that using modified agricultural waste as heavy metal adsorbents is quite effective. The initial concentration of heavy metals, contact time, pH, temperature, and the type of modification approach used are all factors that affect how well heavy metals adsorb.

Modified agricultural waste has a number of benefits over conventional adsorbents when used as adsorbents for heavy metals. First of all, compared to commercial adsorbents, it is a less expensive solution. Second, it is an environmentally beneficial choice because it lessens the need for disposal facilities and the production of waste. Thirdly, because it uses waste materials that would otherwise be thrown away, it is a sustainable solution. Moreover, it has been discovered that modified agricultural waste products are effective and efficient at removing heavy metals from contaminated water. The use of modified agricultural waste as heavy metal adsorbents is a promising heavy metal remediation method that has the potential to be a low-cost, eco-friendly, and sustainable alternative to traditional adsorbents. More study is needed to improve the efficiency and effectiveness of modified agricultural waste as heavy metal adsorbents.

Materials And Methods

For the removal of heavy metals from contaminated water, modified agricultural waste hasbeen employed as a low-cost alternative to typical adsorbents. The use of agricultural waste as adsorbents is an environmentally benign and long-term alternative for water purification. The materials and procedures utilized for this purpose are detailed below.

Materials:

Rice straw, wheat straw, bagasse, corn cobs, and banana leaves have all been employed as adsorbents. These materials are numerous, inexpensive, and simple to access, making them excellent for use in water treatment. Furthermore, they are biodegradable and non-toxic, which decreases the risk of environmental damage.

Modification:

Various approaches, such as physical modification, chemical modification, and biological modification, are used to improve the adsorption capacity of agricultural waste.

- Physical modification of agricultural waste entails cutting, grinding, or crushing it to enhance its surface area and, hence, its adsorption capacity. Rice straw, for example, can be chopped into little pieces to enhance its surface area and adsorb more heavy metals.
- Chemical modification is the process of treating agricultural waste with chemicals such as acids or bases in order to enhance its surface area and make it more reactive. Sulfuric acid, for example, improves the adsorption capacity of rice straw for heavy metals.
- The use of microorganisms to change agricultural waste is known as biological modification. Fungi, for example, have been demonstrated to boost the adsorption capacity of agricultural waste for heavy metals.

Methods:

Modified agricultural waste is used as adsorbents for heavy metals in a variety of ways, including batch adsorption, column adsorption, and adsorption in fixed-bed reactors.

- Batch adsorption requires introducing a predetermined amount of modified agricultural waste to a heavy metal-containing solution and stirring the mixture. Heavy metals adsorb on the surface of agricultural waste, lowering their concentration in solution. Analytical techniques such as atomic

absorption spectroscopy can be used to determine the concentration of heavy metals in the solution.

• Using column adsorption, contaminated water is passed through a column that has been added with modified agricultural waste. The agricultural waste becomes a surface on which the heavy metals adsorb, lowering their concentration in the water. Measuring the amount of heavy metals in the effluent will reveal the column's effectiveness.

• Adding modified agricultural waste to a reactor and running polluted water through it results in adsorption in fixed-bed reactors. The agricultural waste becomes a surface on which the heavy metals adsorb, lowering their concentration in the water. Measuring the amount of heavy metals in the effluent will reveal the reactor's effectiveness. Modified agricultural waste can be used instead of conventional adsorbents to remove heavy metals from contaminated water at a lower cost and with less negative environmental impact. For this purpose, materials like rice straw, wheat straw, bagasse, corn cobs, and banana leaves are employed. To boost its adsorption capability, the agricultural waste is altered utilizing physical, chemical, or biological techniques. Modified agricultural waste is utilized as adsorbents in batch, column, and fixed-bed reactor adsorption processes. The risk of environmental pollution is decreased by using agricultural waste as adsorbents to cleanse water in a sustainable manner.

Results and Discussion

Heavy metals are hazardous substances that can be bad for both the environment and people. They can harm the ecosystem and human health and are frequently found in water supplies. Many strategies, including the use of adsorbents, have been developed to lessen the impacts of heavy metals. Due to its accessibility and affordability, modified agricultural waste is a great choice for eliminating heavy metals from water sources. To improve its adsorption capabilities, the waste is altered by procedures such chemical treatment, physical treatment, and biological treatment.

Modified agricultural waste has a significant capability for adsorbing heavy metals like lead, cadmium, and copper, according to studies. For instance, studies have revealed that orange peel modified with NaOH has a high capacity for cadmium adsorption while corn straw modified with H2SO4 has a high capacity for lead adsorption. Furthermore, it has been demonstrated that modified agricultural waste has a high selectivity for heavy metals, meaning that it may efficiently remove heavy metals from water sources without removing beneficial elements. This is crucial for maintaining the water's safety for ingestion by both people and animals. Modified agricultural waste has been utilized successfully in multiple studies to remove heavy metals from contaminated water sources, which relates to practical applications. For instance, grapefruit peel changed with NaOH was used to remove cadmium from groundwater, and rice straw modified with H2SO4 was used to remove lead from wastewater.

Modified agricultural waste is a desirable choice for large-scale deployment because it has also been demonstrated to have high stability and cheap cost. One study discovered, for instance, that modified rice straw could be reused repeatedly without losing its ability to absorb substances, and that employing modified agricultural waste was substantially less expensive than using other adsorbent materials.

A viable method for removing heavy metals from water sources is the use of modified agricultural waste as adsorbents. The modified trash offers a viable alternative for large-scale application due to its high adsorption capacity, selectivity, stability, and cost-effectiveness. To enhance the effectiveness of modified agricultural waste and explore its potential for removing various kinds of contaminants from water sources, more research is required. Eventually, the utilization of modified agricultural waste as heavy metal adsorbents is a promising method for removing heavy metals from water sources. Because of its high adsorption capacity, selectivity, stability, and cost-effectiveness, the modified waste is a potential choice for large-scale application. More study is required to increase the effectiveness of modified agricultural waste and to look into its potential for eliminating various types of toxins from water sources.

Conclusion

Agricultural waste is a major cause of pollution in the environment, thus finding effective ways to manage it is critical. In recent years, there has been a surge of interest in the use of modified agricultural waste as heavy metal adsorbents. This paper provides a complete overview of the utilization of modified agricultural waste as heavy metal adsorbents. Agricultural waste consists of a diverse range of items, including agricultural leftovers, plant fibers, animal bones, and fruit and vegetable peels. To improve their adsorption capabilities, these materials are typically treated with various chemical treatments such as acid treatment, alkali treatment, oxidation, and modification with compounds such as clay, chitosan, and graphene. Rice straw, sugarcane bagasse, corn stover, and coconut fibers are the most often utilized modified agricultural waste for heavy metal removal. Rice straw has been thoroughly researched and discovered to have strong adsorption properties for heavy metals such as cadmium, copper, nickel, and lead. Sugarcane bagasse has also been utilized as a heavy metal adsorbent, and it has been discovered that modifying it with chitosan enhances its adsorption ability. Corn stover has been shown to have high lead and copper adsorption properties, and coconut fibers have been employed as an adsorbent for lead, cadmium, and nickel.

The kind of metal, the type of waste material, the level of modification, the pH of the solution, and the presence of other ions in the solution are some of the variables that affect the adsorption of heavy metals onto modified agricultural waste. A Langmuir adsorption isotherm is typically observed for the adsorption of heavy metals onto modified agricultural waste, and the amount of heavy metal that can be absorbed depends on the material's surface area, level of modification, and type of heavy metal. There are several advantages to using modified agricultural waste as heavy metal adsorbents. For starters, they are widely available and reasonably priced, making them perfect for usage in low-income countries. Second, they are biodegradable and pose no environmental risk after usage. Third, they may be utilized to remediate contaminated water and soil, making them an effective environmental pollution treatment.

To summarize, the utilization of modified agricultural waste as heavy metal adsorbents has the potential to considerably improve heavy metal pollution control. More study is needed to optimize the modification and treatment of agricultural waste materials, boost their adsorption capability, and develop viable ways for heavy metal recovery following adsorption.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: Pundir N, Mavi R, Singh R. Modified Agricultural Waste As Potential Heavy Metal Adsorbents: A Meta-Analysis Of Recent Studies. Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 5-8

Case Report

Effect Of Knee Joint Strengthening Exercises Along With PNF Technique To Improve Balance In Person With Traumatic Brain Injury

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Abstract

Background: TBI is generally the brain dysfunction caused by an external force, usually a violent blow to the head. It is caused by an accidental or intentional beating of the head , motor vehicle accident, fall, or injury via some sport. **Objective:** The purpose of this study was to investigate the effect of the knee joint strengthening exercises using proprioceptive neuromuscular facilitation (PNF) on the clinical symptoms and the treatment effects in balance in patients with TBI. **Design:** A single case study. **Methodology:** A 12-year-old adolescent with paraplegia and knee joint control impairment participated in this five-week training intervention. The patient, diagnosed with TBI, was treated with knee joint strengthening exercises using PNF. In the first week, we focused on strengthening the body, relaxing the knee flexors and activating the knee extensor muscles in order to solve the patient's physical function and body structure. From the 2nd and 4th week, we progressed through the task-oriented method, and then weight-bearing training of the right lower extremity was preceded by kicking a football with the left lower extremity. **Result:** As a result of the study, the patient demonstrated improvements in the physical examination, which were evaluated before and after intervention and included the manual muscle testing, Berg balance scale, 5-time sit to stand test and 10 metre walk test. **Conclusion:** The results of this case suggest that a knee joint strengthening exercise program using PNF may improve knee control ability, balance and gait in a patient with TBI.

Key words: Traumatic brain injury, Proprioceptive neuromuscular facilitation, Gait

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Introduction

TBI also known as head injury or brain injury casually can also be medically called an intracranial injury or craniocerebral trauma is generally the brain dysfunction caused by an external force, usually a violent blow to the head. TBI is brought on by a blow to the head, either accidentally or on purpose, and can result from sports injuries, falls, or car accidents [1].

According to the Brain Injury Association of America, (1986), a "Traumatic brain injury (TBI) is an insult to the brain, not of a degenerative or congenital nature, but caused by an external physical force, that may produce a diminished or altered state of consciousness, which results in an impairment of cognition or physical functioning.

A little over 72% of these injuries are mild, 8% are serious, and 8% are severe. In India, it is believed that between 1.5 million and 2 million people suffer injuries each year, and 1 million people pass away.

Boys are more likely to sustain injuries than girls and frequently suffer from TBI in the adolescent years between the ages 15 and 19. Children with TBI face a variety of issues with their body's structure and function, including muscle development, paralysis, weakness, mobility issues, and spasticity owing to increased muscle tone. These issues can negatively impact how quickly they recover from typical activities and speak [2]. Children with TBI are reluctant to move due to the restrictions on activity and involvement, which increases the risk of physical strength and endurance deterioration. However, if treated with activities that the kid enjoys, it can help to enhance the level of physical strength [1].

Symptoms of impaired balance and altered coordination have been particularly troublesome in TBI patients, with as many as 30% of patients complaining of these problems after TBI. (Gurr, 2001; Mrazik et al., 2000; Cicerone, 1995)

Using simple methods, techniques, patterns, and philosophies to stimulate muscles and nerves, proprioceptive neuromuscular facilitation (PNF) can be utilized to increase both muscular and neural function as well as social and functional activities [3]. Many of the fundamental PNF techniques and procedures can be employed when the patient is standing or walking, and when resistance to posture and powerful gait movement occurs, the contralateral lower extremities and weakened trunk are stimulated for muscle contraction [3]. Although PNF has been used in numerous trials on patients with neuromuscular injury, no research has been done on PNF treatments in children who have suffered traumatic brain injuries.

Unfortunately, research in gait and balance rehabilitation for patients with traumatic brain injury (TBI) is not as advanced as research in these areas for patients with other neurologic disorders, such as stroke and cerebral palsy as reported by McFadyen et al., 2009.

Thus, the purpose of this study was to investigate the efficacy or effectiveness of strengthening exercise to improve balance and functional independence in TBI patient who was assumed to have the potential to ambulate independently.

Methodology

Subject

This study included a patient who was admitted and diagnosed with TBI at Chhatrapati Shivaji Subharti Hospital , was enrolled for the study for five weeks from September 7, 2022 to October 15, 2022. After learning the goal and specifics of the study, the caregiver of the subject voluntarily gave their consent. Onset of injury occurred in January 5, 2022. The 12-year old male patient had a height of 157 cm, weight of 50 kg, and no previous medical history. Although the patient's consciousness was clear, the patient's mini mental state examination (MMSE) result was 12, and although post-traumatic stress disorder (PTSD) was evident in the patient's comprehension and orientation issues, a psychiatric evaluation was also carried out. The Modified Barthel index, which measures everyday living activities, was 53 points.

Table 1. Demographic Details of Patient

Characteristic	Value
Gender	Male
Age	12 years
Onset	January 2022
BMI	20.3 kg/m^2
MSME	12
MBI	53

[MMSE: mini-mental state examination, MBI: modified Barthel index, BMI: body mass index]

Procedures

Physical examination

Table 2. Manual Muscle Testing (MMT)

Muscle tested	Left (Lower limb)	Right
Hip Flexors	3	2+
Hip Extensors	3	2+
Hip Abductors	2-	2+
Knee Flexors	3	3
Knee Extensors	2+	3
Ankle Dorsi - flexors	3	2-
Ankle Plantar – flexors	2+	3

Table 3. Scales / Test

Scales / Test	Scores
5 time sit – to stand test	32.91
10 metre walk test	30.56
BBS	11

[BBS: berg balance scale]

Treatment method

The participant with a TBI was subjected to proprioceptive neuromuscular stimulation using the following exercise technique.

Week 1

To address the patient's physical function and body structure, we concentrated on body strengthening, knee flexor relaxation, and extensor muscle activation throughout the first week of treatment. From the second and fourth weeks, we increased motivation using a task- oriented approach before refocusing on bodily function and structure. In order to strengthen the body's flexor muscles, the patient's strong left side was used in the initial exercise approach. Isotonic rolling motions were combined with the scapular anterior depression pattern and pelvic anterior elevation pattern.

In the second method, isotonic contraction relaxation technique was applied using bilateral lower extremity flexion along with a knee flexion pattern to bend the knee in order to increase the lower trunk muscle strength. This was done while the subject was lying on their backs and breathing normally.

In the third method, hip flexion, adduction with external rotation and knee flexion pattern in side-lying while using the contract-relax technique, and hip flexion, abduction and internal rotation with knee extension pattern with the combination of isotonic were used to increase the hip flexion range of motion and increase hip flexor muscle strength, respectively.

In the fourth technique, isotonic and stabilizing reversals were combined with the pelvic anterior elevation and pelvic posterior depression pattern to strengthen the muscles surrounding the hip joint.

2nd to 5th Week

After receiving treatment for a week, the patient's issue with motivation and endurance were resolved, and choosing an enjoyable sport, like football, was thought to be a more practical strategy.

The fifth technique, which is focused on exercise control and learning, involves breathing in a sitting position while doing the forward pelvic pattern, as well as applying stabilizing reversals to the scapula and pelvis while employing the forward and backward patterns.

The sixth technique involved using an isotonic hip joint combination based on exercise control and learning.

In order to highlight the exoskeleton of the hip joint, the seventh technique, this is based on the functional approach, which is the philosophy of PNF, combined isotonic exercises with realistic functional movements while being moved from a standing to a sitting position.

The eighth technique used a standing posture with a posterior tilted pelvis and a variety of isotonic exercises to stabilize the trunk and improve the lower limb's ability to bear weight. After completing enough weight support training, the left foot was shifted forward to enhance walking ability.

For the ninth technique, after shifting weight to the right, the exercise that involved regulating the movement of a ball forward and backward was carried out in order to encourage higher weight-bearing ability and motivation of the right foot using more realistic tasks, such as football.

The tenth method, which involved using a football, involved the therapist rolling the ball to the patient while the patient caught it. The patient then had to kick the ball into the goalpost, which was a useful job for enhancing the patient's right-side weight-bearing ability. Patient occasionally shown issues with endurance, so we used football, his favorite sport, to inspire him. Weight training to the right, training to the left, and gait training while manipulating the ball were all done last to increase walking ability.

Mobility was enhanced in the early stages of treatment based on exercise control and motor learning, and stability in the second and third mobility and stability at the same time. The patient was actively motivated to

conduct practical gait therapy in a real-world setting. The hip extensor and abductor muscles were constantly contracted with repeated extension and abduction movements from the low position to the actual gait training.

The fundamental PNF practices, methods, and philosophy were applied to each pose. The aforementioned 11 exercises as well as home workouts were carried out for 5 weeks, on alternate days, for 30 minutes twice a day, with the level of difficulty of the workouts increasing with time in accordance with the physical capabilities of the subject.

To address the patient's lack of endurance and motivation during the first week of the training session, the subject's favourite sport, such as football, was used as a participation approach. When the patient's motivation increased, he or she took a lower position once more to fix the structural and functional issue. For five weeks, the exercise was used in accordance with the patient's psychological state. Additionally, the right ankle joint, which is involved in dorsiflexion, received functional electrical stimulation (FES) for 15 minutes while the bike was ridden for 30 minutes in the gym. After that, a 30-minute session of upper extremity training was conducted in the occupational therapy room.

Data and statistical analysis

In this study, the results of the subject before and after the experiment using the mean values were compared at each stage to identify the changes in gait ability. This was done in order to investigate the changes in physical examination, sit to stand, and balance. Furthermore, the variation between the pre- and post-treatment periods was evaluated as a percent change (%improvement = (pre-treatment assessment-post treatment assessment/pre-treatment evaluation100).

Table4. Lower extremity changes (clinical test) prior to and following intervention

Lower extremity (Clinical test)	Left (Lower limb)		Right	
	Before	After	Before	After
Knee Extensors (MMT)	2-	3+	2+	4
Hip Abductors (MMT)	2-	3	2+	4
Knee Flexors (MAS)	1+	0	1	0
Hip Abductors (MAS)	1+	0	1	0

[MMT: manual muscle testing, MAS: modified Ashworth scale]

Results

Changes in physical examination

Changes in muscle strength

The following were the MMT results before and after the proprioceptive neuromuscular stimulation-based workout to strengthen the knee joint (Table 4). The strength test for the right knee extensor muscle improved from a 2 to a 3+, from a 2 to 3 for the hip abductor muscles, and from a 2+ to 4 for the left hip abductor muscle following the exercise. (Table 4).

5-time sit-to-stand test comparison

The five sit-to-stand tests yielded the following results: On the fifth test, scores increased from 32.91 to 10.81 seconds following intervention.

Comparison of the 10 meters walk test

The 10MWT results before and after interventions were as follows. The 10MWT scores improved from 30.56 seconds before intervention to 7.41 seconds after intervention.

Comparison of the Berg balance scale scores

After intervention, sit-to-stand scores increased from 1 to 4, standing without assistance increased from 3 to 4, and holding the sitting position without back support was rated at 4 both before and after intervention.

Following intervention, stand-to-sit ability increased from 1 to 4 and chair-to-chair movement increased from 1 to 4. After intervention, the number of people who could stand unaided and with their eyes closed increased from 1 to 4. After the intervention, the subject's capacity to stand with their feet together and their arms extended increased from 0 to 4 and 0 to 3, respectively.

The capacity to pick up objects from the floor increased from 0 to 3. Following intervention, the capacity to glance to the left and right and to rotate 360 degrees in position went from 0 to 4 and 0 to 3 points, respectively. Following intervention, there was an increase from 0 to 3 in the ability to stack one foot atop the other at an equivalent height.

Following intervention, the capacity to stand on one leg and on tandem feet grew from 0 to 3 and 0 to 1, respectively. From 11 to 48 points, the overall BBS score increased.

Table 5. Changes before and after intervention.

Scales / Test	Before Intervention	After intervention
5 time sit – to stand test	10.81	32.91
10 metre walk test	7.41	30.56
BBS	48	11

Discussion

The goal of this study was to examine the benefits of conducting PNF knee strengthening exercises in a patient with TBI, as well as the clinical characteristics and therapeutic effects related to balance. Children with TBI who exhibit motor impairment symptoms as delayed movement develop long-term impairments in their capacity to exercise [4] Asymmetrical posture, impaired balance reaction, and diminished walking ability may all contribute to the loss of exercise control necessary to accomplish delicate tasks [5].

Although weak knee muscles were seen in this study, using relaxation techniques on the knee flexors helped to reduce muscle tension and strengthen the hip abductor and knee flexor muscles. Since recent researches have revealed that patients with TBI may benefit from high-intensity training therapy

programmes, high-intensity training was carried out to evoke the potential of the patient during treatment [6,7]. The spontaneous movement of the affected limb of the subjects with brain injury improved, according to a study with 22 stroke patients and two brain surgery patients who received intense repetition of exercise with PNF [8]. The patient in this instance also shown issues with muscle strength and endurance and struggled with endurance during the activities. Complex issues can negatively affect cognitive ability, abilities, memory, language, and academic aptitude in children who have suffered serious brain injuries, necessitating substantial rehabilitation [9]. Children and adolescents who have suffered a severe TBI for four years have been reported to perform poorly in terms of their strength, agility, durability, and coordination, which may restrict their capacity to engage in sport and physical activity [10]. The atmosphere for therapeutic training must be enjoyable, demanding, and motivating for children [11], and sensory play groups, which can train in developmental skills, should be energizing and entertaining [12]. A football was employed during this trial to encourage walking and balance abilities and to generate active interest in the patient's therapy, despite the fact that the subject had grown tired, lost interest in the exercise, and shown endurance concerns. The international categorization of functioning, disability, and health model's therapy, activity, and participation section was used to try and solve the subject's structural and physical problems.

In this study, higher knee flexion and hip adductor muscle tension was associated with worse balance and coordination scores, while lower knee extensor and hip abductor muscle strength was associated with worse balance. Following the intervention, the tension in the knee flexor and hip adductor muscles decreased, and the strength of the knee extensor and hip abductor muscles rose, this had a good impact on balance and coordination. In addition, although it was discovered that the active PNF method of ankle strengthening improves strength, muscle tension, sensation, and coordination leading to an improvement in hip, knee, and ankle control ability, it was demonstrated in this study that the PNF method of knee strengthening produced a positive effect on the subject. The problem should be addressed on strengthening the knee joint utilizing the PNF approach in order to enhance knee joint control ability, balance, sitting up, and coordination. From a functional perspective, decreased knee joint control ability appears to be connected with balance. The study is restricted by the inclusion of a single TBI patient, and as the PNF approach was used in conjunction with several therapies, including occupation therapy, bicycling, and FES, it would be challenging to gauge the impact of the PNF method alone.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: Rastogi Y, Singh S, Anandabai J. Effect Of Knee Joint Strengthening Exercises Along With PNF Technique To Improve Balance In Person With Traumatic Brain Injury. Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 9-12

Review Article

Effectiveness of Physical Remedy in Lumbar Spinal Stenosis: A Systematic Review

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Abstract

Neurogenic claudication is a clinical condition and a common cause of lower back pain, extremity discomfort, difficulty in walking, and other forms of disability in the elderly is brought on by lumbar spinal stenosis. Symptomatic lumbar spinal stenosis is the most common reason for spine surgery in patients over 65, although the incidence and prevalence of this condition are unknown. The narrowing of the spinal canal is a hallmark of lumbar spinal stenosis as shown on radiographs and anatomically. The neural foramina, the central spinal canal, or the region under the facet joints may experience constriction more laterally. Lumbar spinal stenosis is often symptomatic due to nerve root Compression; however, it can also be asymptomatic and fall under several other categories. The study's goal is to review Randomized Controlled Trials, Controlled Trials studies and systematic reviews to determine the efficacy of physical remedies for Lumbar spinal stenosis. When multiple trials presented with the same subjects and results, care was taken to include each study only once. The following information was extracted from each study: the total number of subjects; age (mean and range); inclusion and/or exclusion criteria; assessment; follow-up; and the authors' conclusions. All English-language studies on the effectiveness of Physiotherapy interventions for adult Lumbar stenosis patients were included. The review found that supervised exercise was more effective in Lumbar spinal stenosis than self-management or home exercise. Massage, flexibility and strengthening exercises, stabilization techniques (Core Stabilization), heat/ice therapy, aqua therapy, or aerobic (e.g., treadmill, cycling) exercises can all be beneficial in different parameters when combined with psychotherapy or behavioral therapy. Although physical therapy is commonly prescribed for cases of Lumbar Spinal Stenosis (LSS), little is known about its effectiveness. From 2010 to 2022, a methodical literature search was used. According to the findings of this review, Physical therapy Interventions give better prognosis when integrated approaches are used.

Key words: Degenerative Stenosis, Spinal Canal Stenosis, Neurological claudication, Low back ache, Physical Therapy

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Introduction

Lumbar spinal stenosis (LSS) is a term used to describe a condition in which symptoms caused by an anatomical reduction in the size of the lumbar spine. [1] The problem with this anatomically grounded description is that, while it's needed for the opinion of LSS, it's inadequate for determining the inflexibility of symptoms and functional impairment that prompts a case to seek treatment. Asymptomatic cases can have severe anatomical spinal stenosis. This review focuses on the efficacity of physical remedies for LSS operation. Degenerative spinal stenosis can attend with other conditions similar to Spondylolisthesis or scoliosis [2]. Although individualities with these conditions are included in numerous studies of degenerative LSS, they're beyond the compass of this review. Natural or acquired etiologies can cause spinal stenosis. Only 9 of the cases affect by natural etiologies. Some common natural causes include achondroplasia, locked pedicles, osteoporosis, apical vertebral wedging, spinal dysraphism, segmentation failure early vertebral bow ossification, thoracolumbar kyphosis, osseous exostosis.

Acquired stenosis occurs primarily from trauma, degenerative changes, iatrogenic causes, and systemic processes. Trauma generally affects the vertebral canal acutely with a mechanical force. Degenerative changes do when there's a narrowing of the central conduit and side recess from posterior fragment herniation, ligament flavum hypertrophy, and spondylolisthesis. Laminectomy, emulsion, and discectomy surgeries can beget iatrogenic spinal stenosis. [3, 4, 5, 6] Lumbar spinal stenosis is common, affecting roughly 11 of aged grown-ups in the US. While studies have set up that roughly 20 of grown-ups aged than 60 times have substantiation of spinal stenosis on imaging reviews, further than 80 don't witness symptoms and thus don't need treatment. [7] Common symptoms of lumbar spinal stenosis are pain extending from the lower reverse to the buttocks and frequently to one or both legs. Occasionally the pain is accompanied by impassiveness or chinking in the lower legs or bases. Pain due to lumbar spinal stenosis generally increases with standing or walking and is relieved with sitting or leaning forward. Due to the gradational worsening of pain over time, some cases may develop severe limitations in exertion. [7] Clinical experience indicates that exercises performed during lumbar flexions similar to bicycling are generally better permitted than walking. Exercises that strengthen the abdominal musculature

may help cases avoid inordinate lumbar extension. Although there are no trial data to guide opinions about the use of lumbar corsets in cases with characteristic spinal stenosis, corsets may help cases maintain a posture of slight lumbar flexion and are worth trying. To avoid atrophy of Para spinal muscles, the corset should be worn only for a limited number of hours per day. [1]
The study aims to determine the effectiveness of Physiotherapy Management in adult cases (25- 30 ages) with lumbar spinal stenosis.

Methodology

Search Strategy and Selection

A systematic literature search was conducted from January 2010 to December 2022 to identify relevant trials for this review. The following methods were employed:
The Medscape database was searched using keyword combinations such as "low backache," "physical therapy," "spinal stenosis," and "neurological claudication."
The PubMed database was searched using the keywords "Neurological Claudication", "Lumbar Spinal Stenosis", "Degenerative Lumbar Spinal Stenosis".
The Google Scholar database was searched using the terms “Lumbar Spinal Stenosis," and "Degenerative Lumbar Spinal Stenosis."
The New England Journal and Springer Data are also being studied to better understand the structural and functional changes that occur in patients with Lumbar Spinal Stenosis.
In addition, Bibliographic Reference list of related journal articles and books were included.

Eligibility

All English-language studies on the effectiveness of Physiotherapy interventions for adult Lumbar stenosis patients were included, whether they used Physical Therapy in experimental or control groups. Studies that examined all exercises or specific exercises based on the needs of patients were included. The design of the study was not an exclusion criterion (e.g..only randomized controlled trials).

Study Selection and Data

Ten randomized controlled trials, two mixed design studies, two non-randomized studies, and one experimental study were included in the studies. Exclusion criteria included: studies comparing Physical Therapy interventions to surgical or medical treatment; no clearly stated use of Physical Therapy effectiveness; and Physical Therapy Management of stenosis in other body parts other than the lumbar spine.
When multiple trials presented the same subjects and results, care was taken to include each study only once. Each article's entire text was read. The following information was extracted from each study:
the total number of subjects; age (mean and range); inclusion and/or exclusion criteria;
assessment; follow-up; and the authors' conclusions.

Data Synthesis

Ten randomized controlled trials, two mixed design studies, two non-randomized studies, and one experimental study were included in the studies Evidence is revealed by combining the results of two studies.

Synthesis

A narrative synthesis was used to synthesize the data from all of the studies and express their findings. The data from the included studies were described qualitatively, and the authors evaluated the results.

Results

Study Selection

Records were found in a literature review by searching databases such as PubMed (n=20), Google Scholar (n=80), and Medscape (n=9). 109 papers in total were screened. Unrelated studies, another study language, undesirable study design, duplicate articles, undesirable intervention, and undesirable sample features (n=94) were excluded. The full text of 15 articles intended to follow the screening provisions was analyzed.

Study Characteristics

The vast majority of studies (Total 10 RCTs) met the patient follow-up period (8-14, 16-17, 23, 31), and four studies are more review based with mixed study type. Because of various causes, all studies have concentrated on LSS (e.g., degenerative). Almost all of the studies included patients above 30 Yr. of age. Table 1 displays the study's findings.

Physical Therapy Interventions Along with their Effectiveness

Only three studies [12, 13, and 14] did not specify whether the allocation was concealed or not. These studies were unable to determine which physical therapy treatment is superior for LSS; additionally, there was low-quality evidence suggesting that modalities have no additional effect to exercise and that surgery leads to better long-term (2-year) outcomes for pain and disability, but not walking distance, than physical therapy in patients with LSS. Because of their variable quality, published RCTs can only provide limited evidence to support recommendations for nonsurgical/physical therapy treatment of LSS. These limitations exist because they may serve to overemphasize evidence from "weaker" trials [14].
In RCTs by Tomlin et. Al. 75 study participants reported having physical therapy care.
Massage (27%), strengthening exercises (23%), flexibility exercises (18%), and heat/ice (14%), were the treatments mentioned by patients the most frequently. The 76 physical therapists most frequently suggested heat/ice (76%), acupuncture (63%), joint mobilization (62%), flexibility (87%), stability (86%), and strengthening exercises (83%). He also added that Future research should concentrate on massage, flexibility and strengthening exercises, stabilization techniques, and heat/ice treatments because they offer patients with LSS effective management. This is based on the study's findings. [8]
Exercise is much better than doing nothing, cycling and body-weight-supported treadmill walking have similar effects, and corsets are better than not wearing them, however, the evidence from Luciana et al. RCT results is of low quality [13].

Michael J et al. included 259 participants (mean [SD] age, 72.4 [7.8] years; 137 women [52.9%]) who were randomly assigned to medical care (88 [34.0%]), At 2 months, adjusted between-group analyses revealed that manual therapy/individualized exercise improved symptoms and physical function more than medical care (2.0; 95% CI, 3.6 to 0.4) or group exercise (2.4; 95% CI, 4.1 to 0.8). When compared to medical care (7.6% and 48.7%, respectively) or group exercise (3.0% and 46.2%, respectively), manual therapy/individualized exercise had a higher proportion of responders (30% improvement) in symptoms and physical function (20%) and walking capacity (65.3%) at 2 months. There were no differences in mean outcome scores of both groups responder rates at 6 months. In a randomized controlled.

As a result of these RCTs, it is clear that manual therapy provides better short-term outcomes and can improve walking capacity with nonsurgical approaches. [11]

Maynooth t et al. present findings from a comparison of aquatic physical therapy and conventional physical therapy with (n=24) and analyzed using repeated functional measures right away and Wilcoxon at 33-month follow-up. The findings indicate that aquatic therapy, which is a safe and enjoyable intervention, can provide better short-term improvement in pain and function than Masakazu et al. used single-centered open-labeled randomized controlled trials and analyzed the study using usi. ICQ physical function, self-paced walking test (SPWT) performance, pain as judged by a numerical Pain rating scale (NPRS), and daily step count as measured by a pedometer were all secondary outcomes. Random assignment was used to place patients with LSS in either a PT (supervised PT twice a week for 6 weeks) or a home exercise (HE) group. Manual therapy, individually tailored stretching and strengthening exercises, cycling, and body weight-supported treadmill walking were all part of the physical therapy sessions. At random, 43 patients were split into the PT group and 43 patients into the HE group. Compared to standard therapy, but with weaker support from research [12].

In comparison to the HE group, the PT group had a higher percentage of responders who met the minimal clinically significant difference in ZCQ symptom severity (30.2% [9.1-48.6], p=.01), ZCQ physical function (32.6% [11.6-50.6], p.01), SPWT walking distance (39.5% [18.8-56.7], p.01), and NRS leg pain (34.5% [18.8-56.7], p.01).

As a result, supervised physical therapy (PT) for people with LSS significantly reduced symptoms, physical function, walking distance, pain, and physical activity when compared to unsupervised exercise. [10]

According to their review, Faith et.al. found that supervised exercise was superior to self- management or at-home exercise for LSS. Additionally, workouts for core stability, aqua therapy, or aerobic fitness (such as running on a treadmill or cycling) might be advantageous in several different ways. The exercise was combined with the practical and effective application of manual treatment. [15]

Luciana Gazzi Macedo et. al. included 5 RCTs, 2 controlled trials, 2 mixed design studies, and 1 longitudinal cohort study in their review. The combined results of two studies revealed that adding a physical therapy modality to exercise had no statistically significant effect on outcomes. The pooled effects results of RCTs comparing surgery to physical therapy revealed that surgery was superior to physical therapy only in the long term (2 years). Other findings indicated that exercise is superior to no exercise, that cycling and body-weight-supported treadmill walking has comparable effects, and that corsets are superior to no corsets.

However, no conclusions could be drawn from the review as to which physical therapy treatment is superior for LSS In their RCT, Masakazu Minetama et al. enrolled 86 patients and administered therapies twice weekly for six weeks. The main result was the severity of symptoms on the Zurich claudication questionnaire after a year. Physical function, discomfort, health-related quality of life, and the surgery rate after a year were considered secondary outcomes. At one year, more patients in the physical therapy group than in the home exercise group experienced minimum clinically significant differences in the severity of Zurich claudication questionnaire symptoms (60.5% vs. 32.6%; adjusted odds ratio [AOR] 4.3, [95% CI [1.5-12.3], P = 0.01); physical function on the Zurich claudication questionnaire (55.8% vs. 32.6%; AOR 3.0 [1.1-8.1], P = 0.03); bodily pains surgery rate at 1 year was lower in the physical therapy than in the home exercise group (7.0% vs 23.3%; AOR 0.2 [0.04– 0.9] P = 0.04). Accordingly, the study comes to the firm conclusion that supervised physical therapy resulted in higher improvements in symptom severity and physical function than unsupervised exercise and was linked to a lower risk of needing surgery within a year. [17].

30 patients with lumbar spinal stenosis were randomly assigned to one of two 33-week physical therapy regimens (experimental group, n=15; control group, n=15) by S Kumar et al. Exercise programmes for flexibility, strengthening, and functional/recreational activities were a part of the first programme, while exercise programmes for electrotherapy and canal expansion were a part of the second programme (Hot fomentation, IFT, Flexion Exercises). Indicators of success To gauge perceived improvement, the Oswestry Disability Questionnaire was utilised (ODQ). Secondary outcomes were the Modified Schober Test, Straight Leg Raise, Slump test, and Numeric Pain Rating Scale (NPRS) (MST). It suggests that integrated exercise management has a more significant impact than conventional PT management.

This study published in the pen Journal of Therapy and Rehabilitation concludes that manual therapy along with basic therapeutic exercise objectives provides the following manual techniques yielded positive results: flexion-distraction manipulations, sidelying lumbar rotation thrust, and posterior-to-anterior mobilizations, side-lying to side bending manipulations, thoracic thrusts, and neural mobilizations. It may include lumbar spine and hip mobility exercises, lumbar bending and rotation exercises, spinal flexibility exercises recommended to patients i.e. thoracic extension self-mobilization or stretching exercises and lumbar rotation exercise core strengthening/stabilization is one of the most useful treatment programs for low back pain and it may benefit from the use of biofeedback, the treatment with biofeedback is called RUSI. [18]

Carlo Ammendolia et al. conducted a systematic review of 177 trials and concluded that there is moderate-quality evidence from three trials that: manual therapy

Table 1: Summary of Included articles

Author	Title	Patie nt age	Interventions	Outcome Measures	Results
Michael J et al.	Comparative Clinical Effectiveness of Nonsurgical Treatment Methods in Patients With Lumbar Spinal Stenosis A Randomized Clinical Trial	>50	Manual therapy/ individualized therapy, Group exercises, and Medical care		Manual therapy/ individualized exercise had a greater proportion of responders (30% improvement) in symptoms and physical function (20%) and walking capacity (65.3%) at 2 months compared with medical care (7.6% and 48.7%, respectively) or group exercise (3.0% and 46.2%, respectively)
Luciana Gazzi Macedo et al.	Physical Therapy Interventions for Degenerative Lumbar Spinal Stenosis: A Systematic Review	40 or > 40	Massage, Strengthening, Flexion exercises, Aerobic conditioning, Bracing/ Walking Devices	MA Modified version of Newcastle – Ottawa Quality Assessment Scale, Self-Assessment Scale	Exercise is significantly better than exercise, that cycling and body-weight – supported treadmill walking have similar effects, and corsets are better than no corset. But No conclusions could be drawn from the review regarding which physical therapy treatment is superior for LSS
Masakazu Minetama et al.	Supervised Physical therapy vs. Home exercise for patients with lumbar spinal stenosis: a randomized controlled trial	All age groups	Manual Therapy, Individually Tailored Stretching, strengthening exercises, cycling and Body weight-supported treadmill training	Zurich Claudication Questionnaire (ZCQ), self-paced walking test (SPWT) performance, pain indicated using a numerical rating scale (NRS), and the number of daily steps measured by pedometer	Supervised PT for patients with LSS resulted in significant short-term improvements in symptom severity.

S Kumar et al.	Effect of integrated exercise protocol in lumbar spinal stenosis as compared with conventional physiotherapy-a randomized control trial	>50	Flexibility exercise, Specific experimental canal enlargement exercise, strengthening exercise, functional/ recreational activities), while the other included electrotherapy and exercise program (Hot fomentation, IFT, Flexion Exercises).	ODQ, NPRS, S LR, Slump test, and MST	It suggests that the integrated exercise approach has significant effect than conventional PT management
Kaynoosh t et al.	Comparison of the effect of aquatic physical therapy and Conventional physical therapy in patients with lumbar spinal stenosis (a randomized controlled trial)	50-80	Aqua Therapy and Conventional Physical Therapy	Repeated Measure Test, Wilcoxon Test, Man - Whitney Test	Aqua therapy is more effective than conventional therapy
Carlo Ammendol ia et al.	Non-operative treatment for lumbar spinal stenosis with neurogenic claudication: an updated systematic review	>30	Manual Therapies and exercises, community-based group exercises.	Repeated functional measure	Moderate-quality evidence from three trials that: Manual therapy and exercise provides a superior and clinically important short- term improvementin symptoms and function compared with medical care or community- based group exercise

Faith Ogden et al.	The effectiveness of physical exercise in patients with lumbar spinal stenosis: a systematic review	>18	Core stabilization, aqua therapy, or aerobic (e.g., treadmill, cycling) exercises, ergometric cycling	-	Results showed that Supervised exercise was more effective in LSS than self-management or home exercise. In addition, core stabilization, aqua therapy, or aerobic (e.g., treadmill, cycling) exercises can be advantageous in different parameters.
Luciana Gazzi Macedo et al.	Physical Therapy Interventions for Degenerative Lumbar Spinal Stenosis: A Systematic Review	>18	Ultrasound, TENS, and the eat pack to an exercise, Aqua Therapy, Treadmill training, Flexion exercises, Strengthening and core stabilization technique, lumbosacral corset/ assisted devices	Based on Pain and Disability	Ultrasound, TENS, and heat packs for an exercise program at short-term follow-up. The pooled results demonstrated that the addition of modalities had short-term effect than no modalities also corset is better than no corset.
John K Hsiang et al	Spinal Stenosis	>50	Home exercise program (e.g., flexion-biased lumbar stabilization, flexibility training, gluteal strengthening, aerobic conditioning),	Pain and Disability	Specific exercises show better improvement than no exercise
Masakazu et al.	Supervised physical therapy versus unsupervised exercise for patients with lumbar spinal stenosis: 1-year follow-up of a randomized controlled trial	>50	Supervised HE (Flexion exercise, aerobic and treadmill training, core stabilization, lumbosacral corset/ walking assisted device) and N Non specific treatment	ICQ NPRS SPOT	Supervised PT for patients with LSS resulted in significant short-term improvements in symptom severity, physical function, walking distance, pain, and physical activity compared with unsupervised exercise.
Oswestry Disability Questionnaire (ODQ), Numeric Pain Rating Scale (NPRS), Straight Leg Raise (SLR), Slump test and Modified Schober Test (MST), SSelf–PacedWalking Test (SPWT), Home Exercise (HE)					

and exercise provide a superior and clinically important short-term improvement in symptoms and function compared to medical care or community-based group exercise while demonstrating superior and clinically important improvements in walking distance in the immediate too long term compared with self-directed home exercises.[23]

According to John K Hsiang et al., patients with lumbar spinal stenosis should be educated on how to avoid aggravating factors like excessive lumbar extension and downhill ambulation. Furthermore, patients should be instructed on proper posture and given instructions for a home exercise program (e.g., flexion-biased lumbar stabilization, flexibility training, gluteal strengthening, aerobic conditioning), but the effectiveness of specific interventions cannot be guaranteed. [29]

Back Pain: Discogenic; May 2022, Ya-Ting Chen et al. The most effective treatment option is multimodal physical therapy, but efficacy was not demonstrated in the study. There are several limitations to the current systematic review that should be addressed. To begin, due to the diverse designs of the included studies, only narrative synthesis could be provided. Second, we were unable to access several databases. Third, presenting the effectiveness of a specific type of exercise on spinal stenosis could provide more detailed practical information; however, the number of studies available for inclusion in this systematic review was limited. Finally, due to human error, some studies on this topic may have been overlooked

Discussion

The diversity of interventions as well as the variation in study designs was a weakness of this review. This failure made it delicate to compare studies. Because treatments were constantly" whisked," the impact of a specific physical remedy treatment couldn't be bandied. Physical remedy programs were also constantly listed as "typical physical remedy treatment" without being described in detail (e.g. Parameters, lozenge). Physical remedy programs must be better defined to allow for better interpretation of study results, replication in unborn studies, and operation. Several studies had to be barred because, in addition to physical remedy, surgery, specifics, or epidural steroids were the primary forms of treatment. Because of this limitation, it was delicate to determine What aspect of a case's conservative treatment affected their pain, especially since epidural steroids are a type of pain drug? Still, because we believe that numerous cases will be taking some form of anti-inflammatory or pain drug while entering physical remedy treatment for LSS, we allowed NSAIDs to be used as part of conservative treatment as long as they weren't a major part of the treatment. In one study comparing physical remedy, education, and NSAIDs to surgery, 52 nonsurgical cases also entered steroidal injections. Also, Exercise appears to be a common point of the interventions studied; still, the stylish type of exercise (specific or general), weight loss protocols, corsets, and the addition of primer remedy and other forms of treatment to exercise must be determined. Further mechanisms of action for these and other interventions must be precisely considered and presented to support long term effectiveness of physical therapy in term of improvement in LSS

Conclusions

According to the findings of this review, supervised exercise was more effective in LSS than self-management or home exercise. Physical therapy with a multimodal approach is the most effective treatment option, for example, massage, flexibility and strengthening exercises, stabilization techniques (Core Stabilization), and heat/ice therapy, aqua therapy, or aerobic (e.g., treadmill, cycling) exercises can be beneficial in different parameters along with psychotherapy or behavioral therapy. Clinicians' treatment beliefs should take a patient-specific approach into account. So this is concluded that integrated exercise management has a more significant impact than conventional (only spinal flexion exercise therapy) PT management and provide significant improvement, when corset and exercises are continued by patient in their daily routine.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: Jain S, Singh S, Tyagi G P. Effectiveness of Physical Remedy in Lumbar Spinal Stenosis: A Systematic Review. Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 13-20

Original Article

Effect of Earphones on Hearing Impairments Among College Going Students

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Abstract

Introduction: Loud noise can damage the hair cells. When this happens, the cochlea can't relay sound messages to the brain as well. Unlike damage to other parts of body, inner ear damage never heals. Over time, as more and more hair cells get damaged, hearing will get worse and worse. Earphones can damage the ears if they are used for a long period of time at a high volume, and can result in partial to complete hearing loss, and so on. **Aim:** The goal of this study is to determine whether using in-ear headphones affects the health of students. **Methodology:** The study includes the students of age range between 18 to 25 yrs. A random selection of 150 students participated in this purposive survey. The students answered a self- administered questionnaire about their hearing loss and earphone use habits. **Result:** According to the study's findings, 60.2% of students have hearing problems, and the most common cause is the excessive usage of in-ear headphones. Only 0.2% from control group having hearing problems.

Key words: Hearing, Impairment, Headphones, Earphones

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Introduction

A set of tiny listening devices called earphones is intended to be worn on or around the user's head over their ears. Earphones are little devices that are introduced into the outer ear and are not placed inside the ear canal. These are transportable and useful. (1)
One of the most significant issues concerning social and public health is noise-induced hearing loss (NIHL). For instance, the results of the third National Health and Nutrition Examination Survey (NHANES III) in the United States revealed that children were exposed to too much dangerous noise levels (2).
The frequency and incidence of hearing loss are very high in India. This global and Indian burden of deafness is primarily preventable and avoidable. Between 4.6% and 8.8% of people in South-East Asia are deaf. In the 58th round of the National Sample Survey, which was conducted in 2002, hearing impairment was shown to be the most significant sensory deficit and the second most frequent cause of disability in Indian families. The WHO survey has compiled a list of the principal causes of hearing loss and ear conditions in India. The most typical factor leading to reversible hearing loss was ear wax (15.9%). The second most frequent non-infectious causes of hearing impairment in India are presbycusis and aging (10.3%). Other major causes of hearing loss include middle ear infections including chronic suppurative otitis media (5.2%) and serious otitis media (3%). The other reasons are bilateral hereditary and congenital deafness (0.2%) and dry tympanic membrane perforation (0.5%). (3)
Most teenagers and young people today frequently listen to their MP3 players at maximum level, exposing them to hours of loud music on purpose. According to several studies, teenagers and young adults who use headphones have lower hearing thresholds than those who do not use them. It is alarming that portable music players and other devices that link directly to the ear, like cell phones, are becoming more and more popular since they could increase the prevalence of hearing loss in young people. (4,5)
In 2011, Ansari and colleagues conducted descriptive research in Tabriz, in the northwest of Iran, to look at how 2359 high school pupils used headphones and music players. The findings revealed that 36.8% of participants listened to music nonstop for an extended period, 49.6% of students admitted to listening to music that was "quite loud" or "extremely loud," and 44.3% of respondents said they had previously experienced hearing issues. In another descriptive study conducted in India, it was shown that 91.2% of college students wore headphones, 10.4% of them for longer than an hour each day, and 52% of them were set to a volume greater than three-quarters of their maximum output (6).

Methodology

Materials: Questionnaire (The 17-Item Hearing Loss Questionnaire), Laptop
Location and Sample: The study was conducted in the Swami Vivekananda Subharti University of Meerut. Total 150 students both male and female were chosen for the study and they all were from Swami Vivekananda Subharti University, Meerut.
Study design: Purposive study
Methodology: A survey prior to the study was conducted so that we can find out the use of different gadgets and how much time they spent on them. The sample were chosen using a purposive sampling procedure used to evaluate the results, between students of 18 to 25 years of age. A questionnaire (The 17-Item Hearing Loss Questionnaire) was used to determine whether the ear phones effect the hearing. For the study, a total of one hundred fifty (150) participants were included. The following two groups

were formed by splitting up the subjects into two groups on the basis of survey: Group A, which included 75 headphone users, served as the study group, while Group B, which included 75 non-users of headphones, functioned as the control group. A questionnaire was given out asking about sex, age, hearing problems in the past, how long people had been using headphones, what volume they preferred, and in which ear mostly they preferred to use the headphones.

Result

150 students that were chosen for the study took part and answered the questionnaire (response rate: 100%). The sample's pupils ranged from 18 to 25 years, with an average age of 21.15 (standard deviation: 3.10). 64.5% of the students were female and 35.5% were male, on average. Additionally, the findings of the survey revealed that 86.4% of the individuals had worn headphones. The majority of the participants (81.7%), laptops (10.8%), computers (4.1%), and MP3 players (3.4%) have all been used to listen to music. Regarding the uses of earbuds, 89.6% of the participants said they wore them to listen to music, 4.6% to attend lectures, 4.2% to practice their English, and 1.6% to play video games. According to the findings, earbud-style earphones were used by 51.3%, supra-aural earphones by 42.2%, and headphones by 6.5% of those who used earphones. 28% of the students said they had listened to music that was "somewhat loud" {gain set at 50%–75% or "extremely loud" (gain set at more than 75%)}. 32% of the students said that using earbuds made them queasy. The descriptive data also showed that 86 (57.3%) students never lowered the volume while listening with headphones, compared to 64(42.67%) students who did so constantly or frequently. Only 12 (8.1%) of the students who listened for an extended period of time using headphones said they took a break. In comparison to control group students, individuals who used earbuds more frequently during the week, for a
longer period of time, and more frequently overall scored higher for hearing loss. Notably, 60.2% of the students reported having hearing loss or impairment in the past. Of the overall sample, 26 students reported a history of ear disease, 42 students reported hearing loss, 28 students reported ear infection, and 54 students reported ringing in the ears and dizziness.
According to the study's findings, 60.2% of students from experimental group having hearing problems, and the most common cause is the excessive usage of in-ear headphones. Only 0.2% from control having hearing problems.

Discussion

In this study, a sample of students from SVSU were used to determine the link between earphone use and hearing loss. According to the findings, around 60% of the students had a history of ear conditions, ear infections, tinnitus, or vertigo that could have caused hearing loss or impairment. Review of Literature suggest that students in India frequently used earbuds (86.4%). According to recent research on Iranian students by Wandadi et al. [5] and on coastal South Indian students by Rekha and colleagues [8,9]. Nearly one-third of India high school students, according to another study, listen to music for longer than two hours each day. According to a study by Ansari and colleagues 44.3% of the high school pupils in Tabriz, Iran, had a history of hearing loss or injury. A number of studies from Iran and other nations have also shown that teenagers and young adults misuse earbuds by listening to loud music, wearing them nonstop, and failing to take breaks while doing so. The improper earphone usage may be a result of their ignorance about the dangers of listening to loud music. [10,11]
Improving awareness is crucial to combat the improper use of earbuds among Indian young population because there is a rising tendency in the usage of earphones and personal listening devices [12] among adolescents and youth.
Additionally, because hearing loss and temporary or permanent tinnitus are relatively common in young people and adolescents [10,13], it is important to develop environmental interventions and training programs to increase awareness of these issues among these group's[14]. However, it appears that increasing awareness alone is insufficient to change this age group's attitude and performance [15].
The frequency of listening to loud or extremely loud music differs by nation. For instance, research in Brazil and the USA estimated that 37.4% and 35% of people, respectively, listen to loud or very loud music. The subjects' ages and other sociodemographic characteristics, such as cultural differences, may have an impact on the observed differences. The findings revealed that although only 6.5% of students reported using earphones, they were more likely to use compact, portable devices like earbuds (51.3%) and supra-aural earphones (42.2%) that went straight into their ear canals. These findings agreed with those of previous research conducted in different nations [4,16]. Young people may use in-ear headphones more often because they come with personal music players or because they are less expensive than other types of earbuds [17]. In-ear headphones are still thought to carry a higher risk of hearing loss than other types of headsets [18].
In-ear headphones can significantly increase the risk of ear infection and bacterial transmission if these devices are shared. Studies have shown that those who use earphones rather than headsets prefer to listen to loud music.
Finally, the results of the ROC curve (0.706), which compares hearing loss measured by the designed questionnaire suggested to identify hearing loss. The proposed questionnaire can therefore be used in comparable research, especially in developing countries where the resources are too limited to employ other standard methods, given the relatively low cost connected with the use of the questionnaire to detect hearing loss problem. As the recent reviews suggest, in some countries, for example in Canada, hearing loss was mainly measured using self-reported data. Using the designed questionnaire to assess hearing loss may be better than using self- reported hearing loss.
This is because some studies have already demonstrated that self-reported hearing loss may underestimate hearing loss problem, especially in mild and moderate hearing loss among the youth.[20,21].

Conclusion

In conclusion, this study suggested that students have a risky pattern of using listening devices. In order to implement interventions and develop methods for

improving students' understanding and attitude about the use of personal listening devices, greater attention is needed to the higher hearing loss score among headphone users. Therefore, it is recommended that an over the ear type of headphone should be used, rather than the ear plug type and better still, a noise cancelling type of headphone should be used.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: Tyagi A, Anandabai J, Singh S, Tyagi G P. Effect of Earphones on Hearing Impairments Among College Going Students. Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 21-3

Original Article

Analysis Effect On Boron In Grade 40 Cast Iron

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Abstract

As we know, nowadays use of boron in automotive steels progressively contaminates cast iron charge mixtures. There are opinions about the effect of boron on the structure and the properties of cast iron no agreement about acceptable critical concentrations of this element. Therefore, an experimental study was perform to uncover the effects of boron in gray cast iron of Garde-40. Ferro-boron additions increased boron up to 130 parts per million in laboratory heat. Thermal analysis was utilize to determine the effect of boron on phase transformations during eutectoid transformation and solidification. Mechanical property test and microstructural analysis were conduct to assess the effect of boron on different carbon equivalents. The results showed that the effect of boron in gray cast iron was significantly affected by carbon equivalent. A preliminary discussion about the mechanisms of boron effects on phase transformations and properties of gray cast iron is present

Key words: Boron, Cast Iron, Thermal Analysis

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Introduction

Casting capabilities, sound physical and mechanical properties, simplicity in production, and the lost cost makes gray cast iron versatile in industrial applications. Although most properties are affected by the chemical content of elements like C, Si, Mn, and Cr the trace elements in gray cast iron also have their fair part of the contribution towards enhancing the properties of the casting. One of these trace elements which has been causing some problems for the Iron foundries is boron.

During the last decade, the addition of boron to automotive-grade steel has increased. The hardenability provided by boron has found many applications in automotive panel-grade steels. This boron-added steel then finds its way through waste into the gray cast iron charges. Problems have been received from the gray cast iron foundries about intended quality control issues with such boron-added material. Another source of boron in gray cast iron can be the fresh furnace linings.

The effect of boron on gray cast iron is not very precisely studied. Boron is known as a strong carbide stabilizer. According to Ankama et.al [1], the presence of boron above 550ppm can be disastrous to the iron in terms of chill and cracking problems in thin section castings. It can also cause the formation of undesired graphite flake structures like another grade of boron and reduce the strength of the material. Smaller graphite structures like another grade of boron can create small carbon diffusion distances from the matrix to the graphite flakes ultimately creating regions of ferrite that can adversely affect the mechanical properties of gray cast iron. Boron is recommended to be maintained under 50 ppm to avoid the chill.

The effect of boron is that it is a ferrite stabilizer [2]. Presence can cause severe effects on pearlitic grades of gray cast iron. Boron may prevent with pearlite stabilizing elements like Cu and Mn resulting in 'soft' pearlitic castings. Prevents the diffusion of carbon and Cu alloying tend to segregate to the austenite-graphite interfaces, resulting in the transformation of austenite into pearlite. Therefore, disrupting the effect of Cu and boron may accumulate around graphite. This segregation of boron was confirmed by another author using secondary ion mass spectroscopy [3]. Boron was detected surrounding graphite nodules in ductile iron. The boron content used in that study was 50 to 60 ppm. The ferrite stabilizing effect of boron was also shown in ductile iron [4] where specimens higher in boron were found to have an increased amount of free ferrite and consequently a reduction in pearlite.

The effect of boron on austenite is said to be similar to that of Ti, and boron additions can stabilize nitrides that serve as substrates for the nucleation of austenite [5]. Another effect can be increased undercooling and the reduction of graphite nucleation potential. The effect of boron on graphite flake size was studied by Alexander et.al [6]. The study concluded that the higher additions of boron reduce graphite flake size. Therefore, it should be noted that this study dealt with B levels of 0.003wt. % to as high as 0.34wt. %. In the same study, increasing boron content was seen to decrease the temperature gap between liquidus and solidus temperatures and increase the undercooling effects.

The purpose of this check, funded by the American Foundry Society, is to provide experimental information on the effects of boron in gray cast iron of different grades. This article reports Phase-I results dedicated to Class-40 cast iron. The properties under investigation were thermal analysis parameters, microstructure, chilling tendency, strength, and hardness.

Methodology

Two types of Grade 400 GI heat was cast in the laboratory. Heats were perform in a 210lbs induction furnace. The first heat was plan to be a high carbon equivalent (CE) heat with a CE target of 4.3-4.4 (high-CE) the second with a CE target of 4.0-4.1 (medium-CE). Future studies will be perform with low CE also (3.8-3.9) effect of boron was study across four different levels of boron addition for the same chemistry. The initial chemistry had no boron addition. Then the boron was intentionally added in level of 20ppm, 40ppm, and 100ppm. The boron addition was complete in the induction furnace to enhance the boron recovery [6].

The charge for both the heat consist of high-purity induction iron ingots, ferrosilicon, ferromanganese, metallic chromium, high-purity graphite, and foundry returns from our foundry sponsor (Table 1). An argon cover at a flow rate of 25 SCFH was use to increase recovery rates. The target chemistries for high-CE and medium-CE heats are given in the Table.2

* Inoculant composition: Si: 70wt. %; Al: 0.17wt. %; Sr: 0.76wt. %; Co: 0.039wt. %

Table 1. Chemical composition (wt. %)
Si target before inoculation

Heat	C	Si	CE	B (ppm)	Cr	Mn
High-CE heat	3.40	2.5 - 2.6	4.3	2/20/40/100	0.10 - 0.15	0.20 – 0.30
Medium-CE heat	3.35	1.8 - 1.9 #	4.0	2/20/40/100	0.15 - 0.20	0.45 – 0.55

Check the CE in the melt, thermal analysis with tellurium (Te) added cups were used. The tapping temperature for the heat was maintained between 1360-1380°C. The metal was tapped into 22lbs hand ladles. A total of four chemistries were planned for the heats with varying boron additions. The 1st chemistry was no boron-added, 2nd 20ppm. 3rd 40ppm and the 4th 100ppm boron additions. Chemistry required two hand ladles. The inoculation was done for each hand ladle during tapping. The inoculant used for the heats was Superseded (Si 70%) and was taken as 0.2% weight of each hand ladle capacity.

In order to check the chemical composition of each chemistry, two types of samples were taken: an immersion sample and a sample poured into a Cu chill mold. To understand the boron effect on the mechanical properties of gray cast iron, multiple molds were poured for each chemistry, including a step block, ASTM A48 B-bar molds, and a chill wedge. The step block (Figure 1) had four steps 5, 10, 20, and 30mm. A total of 6 boron-bar samples were obtained from each chemistry.

Charge Source	C	Si	B	Cr	Mn	Cu	P	S
Waupaca foundry returns	3.46	2.14	0.0004	0.21	0.58	0.21	0.029	0.086
Induction iron	0.0017	0.002	0.0001	0.01	0.01	0.002	0.005	0.0025
Ferro-Silicon (Fe75Si)	--	75	--	--	--	--	--	--
Ferro-B (Fe18B)	0.26	0.57	18.52	--	--	--	0.028	0.003
Desulco graphite	99.99	--	--	--	--	--	--	--
Inoculant *	--	70	--	--	--	--	--	--
Metallic chrome	-	-	--	98	--	--	--	--
Ferro-Manganese	1.00	1.00	--	--	76	--	--	--

Table 2. Target chemistries (wt. %) for the heats.

Perform thermal analysis by obtaining the cooling curves from ATAS software using non-Te-coated cups. The obtained cooling curves were used to analyze the effects of boron on eutectic and eutectoid reactions. The variation in critical parameters of the cooling curves was studied as suggested in the work of J. Sertucha et.al [7] and Stefanescu et.al [8] to understand the effect of boron on solidification and solid-state transformations of gray iron. The nomenclature of the used parameters is shown in Figure 2[8].

Step blocks taken in specimens for optical metallography. The specimens were sectioned from the center of the step block and the center of each step as shown in (Figure1). Polishing for optical metallography was performed by standard metallographic techniques. Unetched and etched images were taken from each specimen. 3% Nital was used as the etchant. For quantifying the matrix and graphite flake structure, images were analyzed using ImageJ software.

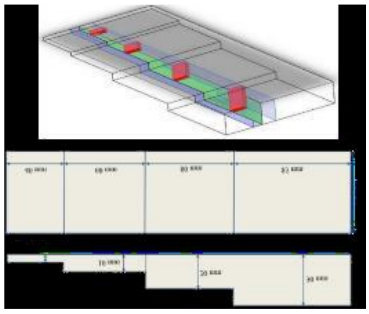

Fig -1: Side, top, and isometric view of step block. The red area was used for metallographic analysis and hardness was measured in the green section.

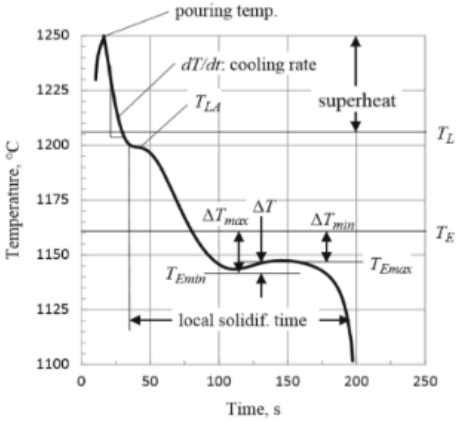

Fig -2: Nomenclature of the used parameters of thermal analysis (from the ATAS software [8].

The chemical composition analysis was done using optical emission arc spectroscopy (OES) and combustion analysis using a commercial C/S and O/N analyzer. The B content of the standards used is given in Table. 3.

Tensile tests were performed on a 250kN servo-hydraulic load frame in accordance with the ASTM A-48[9]. Test bar specifications used for the tensile test were according to the boron-type test bar. The tensile test was performed at a strain rate of 0.02mm/s. Hardness tests were performed on a Brinell hardness tester, and the tests were performed following the ASTM E10-18[10]. Standard hardness blocks were tested before and after the test of actual specimens. Hardness tests were repeated four times per sample and only for the 20mm and 30mm steps of the step blocks.

Table 3. OES calibration for B (ppm). OES values are the average of six measurements.

Standard Name	Certified B (ppm)	OES B (ppm)
BS 4C	2	1
34A	76	72
RN 14/39	30	38
RG 14/161	400	400

The chemical compositions of the heat obtained from the OES are given in Table. 3. To check the boron content as low as possible, a 2ppm boron standard was used. All the standards were tested before testing the actual specimens. The actual chemistries of the heat were close to the target chemistry. It should be noted that Cr and Mn content ranged from 0.12wt.% to 0.20wt.% and 0.30 wt.% to 0.50wt.%, respectively. Si was reduced from 2.7 wt.% to 2.0 wt.% from the high-CE heat to medium-CE heat. The target carbon content was higher for both the heats by 0.1wt.%. In this article, boron additions were used for data analysis.

Table 4: Future comparisons will be performed for heats with different CE using actual boron concentrations.

Heat	Ladle	B-added	C*	Si	CE	B (ppm)	Cr	Mn	Cu	P	S*	Sn	Heat
High-CE Heat	1A	NoB-added	3.56	2.70	4.46	22	0.12	0.29	0.14	0.028	0.064	0.013	1A
	1B	20	3.52	2.77	4.44	38	0.12	0.29	0.13	0.028	0.071	0.013	1B
	1C	40	3.47	2.69	4.37	56	0.12	0.29	0.13	0.028	0.071	0.014	1C
	1D	100	3.53	2.67	4.42	113	0.12	0.29	0.14	0.030	0.074	0.014	1D
Medium-CE Heat	2A	NoB-added	3.45	2.05	4.13	5	0.21	0.58	0.034	0.025	0.020	0.009	2A
	2B	20	3.44	2.07	4.13	25	0.21	0.58	0.036	0.023	0.019	0.008	2B
	2C	40	3.41	2.03	4.09	46	0.21	0.58	0.034	0.024	0.017	0.008	2C
	2D	100	3.39	2.07	4.08	98	0.21	0.59	0.035	0.024	0.018	0.008	2D

* C, and S readings taken from commercial C, S, N, O analyzer

ATAS software obtained for thermal analysis parameters using the non-Te cup is shown in Table. 5. It can be clearly seen from the data that the liquidus temperature
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(TL) rises as B content increases. This is true for both the heats irrespective of the CE. Another effect that can be noted is that the eutectic minimum temperature (Temin) dropped as the B content increased. The eutectic cooling curves for high-CE heat are shown in Figure 3 and the cooling curve for medium-CE heat is shown in Figure 4. The observations from Table. 5 are clearly visible in these graphs.

Table 5. Thermal analysis data obtained from ATAS software for both the heats.

Heat	High-CE Heat				Medium-CE Heat			
Chemistry	No B-added	20ppm B-added	40ppm B-added	100ppm B-added	No B-added	20ppm B-added	40ppm B-added	100ppm B-added
Liquidus Temp, TL (˚C)	1157.3	1157.3	1158.4	1159.3	1193.3	1195.8	1199.3	1202.2
Eutectic Start (˚C)	1154.9	1154.5	1155.5	1155.1	1176.9	1178.6	1180.3	1180.9
Eutectic Minimum, Temin (˚C)	1151.4	1149.7	1151.4	1150.3	1147.5	1146.3	1146.7	1144.8
Eutectic Maximum, TEmax (˚C)	1154.2	1153.2	1154.8	1153.8	1150.5	1150.1	1149.9	1148.2
Solidus Temp, TSol (˚C)	1109.4	-	1108	1108.4	1100.8	1108.5	1106	1107
Recalescence, ΔT (˚C)	2.8	3.5	3.4	3.5	3.0	3.8	3.2	3.4
Graphite Factor 1	70	-	69	75	72	75	62	71
Graphite Factor 2	20	-	20	17	24	19	32	35

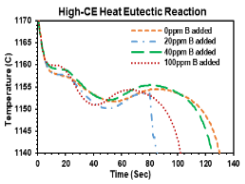

Fig 3. Eutectic cooling curve for high-CE heat.

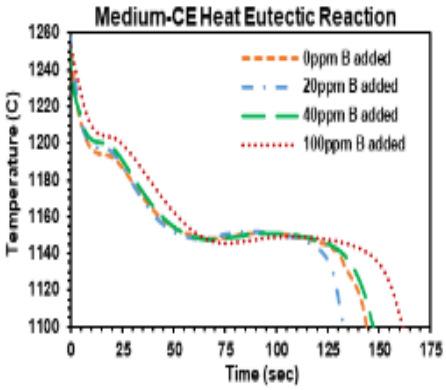

Fig 4. Eutectic cooling curve for medium-CE heat.

The cooling curves shown in Figure 5 and Figure 6 represent the eutectoid reactions for high-CE and medium-CE heats respectively. The red-dotted line represents the VTrans for the eutectoid reactions. Eutectoid parameters like temperatures of eutectoid low and the eutectoid recalescence were analyzed to understand the effect of B in solid-state transformation reactions. In addition, the 1st derivative of the cooling curve was plotted against the temperature for the eutectic and eutectoid reactions to analyze the change in cooling rates related to the latent heat liberation and the eutectoid parameters like VTrans. These graphs are presented in the discussion part of this article.

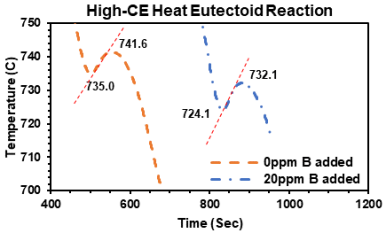

Fig 5. Eutectoid reaction curve for high-CE heat.

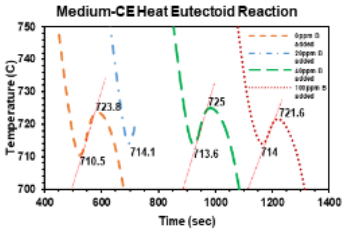

Fig 6. Eutectoid reaction curve for medium-CE heat.

Etched and unetched microstructures obtained from the 30mm step of high-CE heat are shown in Figure 7 and Figure 8. Higher ferrite content is observed in the matrix of higher boron specimens. Although image 1A in Figure 7 seems to have a higher ferrite content, it must be noted that the area represented in the metallographic analysis is very limited and thus cannot be accurately considered as a complete representation of the structure. The unetched and etched microstructures from the 30mm step of the medium-CE heat are shown in Figure 9 and Figure 10. No considerable difference between the specimens can be seen. Although it can be noticed that the ferrite content is higher in high-CE heat as compared to medium-CE heat which is understood because of the higher Si

content in the former. Analysis of the microstructure images from the smaller steps i.e., 10mm and 20mm of both the heats was also performed. As the cooling rates in the smaller steps are higher, the microstructure was mainly pearlite, and the ferrite content of the microstructure was low as compared to the 30mm step. The etched images from the 20mm step for the high-CE and medium-CE are given in Figure 11 and Figure 12, respectively. Similarly, microstructure images from the 10mm step for the high-CE and medium-CE are shown in Figure 13 and Figure 14, respectively.
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The chill wedge images from high-CE and medium-CE heat are shown in Figure 15 and Figure 16, respectively. The microstructure analysis of the chill wedge was done in five areas, the tip and then at 5mm increments up to 20mm from the tip. It is clearly shown that the chill depth increases for higher boron content for both the heats. The chill depth increased from 7.28mm to 13.1mm as the boron content increased. Carbide structures are visible further away from the tip in higher boron content for both of the heats. Carbide structures in high-CE heat are only seen in the microstructural analysis. The carbide can be seen at a distance of 5mm in the higher boron sample, whereas the low boron samples do not have carbide structures beyond the chill tip portion. This is a clear indicator that boronacts as a carbide stabilizer.

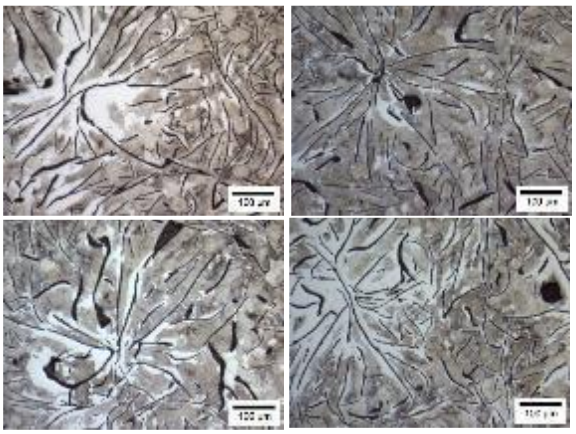
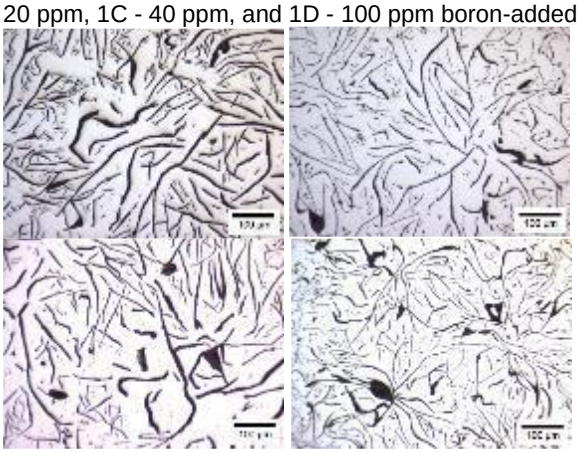


Fig 7. Etched microstructures taken from the 30mm step of the high-CE heat: 1A - no boron-added, 1B - 20 ppm, 1C - 40 ppm, and 1D - 100 ppm boron-added.



``. Unetched microstructures taken from the 30mm step of the high-CE heat: 1A - no boron-added, 1B - 20 ppm, 1C - 40 ppm, and 1D - 100 ppm boron-added.

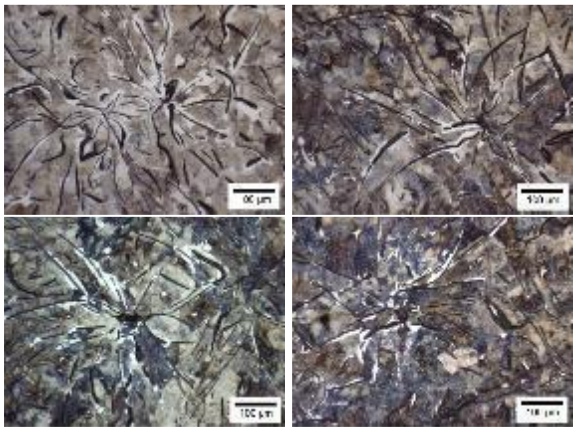


Fig 9. Etched microstructures taken from the 30mm step of the medium-CE heat: 2A - no boron-added, 2B - 20 ppm, 2C - 40 ppm, and 2D - 100 ppm boron-added.

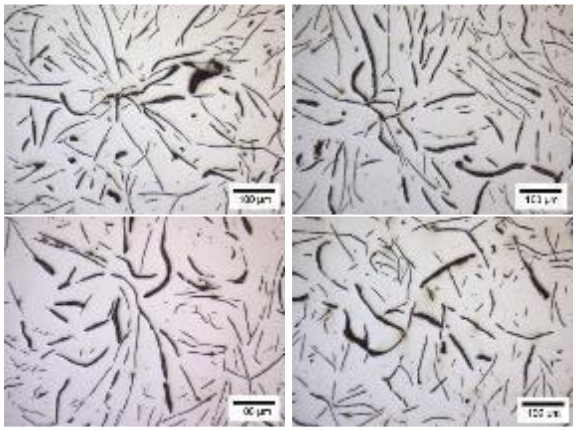
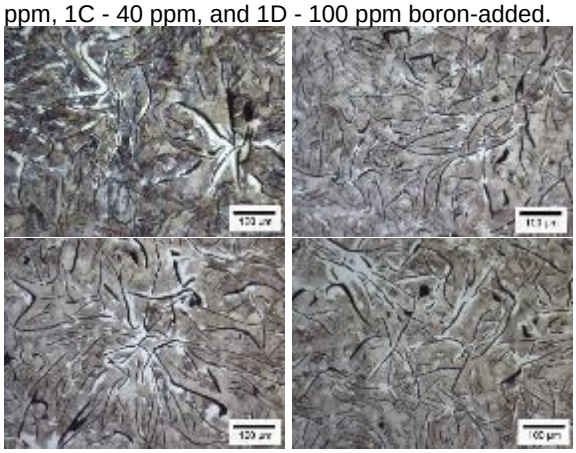


Fig 10. Unetched microstructures taken from the 30mm step of the medium-CE heat: 2A - no boron-added, 2B - 20 ppm, 2C - 40 ppm, and 2D - 100 ppm boron-added.

Fig 11. Etched microstructures taken from the 20mm step of the high-CE heat: 1A - no boron-added, 1B - 20 ppm, 1C - 40 ppm, and 1D - 100 ppm boron-added.



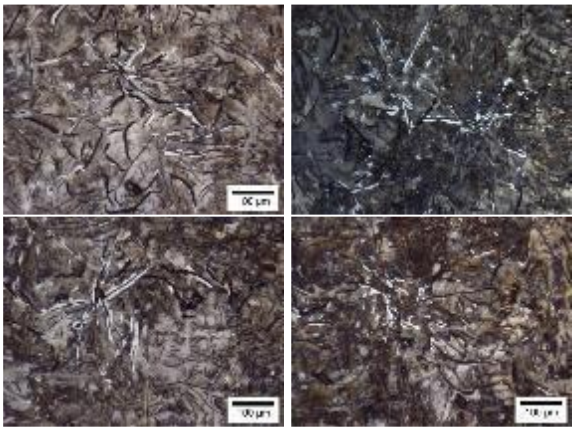


Fig 12. Etched microstructures taken from the 20mm step of the medium-CE heat: 2A - no boron-added, 2B - 20 ppm, 2C - 40 ppm, and 2D - 100 ppm boron-added.

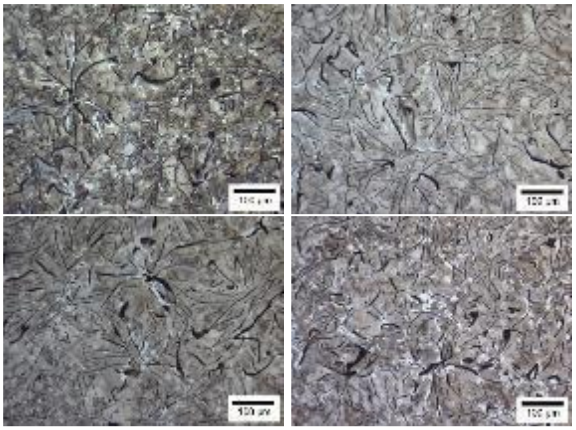


Fig 13. Etched microstructures taken from the 10mm step of the high-CE heat: 1A - no boron-added, 1B - 20 ppm, 1C - 40 ppm, and 1D - 100 ppm boron-added.

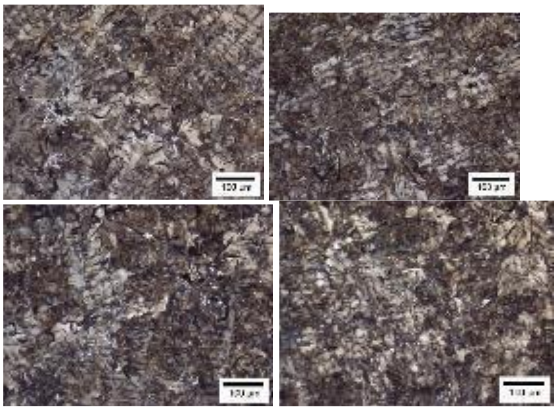


Fig 14. Etched microstructures taken from the 10mm step of the medium-CE heat: 2A - no boron-added, 2B - 20 ppm, 2C - 40 ppm, and 2D - 100 ppm boron-added.

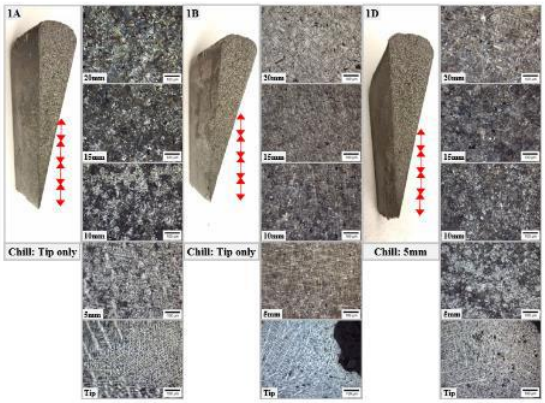


Fig 15. High-CE heat chill wedge fractures and etched microstructures taken at the chill tip and regions at 5mm increments up to 20mm: 1A - no boron-added, 1B - 20 ppm, and 1D - 100 ppm boron-added. The chill tip is not visible in the images.

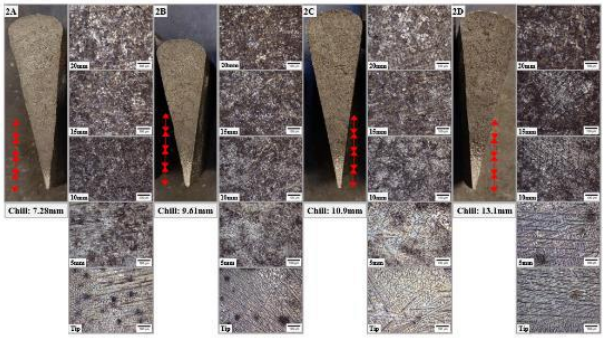


Fig 16. Medium-CE heat chill wedge fractures and etched microstructures taken at the chill tip and regions at 5mm increments up to 20mm: 2A - no B-added, 2B - 20 ppm, 2C - 40 ppm, and 2D - 100 ppm B-added. The chill tip is visible in the images.

The tensile results from the heats are given in Table. 6. The ultimate tensile strength (UTS) of high-CE heat is lower than that of medium-CE heat and this is due to the high levels of Si. A clear trend of increasing tensile strength of the specimens is shown for the medium-CE heat, but this is not the case for high-CE heat. In this heat, the UTS rises for the initial B addition and then decreases when B additions increase. The hardness results are shown in Table. 7 and were in affirmation with the tensile results. The hardness values for the high high-CE heat are lower.

Table 6. Ultimate tensile strengths as a function of boron for both heats.

Heat	Step	No B-added	20ppm B-added	40ppm B-added	100ppm B-added
High-CE heat (CE = 4.43)	Step 4 (30mm)	125± 1	135 ± 5	126 ± 2	125 ± 3
	Step 3 (20mm)	125 ± 5	137 ± 6	128 ± 5	133 ± 2
Medium-CE heat (CE = 4.1)	Step 4 (30mm)	143 ± 2	148 ± 3	153 ± 4	162 ± 3
	Step 3 (20mm)	150 ± 2	153 ± 1	155 ± 5	166 ± 3

Discussion

Two cast irons with high and medium levels of CE were produced with different levels of boron. This study intends to evaluate the specific effect of Boron additions on phase transformations, microstructure, and mechanical properties of gray iron at different CE levels.

3.1. SOLIDIFICATION

Table 7. Hardness (BHN) results as a function of boron for both the heat.

Heat	B-added, ppm	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average TS	Std Dev
High-CE heat (CE = 4.43)	No B-added	20.2	21.0	20.7	20.9	20.6	20.3	20.6	0.32
	20	22.9	23.3	22.4	22.9	22.4	22.8	22.8	0.33
	40	22.4	22.8	21.7	21.2	22.0	22.3	22.1	0.58
	100	20.4	21.6	21.4	20.4	21.8	21.1	21.1	0.60
Medium-CE heat (CE = 4.1)	No B-added	30.6	30.6	27.2	28.5	28.5	28.1	28.9	1.4
	20	32.6	33	28.8	30.3	29.2	28.8	30.5	1.9
	40	33.5	32.7	30	29.8	29.3	29.4	30.8	1.8
	100	33.8	34.9	30.6	30.9	31.3	30.9	32.1	1.8

Both cast irons were hypoeutectic, and solidification started with primary austenite. The cooling curves from both the heats (Figure 3 and Figure 4) show a clearly indicated trend of increasing liquidus temperature with boron additions, which relates to the stimulation of austenite solidification. The effect of boron addition on the eutectic transformation depended on CE. It is known that the undercooling of the eutectic reaction is related to the nucleation of graphite and higher boron content makes it slightly difficult for graphite nucleation and stabilizes austenite. Plots of the 1st derivative of the cooling curve as a function of temperature in Figure 17 and Figure 18 show that the rightmost peak in the plot marks the austenite liquidus temperature. The loop in the graph is the eutectic decalescence. The leftmost point of the loop is the eutectic low temperature, TEmin, while the rightmost point of the loop is the eutectic high, TEmax. The diameter of the loop will give the eutectic decalescence. It is visible that the temperature difference between the austenite liquidus and the eutectic low rises with B content. This trend is observed in both the heats (Figure 17 and Figure 18). The difference between TL and TEmin is shown in Table. 8.)

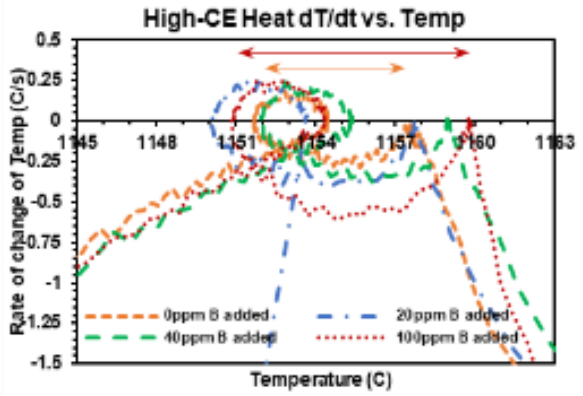


Fig 17. 1st derivative of the cooling curve plotted against temperature for high-CE heat for the solidification. The difference between the TL and TEmin is highlighted by arrows.

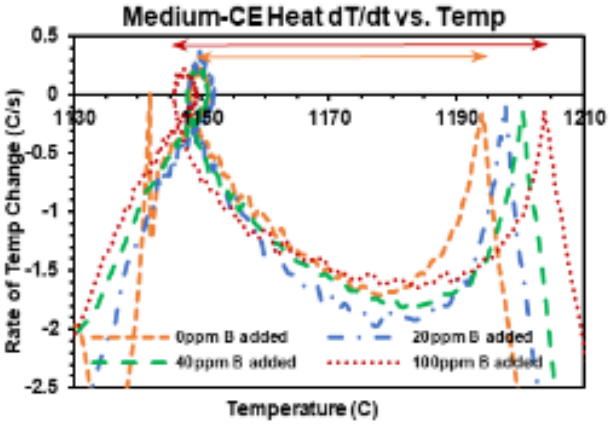


Fig 18. 1st derivative of the cooling curve plotted against temperature for medium-CE heat for the solidification. The difference between TL and TEmin is highlighted by arrows.

Table 8. The difference between the liquidus and eutectic minimum temperature for both the heats.

Heat	B-added, ppm	TL (˚C)	TEmin (˚C)	TL – TEmin
High-CE heat	No B-added	1157.3	1151.4	5.9
	20	1157.3	1149.7	7.6
	40	1158.4	1151.4	7
	100	1159.3	1150.3	9
Medium-CE heat	No B-added	1193.3	1147.5	45.8
	20	1195.8	1146.3	49.5
	40	1199.3	1146.7	52.6
	100	1202.2	1144.8	57.4

Observation and ImageJ quantitative analysis of the unetched microstructures for both heats were done to understand the boron effect on graphite morphology (Figure 19). A measurement error of ±10% is considered for both the heats.

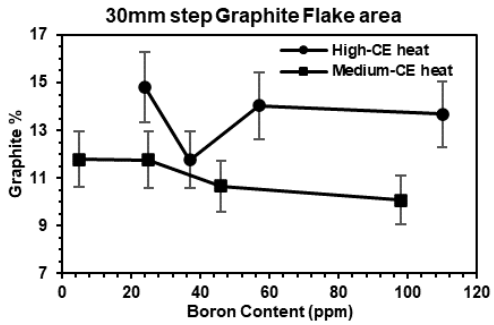


Fig 19. The area of graphite flakes for the 30mm step of the step block for both the heats.

3.2. EUTECTOID TRANSFORMATION

The first derivative of the cooling curve as a function of temperature for high-CE and medium-CE heats are shown in Figure 20 and Figure 21, respectively. Similar to the eutectic graph, the diameter of the loop is the eutectoid decalescence. The parameters VTrans and TTrans are obtained from these curves. The highest value of the first derivative of the cooling curve is called the velocity of transformation (VTrans) whereas the temperature corresponding to this value is TTrans. This data is tabulated in Table 9. In a previous work by Sertucha et.al [7], these parameters were used to predict the ferrite-pearlite formation. When ferrite content in the matrix decreases, and consequently the pearlite content increases, the solid-state transformations occur at lower temperatures and higher Vtrans.

Hence, the eutectoid decalescence is higher during pearlite formation and lower for ferrite formation. In Table. 9 it is seen that both conditions are preferable for ferrite formations for the medium-CE heat with boron additions above 20ppm. However, 20 ppm boron addition increased the VTrans in both heats, which is an indicator that small boron additions can 33 affect the pearlite transformation. These results indicate that the effect of boron on eutectoid reaction is not linear and depended on CE.

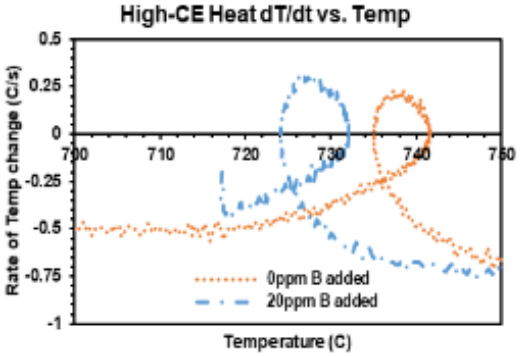


Fig 20. 1st derivative of the cooling curve plotted against temperature for high-CE heat for the eutectoid reaction.

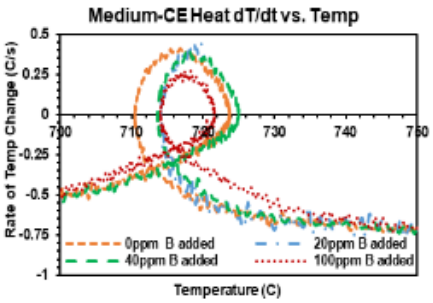


Fig 21. 1st derivative of the cooling curve plotted against temperature for medium-CE heat for the eutectoid reaction.

Table 9. Eutectoid parameters obtained from the cooling curve and the first derivative of the cooling curve of the eutectoid reaction.

Heat	B-added, ppm	Eutectoid Low (˚C)	VTrans, C/s	TTrans (˚C)
High-CE heat	No B-added	735	0.232	738.5
	20	724.1	0.315	726.4
	40	-	-	-
	100	-	-	-
Medium-CE heat	No B-added	710.5	0.411	716.8
	20	714.1	0.442	-
	40	713.6	0.386	717.7
	100	714	0.273	718.3

3.3. MICROSTRUCTURE ANALYSIS

The microstructural analysis of the specimens was used to validate the results obtained from the thermal analysis. The chill wedge analysis was done in order to understand the effect of boron on carbide forming tendency. Images taken from the chill wedges of the high-CE and medium-CE heat are given in Figure 15 and Figure 16, respectively. For the high-CE heat, the chill tip was not visible to the naked eye, whereas, in the case of medium-CE heat, the chill tip was clearly visible. The chill depth for medium-CE heat increased with boron additions. The chill depth measured is shown in the image. To check the carbide structures in high-CE heat, etched microstructures were taken at 5 areas, at the chill tip, and then at 5mm increments from the tip up to a distance of 20mm. The images were then arranged in a way to get a panoramic view of the chill wedge as seen in Figure 15. The same procedure was done for the medium-CE heat as well in Figure 16. As boron increased in high-CE chill samples, carbide became visible in the chill tip. For the highest boron samples, the carbides are seen up to 10mm from the chill tip. For the medium-CE specimens, the carbide precipitates are clearly visible and are seen further away from the chill tip as the amount of boron increases. Analysis of the smallest step, i.e., the 5mm step of the step block, was done as a supplement to the chill wedge analysis. The etched microstructures of the 5mm step are given in Figure 22 and Figure 23 for high-CE and medium-CE heats, respectively. It is clearly shown that there is carbide precipitation in the highest boron sample of the medium-CE heat. The appearance of carbide is a clear indicator of the carbide stabilizing capabilities of boron. The carbide promoting effect of boron may be dependent on the cast iron CE because, at the same

boron level, no such carbide precipitation was shown in the high-CE heat.

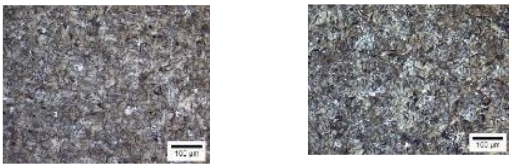


Fig 22. Etched microstructures of the 5mm step of high-CE heat step block, (a) 20ppm B-added and (b) 100ppm B-added. There is no visible carbide precipitation.

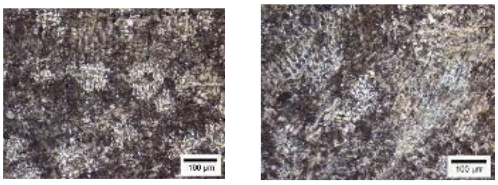


Fig 23. Etched microstructures of the 5mm step of medium-CE heat step block, (a) 20ppm B-added and (b) 100ppm B-added. Carbide precipitation is visible in the highest B sample highlighted by a dashed circle.

The microstructures obtained from the 30mm step of the step block were used to evaluate ferrite forming tendency. In the high-CE heat (Figure 7) the microstructure of the matrix mainly consists of pearlite along with a considerable amount of ferrite enveloping the graphite for all B additions. These specimens had higher amounts of ferrite because of the well-known ferrite stabilizing effect of Si. The microstructures from the 30mm step of the step block of the medium-CE heat are had a mainly pearlitic matrix, with very minor areas of ferrite surrounding the graphite (Figure 9). Using ImageJ for quantification of the ferrite area of images in Figure 7 and Figure 9, the graph in Figure 24 was generated. From the graph, it is shown that the ferrite content for high-CE heat increases with the exception of the specimen without boron (Image 1A in Figure 7). The same effect can be observed for the medium-CE heat, however, the increase in ferrite is very low as compared to high-CE heat. This trend is also observed in the 20mm step as well as the 10mm step. The change in the intensity of the effect of B addition is notable. This effect is more profound in the high-CE heat than that in the medium-CE heat. This is additional proof that the B effect is dependent on CE.

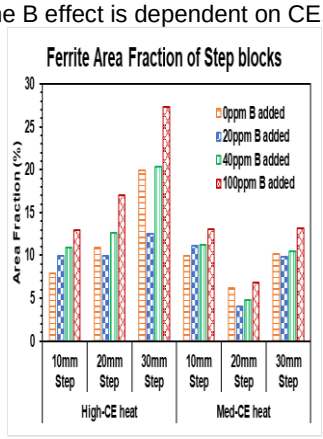


Fig 24. The ferrite area coverage as measured by optical metallography of the step block casting for medium and high CE heats.

3.4. MECHANICAL PROPERTIES

The tensile data are given in Table. 6 for both the heats. In the high-CE heat, the tensile strength increases for the 20 ppm boron addition, but then it tends to reduce for higher boron additions. In the medium-CE heat, a clear trend of increasing UTS with increasing boron content (Figure 25) is observed. A one-way ANOVA analysis and Fisher's Criterion analysis were used for statistical evaluation of these differences at an 80% confidence level. The Fisher analysis graphs are plotted for high-CE heat in Figure 26. Similarly, Fisher analysis graphs are plotted for the medium-CE heat in Figure 28. Based on the results from the statistical analysis, the data is statistically significant with 80% confidence with few exceptions. The hardness specimens were taken from the step block in the area closest to the central plane of the casting (Figure1). The data for both the heats is given in Table. 7. Hardness increased with tensile strength.

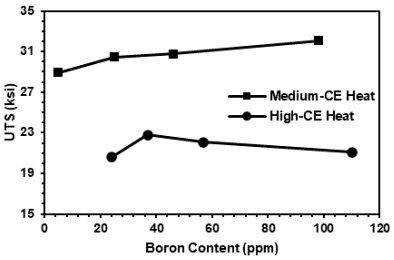


Fig 25. Comparison of UTS as a function of boron for both CE heats.

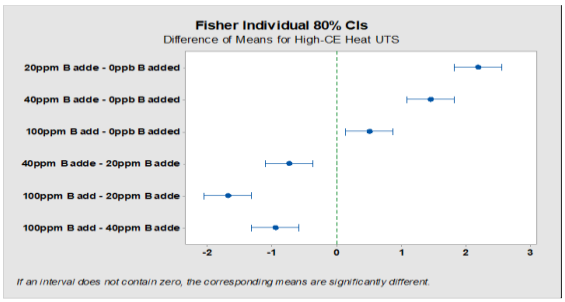


Fig 26. Fisher's analysis of UTS statistical significance as a function of boron for high-CE heat. The top three pairs of test results are significantly different at an 80% confidential level.

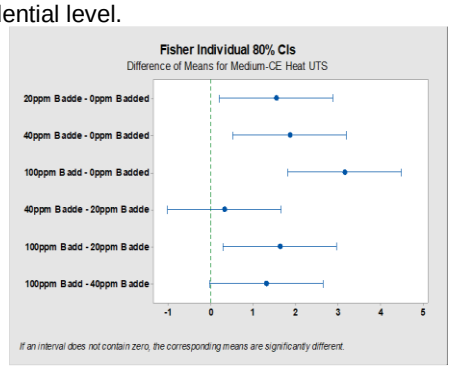


Fig 28. Fisher's analysis of UTS for medium-CE heat as a function of boron content. The results show that UTS is significantly different at an 80% confidence level, except for pairs of 40-20 boron ppm and 100-40 B ppm.

Conclusion

The effects of boron on the microstructure and mechanical properties of gray iron were studied in two heats with high and medium carbon equivalents, CE, related to ASTM A48 Class 30B cast irons. Thermal analysis of the solidification and solid-state cooling curves showed that boron acts as an austenite stabilizer and affects the nucleation of graphite by changing undercooling during the eutectic reaction. The carbide forming tendency of large boron additions was confirmed by a metallographic study of chill wedge depth and step block castings. During the eutectoid reaction, the thermal analysis showed that the effect of boron on the ferrite/pearlite transformation is significant. Boron acts as a ferrite stabilizer when present in high amounts (above 35ppm). However, the effect of low boron additions (less than 20 ppm) was not understood clearly. The microstructural analysis of the heats replicated the results predicted from the thermal analysis, although the intensity of the effect was different for both the heats, suggesting the effect of boron is dependent on CE. More studies will be performed in the future to uncover the mechanisms for the ferrite stabilizing effect of boron. The effect of boron on the mechanical properties of gray iron might also be influenced by the CE of cast iron. In the high-CE heat, tensile strength increased only with 20 ppm boron addition, however, boron additions increased the tensile strength consistently in the medium CE heat. Future work will include a study of boron addition in low CE cast iron, class 30.

Source of Support: Nil
Conflict of interest: Nil
Acknowledgement: None

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How to cite this article: Kumar R, Kumar P. Analysis Effect On Boron In Grade 40 Cast Iron Subharti J of Interdisciplinary Research, Dec. 2022; Vol. 5: Issue 3, 24-33