Patient's Opinion about using 3D-Printed Splints in Bangladesh

By

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Dedication

My honorable and beloved parents

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List of Abbreviations

BHPI	Bangladesh Health Professions Institute
CRP	Centre for the Rehabilitation of the Paralysed
FFF	Fused Filament Fabrication
IRB	Institutional Review Board
PLA	Polylactic Acid
3D	Three - Dimentional

Abstract

Background: The hand is one of the most important and primary organs of human body for movement. It has been estimated that around 92% tasks of daily life are being performed by hand of human being. There could be several chronic or traumatic conditions that interfere with the hand's ability to function normally. Traumatic hand conditions can result from a variety of injuries, whereas chronic hand conditions can be brought on by neuro-musculoskeletal illnesses and complaints over an extended period. Damage including fractures, joint deformity, contractures, or uncomfortable circumstances might result from these hand diseases. Splints can provide safe, gentle pressure on broken, or contractured body parts in certain situations. Splints also helps to extend muscle comfort and enhance muscular strength as well as functional mobility and improvement. Nowadays, several materials and methods are being used to make splints. In recent times, Hand Therapy Unit of Occupational Therapy Department of Centre for the Rehabilitation of Paralysed (CRP), Bangladesh has produced 3D-printed splints and provided these splints to the patients to recover from their hand injuries. Therefore, the researcher wants to know the opinion of patients who have got 3D-printed splints from Hand Therapy Unit of CRP, Bangladesh.

Aim: The study aims to explore the patient's opinion of 3D-printed splints.

Method: The study was conducted by qualitative study design through face to face interview among ten participants who used 3D-printed splints. The participants were chosen from the Hand Therapy unit of CRP using a purposive sampling method. A self-developed interview guide was used for conducting the semi-structured interview. The study was conducted in the participant house of different areas in Dhaka, Bangladesh. Additionally, the researcher analysed all data by following Qualitative Content Analysis (QCA).

Result: Most of the participants told that they are pleased with the comfort, personalized fit &

light weight design of 3D-printed splints. Participants also told that the 3D-printed splints are easy to carry and safe to use. Moreover, majority of the participants expressed that their hand function improved by using this splints and they provide positive feedback to other patients to use also. However, majority of the participants found 3D-printed splints are low in price. Furthermore, the patients told that they got the instructions from the professionals on how to use the 3D-printed splints and they appreciated this service.

Conclusion: The extensive use of 3D printed splints in clinical settings opens up new paths for investigation and advancement. There are several advantages to using 3D printed splints in clinical settings, such as increased personalization, patient involvement, and chances for research and development. To enhance treatment results and patient satisfaction, additional involvement may involve refining design parameters, investigating innovative materials and manufacturing processes, and incorporating sophisticated sensing and monitoring capabilities. According to patient feedback, these splints are lighter, more comfortable, and more adjustable than conventional splints. However, 3D printed splints are not available in all areas of the country. Therefore, to ensure that patients are able to recover quickly from hand injuries using 3D-printed splints, the authority should focus on increasing its supply at Community Clinic level.

Keywords: Occupational Therapy, Hand Therapy, Hand Injury, 3D Printer, Splint.

CHAPTER I: INTRODUCTION

1.1 Background of the Study:

The hand is one of the human body's primary organs for movement. According to some estimates, a human being's disability increases by about 57% when their hands stop working, and by 95% when upper extremity concepts are considered (Skirven et al., 2011). There could be several chronic or traumatic conditions that interfere with the hand's ability to function normally. Traumatic hand conditions can result from a variety of injuries, whereas chronic hand conditions can be brought on by neuro-musculoskeletal illnesses and complaints over an extended period. Damage including fractures, joint deformity, contractures, or uncomfortable circumstances might result from these hand diseases (Surucu et al., 2022). The quality of life may be severely hampered by these damages.

It has been roughly calculated that nearly 35-40 million individuals require orthotics and prosthetics (Baghbanbashi et al., 2022). However, it is currently estimated that only 5-15% (1 in 10 people) have access to prosthetic and orthotic devices in need (Healy et al., 2018). In the year 1980, a new technology was developed named 3D printing. 3D printing refers to additive manufacturing technology by computer-aided design which creates a three-dimensional object layer by layer (Katt et al., 2021). This technology is especially useful in the field of musculoskeletal medicine, where it is currently being used to make orthotics, prosthetics, and customized total joint arthroplasty implants, among other things. While the innovation is as of now accessible, there is little information connected with the utilization of 3D-printed orthotics in the clinical setting for furthest-point pediatric breaks (Katt et al., 2021).

Splints can provide safe, gentle pressure on damaged, broken, or contractured body parts in certain situations, extending muscle comfort and enhancing muscular strength. The utilization of 3D printing technology in orthopedics and rehabilitation has been the subject of

numerous recent discussions. As a result of these procedures, patients are more satisfied with their splints since they may be made specifically for them (Yang et al., 2021).

3D printing can be used to create custom structures based on a patient's or healthcare professional's specific needs. This innovative technology can be used to do what hand therapists have done manually for decades with a thermoplastic material (Choo et al., 2020). 3D printing can be used to create almost any cast, splint, or hand rehabilitation device. However, not every field of 3D printing is beneficial to the patient. Over the last few years, 3D printing has become increasingly popular in hand surgery (Surucu et al., 2022). Potential applications of 3D printing include training of young surgeons; patient education; preoperative planning; patient-specific surgical guides; or printing of custom-made splints or prostheses. However, one of the most well-known applications is for hand rehabilitation (Keller et al., 2021).

Orthoses are devices used to help the human body function. They typically have the following functions: Body protection, Restriction of motion, Weight-bearing assistance, Movement assistance, and Deformity prevention or correction (Surucu et al., 2022). Orthoses are commonly used to help patients with physical disability and disability caused by muscular dysfunctions such as fractures, sprain, arthropathy, tendinopathy, and neurological disorders in the brain, spinal cord, and peripheral nerves (Ta-Cheng et al., 2019). The traditional method of producing orthoses is time-consuming. Orthoses must be manually corrected according to the patient's body's shape and dimensions. It is difficult to produce several customized orthoses of the same quality (Choo et al., 2020). Sometimes complex designs can be implemented. However, with the help of recently developed 3D printing technology, orthoses can be precisely designed with exact dimensions using a computer graphic program. The disadvantages of the traditional method can be adequately addressed as 3D printers are very accurate (Baghbanbashi et al., 2022). Hence, utilizing 3D printing innovation, it is feasible to plan an orthosis with precise mathematical upsides of the aspects through a

planned program and make structures that are challenging to physically execute. Additionally, whereas a hand-made orthosis would take about a week to produce, a 3D printer can complete this task in a single day. Thus, in the field of orthoses, critical consideration is being paid to orthoses produced with 3D printing advancements (Choo et al., 2020).

In recent years, the technology of 3D printing has been utilized in the medical field. This innovation has to some degree tackled a few issues raised from airlessness, clothing, and awkwardness of wearing the customary clinical assistive gadgets, like supports (Surucu et al., 2022). Besides, 3D printing innovation has accomplished a further leap forward in upholding the viability of lessening patients' sensations of mediocrity while wearing assistive support. As a result, developing more effective splints using 3D printing has emerged as a viable option for resolving the issues (Keller et al., 2021). In medical applications, there are numerous medical information systems, the majority of which are information-sharing systems for sharing patients' medical records (Waldburger et al., 2021). Be that as it may, there are not many data framework stages created with the end goal of clinical gadget assembling and little data about practical treatment units. In this manner, specialists and word-related advisors should depend on paperwork, phones, eye-to-eye, or extra utilization of correspondence programming to speak with one another so such correspondence process is tedious (Surucu et al., 2022). With the 3D printing innovation, the support creation technique has been changed from hand-made to advanced creation. Without the data, and correspondence stage, checking the outline of the brace on the stage by all the connected clinical consideration parties becomes unimaginable (Ta-Cheng et al., 2019).

The advancement of PC-supported plan (computer-aided design) programming and 3D-printing of redone supports acquainted a choice with work on the non-operative treatment (Van Lieshout et al., 2022). While this presented choices that consider individualized displaying and creation of supports, it additionally confronted specialists with challenges regarding plan

decisions, material choices, and added substance fabricating choices. The accessible materials have their properties that might influence the nature of the printed item, and the different printing methods influence the printing time (Van Lieshout et al., 2022)

The method hasn't changed much since the 10th century when plaster casting (also known as gypsum plaster or plaster of Paris) was introduced (Keller et al., 2021). Although their heavy weight, low breathability, and lack of water resistance, in addition to the inability to directly observe soft tissue and the potential skin reactions, limit their use, the advantages of traditional casts include their ease of handling, subsequent plasticity, and low cost (Surucu et al., 2022). In the 1970s, fiberglass casts became available, offering a more long-lasting and water-resistant alternative but unable to eliminate the other drawbacks. The custom fit, breathability, lighter weight, and waterproofness of the 3D-printed casts are just some of the benefits (Schlégl et al., 2022). They can also be made to have an opening over the wound to prevent pressure points. In addition, they might have an attractive design that was made specifically for them. Better patient satisfaction and compliance may result from these factors (Schlégl et al., 2022).

Operative and non-operative treatment of injury and degenerative illnesses of the hand depends on the immobilization of the impacted designs (Keller et al, 2021; Schlégl et al., 2022). Significant highlights of immobilization gadgets incorporate precise attack of the impeded hand and protection of the non-impacted hand capabilities (Schlégl et al., 2022). One of the quick advancing advancements with interest in clinical fields is the three-layered (3D) innovation. 3D filtering frameworks and 3D printers permit the manufacture of 3D actual articles with applications in various clinical trains like muscular health, spinal medical procedures, maxillofacial medical procedures, or neurosurgery. The creation of orthoses and supports is a possibly simple application in 3D printing (Schlégl et al., 2022). A few examinations and case reports have proposed different plan calculations for 3D supports and

assistive gadgets for hand a medical procedure (Keller et al., 2021). Others have shown the chance of creating 3D-printed braces with comparative mechanical properties to those of fiberglass projects. In sound workers, the solace and fulfillment of 3D-printed short-arm braces were evaluated as being better than that of fiberglass projects (Waldburger et al., 2021). It seems unfair to compare circular plaster casts with perforated 3D-printed splints, but only one study compared thermoplastic and 3D-printed splints. It showed a more prominent capability of the 3D-printed braces to decrease spasticity and enlarging and to work on engine capability north of about a month and a half of treatment in hemiparetic patients (Waldburger et al., 2021).

Most people in Bangladesh are currently not very familiar with 3D-printed splints. Based on data gathered from patients residing in Bangladesh via questionnaire, the happiness of patients utilizing 3D-printed splints analyzed qualitatively in this study report. The results of this study showed how effective 3D-printed splints are for humans. As a result, more individuals were aware of and interested in using 3D-printed splints to recover comfortably and prevent further impairment.

1.2 Justification:

Historically, patients have been using traditional splints for recovering from different hand injuries. However, in the modern era, several materials and methods are being used to make splints. Specifically, for the first time in 2019, Hand Therapy Unit of Occupational Therapy Department of Centre for the Rehabilitation of Paralysed (CRP), Bangladesh has started producing 3D-printed splints as a part of hand therapy intervention of hand injuries and patients have been using those splints for their improvement. In this circumstances, the focus of the research is to explore the opinion of patients who are using 3D-printed splints and accumulate their feedback to work on subsequent improvement of 3D-printed splints. 3D-printed splints is a digital manufacturing technology. Therefore, manufacturing with this technology is done using computer drawing software and then manufactured using a 3D-printing machine. The research will be a base ground of study for future researchers. Occupational Therapy practitioners will get detailed ideas about using 3D-printed splints and Therapists can focus on making 3D-printed splints available for those people who need this product.

In this research paper, I took feedback from individual patients who has taken 3D-printed splints and have evaluated their feedback to draw a summary of whether 3D-printed splints are more convenient to use or beneficial for patients rather than conventional orthosis. It is evident that people who are using traditional splints, they observed that it took longer time to produce, with heavy weight, low breathability, and lack of water resistance from their injuries using those typical splints. However, in the recent past, it has been noticed that the perception of the people has changed towards 3D-printed splints. The research is a guidance for improvement in the rehabilitation process related to injuries in the hand function.

1.3 Operational Definition:

3D printer: Three-dimensional (3D) printing is an additive manufacturing process that creates a physical object from a digital design. The process works by laying down thin layers of material in the form of liquid or powdered plastic, metal, or cement, and then fusing the layers **(**Hayes, 2021**)**.

Splint: A splint or orthosis is a supportive device that when applied to the body can protect, promote healing or improve function. The term splint and orthosis can be used interchangeably and mean the same thing (Canberra Hand Therapy, 2021).

1.4 Aim of the Study:

The study aimed to identify patients' opinion about using 3D-printed splints in Bangladesh.

CHAPTER II: LITERATURE REVIEW

The chapter covers information regarding 3D-printed splints and patient's opinion of using these three-dimensional splints. While going through an in-depth study on-3D printed splints, patients' satisfaction level, and effectiveness of 3D-printed splints, design, manufacturing and trial of such splints on hand injuries with the help of technological advancement have been noticed. This chapter will reflect on patient's opinion from different countries on using 3D-printed splints. Please see the below figure for a summary of the literature review findings.

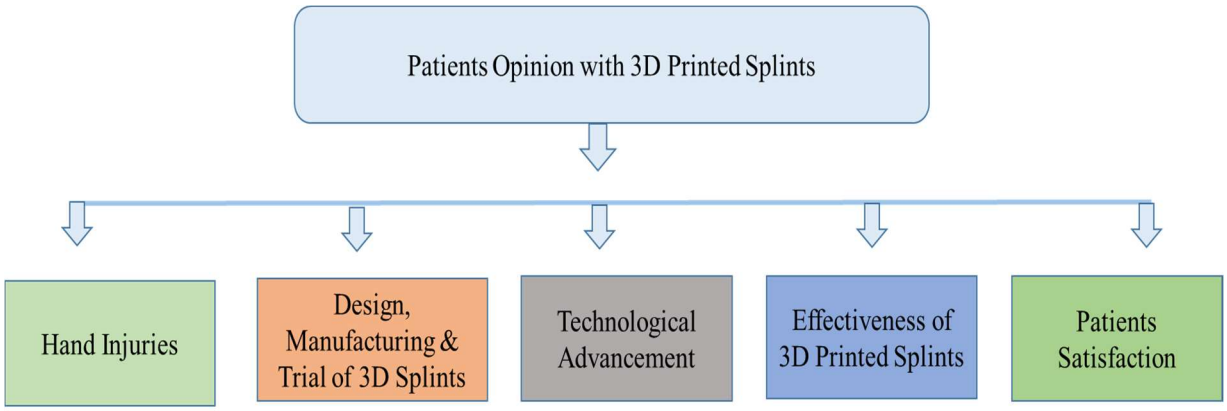


Figure 01: Overview of literature review findings

2.1 Hand Injuries

Several studies have been conducted on common hand injuries such as Boutonniere deformity, Swan neck deformity, and mallet finger, peripheral nerve injuries, forearm and wrist fractures, distal radius fractures, contractures, burns occur in human beings (Ta-Cheng et al., 2019; Arulmozhi et al., 2018; Oud et al., 2021; Choi et al., 2019; Surucu et al., 2022; Van Lieshout et al., 2022). In another Korean-published journal named “Hindawi”, there was a research published where the researchers aimed to use plaster of Paris, a material that has historically been used in clinical practice, and 3D printing technology, this study created personalized casts for the treatment of mallet finger and assessed their benefits and drawbacks for patients by measuring how well they fit (Choi et al., 2019). While examining, the 3D-printed lattice casts produced outcomes comparable to those of the conventional plaster of Paris castings. Overall, nevertheless, participants said they were "very satisfied" or "satisfied" with the weight, adjustability, comfort, and proportions of the 3D- printed casts. Compared to the plaster of Paris cast, the subjects preferred the weight and use of the 3D-printed casts (Katt et al., 2021). However, the study site, age, gender, data analysis procedure, data collection method, and types of sampling are all missing in the study. Young patients with forearm fractures may benefit from the use of 3D printing, a rapidly developing technology (Choi et al., 2019; Arulmozhi et al., 2018). In regards to 3D printing in children, almost little has been written. We report on two juvenile patients who underwent treatment for upper limb fractures by donning specially designed casts created via 3D printing. The clinical results of the most recent follow-up, which occurred at least a year after the accident, were fantastic (Katt et al., 2021). Understanding the possibilities of the technology used for 3D printing and putting it to use in clinical practice, along with coming up with new applications for it, might be beneficial for orthopedic surgeons. The creation of a 3D-printed cast that can easily fit a bone stimulator is just one of the many inventive ways that orthopedics can use this technology to its full

potential (Arulmozhi et al., 2018). One of the materials most frequently utilized in 3D printing is poly-lactic acid (PLA), and this was used to make the casts in this research. Notably, records also exist demonstrating the use of materials like extremely dense polyethylene as well as polypropylene in the production of 3D casts (Katt et al., 2021). According to a systematic review, it was identified that, historically, a plaster or synthetic cast has been used to treat forearm fractures, such as distal radius fractures. Patients frequently complain of skin issues, cast discomfort, and infrequently, numbness in the radial sensory nerve (Waldburger et al., 2021; Van Lieshout et al., 2022). Casting is known to have a high rate of secondary dislocation. More and more people are using customized 3D-printed braces as an alternative to casts. An overview of recent advancements and practical experiences with 3D-manufactured forearm braces is given in this review. The design specifications, materials employed, technical specifications, and preclinical and clinical findings were the main areas of focus (Van Lieshout et al., 2022).

2.2 Design, Manufacturing & Trial of 3D Splints

The research was conducted to determine how to create individualized 3D-printed splints for patients and whether these splints can be helpful to people (Oud et al., 2021; Chhikara et al., 2023; Waldburger et al., 2021). The outcome was favorable, and patients were pleased with the 3D-printed splints. Within the allotted time, the patient's joint postures were rectified. Additionally, a 3D-printed splint was regarded as a highly successful low-cost therapy option. However, no consideration was given to gender in that study, and a larger sample size with participants of varying ages and joint placements would have improved the study's findings (Chhikara et al., 2023).

In 2021, there was a journal published named “Journal of Rehabilitation Medicine Clinical Communications” where some researchers published their research work (Oud et al.,

2021). Several studies were conducted to compare 3-dimensional printed hand orthoses with traditional hand orthoses for this demographic to see which was more feasible in terms of production time and user satisfaction (Oud et al., 2021; Chhikara et al., 2023; Copeland et al., 2022). However, the use of a small convenience sample of only 10 participants poses a restriction to this study. Therefore, even though all types of illnesses (neurological, neuromuscular, and musculoskeletal) were represented, the generalizability of the results to people with chronic hand and wrist impairments in general may be hindered (Oud et al., 2021). The used questionnaire was self- designed, and its validity was not examined. According to research conducted in 2021 by Waldburger, it was found that they compared traditional custom-made thermoplastic splints with three-dimensional (3D) printed made-to-measure splints in this randomized controlled pilot study. It was assessed considering generalizability and potential advantages for immobilization in patients undergoing hand surgery in a clinical context (Waldburger et al., 2021). Regardless of the splint design, there were 20 patients included whose condition called for immobilization for at least 4 weeks. Questionnaires were used to gauge patient comfort and satisfaction during the splint fitting process as well as two, four to six weeks thereafter. Using a 3D surface scan, the in-house designers and printers created the 3D splints using Polylactic Acid (PLA) (Waldburger et al., 2021). Our findings imply that 3D-printed splints are practical, and patient satisfaction scores for thermoplastic and 3D-printed splints were comparable (Waldburger et al., 2021). Before manufacturing 3D-printed splints, other materials must be examined, and the technique of producing them refined (Factor et al., 2022; Waldburger et al., 2021). Some other research has been published on 3D printed splints where was aimed to investigate the clinical viability and outcomes of a multidisciplinary workflow that uses a high-speed printer and rapid 3D scanning and modeling software to produce patient-specific 3D-printed casts for the treatment of non-displaced hand as well as wrist fractures in hospitals (Chhikara et al., 2023; Factor et al., 2022). A review of twelve trials revealed that an open design was adopted in every printed

brace. The most popular 3D printing method is fused deposition modeling (seven studies), while the most popular material is polylactic acid (five studies). Six investigations were conducted for clinical evaluation; the majority of the trials involved distal radius fractures, as well as the results typically indicated a low risk of complications and good consumer satisfaction using the printed support (Van Lieshout et al., 2022). More research is needed to determine whether or whether results from 3D printed supports are better than those from casting (Van Lieshout et al., 2022; Copeland et al., 2022). The usage of 3D-printed supports has several drawbacks and restrictions, such as the requirement for imaging of some kind, the requirement for image subsequent processing, and the requirement for manual brace processing and assembling, financial concerns, and quality assurance of the printed result (Van Lieshout et al., 2022; Copeland et al., 2022). Even while the use of customized 3D-printed braces complies with laws like the health care device regulation at the moment, more regulations are anticipated for these devices in the future (Van Lieshout et al., 2022).

2.3 Technological Advancement

Taiwan professor published a research where he insisted that any equipment or technology that helps people with impairments maintain or enhance their quality of life and mobility is referred to as an assistive device (Ta-Cheng et al., 2019). Because of time limits, splints—among numerous medical aids—have been extensively utilized in healthcare departments, including orthopedics and rehabilitation. A cast or splint is a type of orthopedic device used for limb support and immobilization that is applied externally to the body (Ta-Cheng et al., 2019; Arulmozhi et al., 2018). Splints are used to assist people to use their extremities normally as well as to minimize limb discomfort. We require a splint that is lighter, cleaner, and more permeable to air than the plaster splint. Thus, it is appropriate for decent people to remove the plaster. One of an Occupational Therapist's specialties is making splints (Ta-Cheng et al., 2019;

Arulmozhi et al., 2018). A multitude of elements can be used to create a splint. A conventional splint can be customized to fit each patient's unique limb curvature and is often composed of thermoplastic materials. This function makes it easier for patients to wear splints, fixes the issue with gypsum breathing, and facilitates wound dressing and skin cleansing around the wound (Ta-Cheng et al., 2019). On the other hand, the standard splint materials cannot hollow out any location on the splint surface, are not waterproof as well, and are sensitive to rashes in addition to being difficult to form on the extremities. Moreover, with the use of 3D printing, any type of image may be created directly, with no limitations on color, size, or shape using a three-dimensional software layout (Ta-Cheng et al., 2019). Its intricate design and great degree of freedom make it more practical for producing small- scale limb splints. It can also enhance the patient's comfort and fit when wearing a splint. This minimizes discomfort to the skin or ulceration in the affected portion of the body by enhancing the splint's waterproof and ventilation properties. Through the implementation of 3D printing, manufacturing expenses can be decreased and needless disposal of materials can be avoided. Following 3D printing, splints don't require any additional upkeep. Thus, the ability to produce splints using 3D printing is nowadays crucial for Occupational Therapists (Ta-Cheng et al., 2019).

To design a finger splint that is specifically tailored to each patient's needs using 3D modeling, and to construct and print the design model using 3D printing, research was conducted and published in an Indian journal (Arulmozhi et al., 2018). While evaluating the outcome, it was found that the splints were fitted to the three volunteers' finger requirements. Volunteer 1 has a finger with a Boutonniere deformity. The patient thought that the splint was a good fit and reduced stiffness after being fitted with it (Arulmozhi et al., 2018). He perceived it to be heavy in weight at the same time. Volunteer 2 has a finger that is Boutonniere malformed. After receiving the splint, the patient was quite comfortable and at ease. The splint, in her opinion, was lightweight and simple to use. Volunteer 3 has a finger with a Swan neck deformity. After receiving the splint, the patient initially felt unwell but gradually began to feel

much better. She believed that wearing the splint had made her finger flexion noticeably better, and a chart shows the summary of validation results based on volunteer satisfaction (Arulmozhi et al., 2018).

2.4 Effectiveness of 3D Printed Splints

Researchers have spent a lot of time studying the benefits of 3D-printed splints for humans and how they might help the injured (Copeland et al., 2022; Chae et al., 2020; Surucu et al., 2022; Oud et al., 2021). Even though these 3D-printed splints represent some recent scientific advances, this hasn't prevented researchers from continuing to work for the benefit of society (Yang et al., 2021). Researchers have examined the effectiveness of 3D-printed splints in comparison to traditional splints and patient satisfaction with 3D-printed splints. Some of these studies have been published (Copeland et al., 2022; Surucu et al., 2022).

In 2021, in Taiwan, the researcher conducted a study on the effectiveness of a new dynamic splint on wrist and finger flexor muscle spasticity in stroke survivors using RCT (Randomized controlled trial) (Yang et al., 2021). The outcome of the research showed that 3D-printed dynamic hand-wrist splints are very effective in reducing flexor muscle spasticity significantly after 3 weeks. However, in most of the cases, dynamic splint completely reduced the wrist and finger muscle spasticity after 6 weeks. However, there were some limitations to the research. The research was mainly limited to stroke survivors with moderate upper limb impairments. Hence, the outcome of the research cannot be generalized to all stroke patients (Yang et al., 2021). One of the renowned authors in Korea did one research to protect injured tissues, enhance the healing environment, prevent, or minimize contracture formation, replace lost motor function, and facilitate and improve functional daily activities are all goals of orthosis for patients with peripheral nerve injury (Chae et al., 2020). It was found that the 3D-printed orthosis was well-liked by patients who had suffered peripheral nervous system

injuries (Yang et al., 2021; Chae et al., 2020). It was estimated that the impairment status of patients with peripheral nerve injury and designed and produced a patient-specific assistive device utilizing 3D printing procedures optimized for patient function. However, one limitation of that study was that there were fewer participants included in that research. With greater numbers of participants, the researcher could have found solid better outcomes (Chae et al., 2020; Copeland et al., 2022). Research was conducted in the Netherlands to identify knowledge gaps and comprehensively map and summarize research evaluating the efficacy of 3D-printed orthoses for acute and chronic hand problems. Four randomized controlled trials, four uncontrolled trials, four case series, and five case reports were among the seventeen studies that were included (Oud et al., 2021). The effectiveness of 3D- printed orthoses on hand function, functionality, and satisfaction was supported by four investigations on forearm fractures that ranged in quality from poor to fair (Chae et al., 2020; Copeland et al., 2022; Oud et al., 2021). One credible study on spasticity showed how 3D-printed orthoses improved hand function. One study on pain with low quality found few beneficial impacts on satisfaction (Yang et al., 2021). Studies on joint contractures and muscular weakening did not reveal any advantages. However, Research methodology, participant numbers, demographic information (age, gender), and data collecting, and analysis procedures are all missing from that study (Oud et al., 2021). Hungarian researcher performed a thorough research where he pointed out some of the effectiveness of 3D printed splints by articulating conventional cast materials, which are frequently used for treatment, have a few drawbacks, such as poor cleanliness, smells, and a lack of mechanical and water resistance (Schlégl et al., 2022). A rapidly evolving technology that has the potential to replace traditional casts is three-dimensional printing. To create a cast that could be used, the study compared and examined standard materials (plaster cast and fiberglass cast) with composite materials made of polylactic acid (PLA) and PLA–CaCO3 that were produced using fused filament fabrication (FFF) technology (Schlégl et al., 2022). Tensile, flexural, hardness, and variable load cycle

tests were used to characterize the materials. An absorbed water test was also performed. Cost-effectiveness was also assessed and contrasted. As the concentration of CaCO3 increased, the observed values for tensile strength and flexural strength declined. Only the 3D-printed materials displayed typical fatigue curves in the fatigue testing; the fiberglass and plaster casts did not (Schlégl et al., 2022). Cycle tests with variable loads revealed that after using a greater load, typical castings are unable to support the same weight at the same deflection. 3D printing may prove to be a viable substitute for specially made splints and casts, as the results of the mechanical testing clearly show that the materials produced by 3D printing function better in both static and dynamic scenarios (Schlégl et al., 2022).

2.5 Patient Satisfaction Level

Solidarity is a fracture treatment method that has not been changed over the years and it is still being practiced by experienced professionals (Surucu et al., 2022; Portnoy et al., 2020). In Turkey, there was a study conducted regarding the evaluations of patients' satisfaction with using 3D printed medical casting in fracture treatment to assess through a questionnaire the functionality and efficacy of using three-dimensional printed medical casts (Surucu et al., 2022). A total of 24 patients were selected and the average age of the participants was 30 years even with an upper extremity fracture patients were also included in the study. While going through the critical assessment the researcher noticed that there was a gap in the study which is the heterogeneous structure of the patients in the study group (Surucu et al., 2022). It was found in the results of that study that almost all of the fractures were healed in between 4 to 6 weeks without any complications. Patients with upper extremities are satisfied with the 3D-printed medical casts and the patients rated the 3D-printed medical casts as safe, easy to apply, and effective (Choi et al., 2019; Irani & Ozelie, 2023; Surucu et al., 2022; Van Lieshout et al., 2022). A recent study was conducted in the USA to identify an attractive 3D printed orthosis

device that can easily be adjusted for individual patients and the satisfaction of using 3D printed finger splint in comparison with commercial silver ring splints (Irani & Ozelie, 2023; Copeland et al., 2022; Van Lieshout et al., 2022). In the result of that study, it was revealed that no significant satisfactory score was obtained on 3D printed splints when compared with the commercial silver ring. However, the sample size was small, and all the participants were from similar demographic groups which limited the generalizability of the study to different groups of populations (Irani & Ozelie, 2023; Surucu et al., 2022). The study focused on the use of orthoses on a short-term basis, but the 3D-printed splints can work permanently. This is what the researcher did not emphasize in his study (Irani & Ozelie, 2023).

In the Journal of Hand Therapy published in 2022, Research was conducted to develop software that automatically modifies an orthosis model for 3D printing. Patient-specific splints are based on the input of the finger's anatomical dimensions and compare the manual approach and the automatic 3D printing method for Occupational Therapy students in terms of preparation time, product weight, and user satisfaction (Irani & Ozelie, 2023; Portnoy et al., 2020). The result showed that the manual orthosis was much heavier than the 3D-printed orthosis, although it required more time to prepare. The subjects expressed more satisfaction with the 3D-printed orthosis fit, aesthetics, overall procedure, and final product (Portnoy et al., 2020). Professor Copeland investigated in the USA to compare functional outcomes and patients' satisfaction between standard trans-radial prostheses fitted in a clinic with 3D-printed prostheses fitted remotely. The professor found that Patients with 3D-printed prostheses fitted on their upper limbs are more satisfied and are more functional than those patients who are wearing standard trans-radial prostheses (Copeland et al., 2022). One of the main limitations of the professor's study is the learning effects and conflicting survey scores. The learning effects seem to be insignificant due to the limited number of trials that the professor conducted. In future research, the increased number of trials should be taken into consideration to come to the conclusions of any research findings (Oud et al., 2021; Copeland

et al., 2022). In conclusion, there was a high degree of user satisfaction and comfort, good clinical and radiological outcomes, and an efficient in-hospital workflow. For both hand and wrist fractures that are not displaced, our medical facility now often offers this 3D-printed cast alternative (Factor et al., 2022).

2.6 Key Gap of the Study

1. Majority of the study the researchers considered a small sample size in evaluating the performance of 3D-printed splints. Had it been a larger sample size, the outcome would have been more effective.
2. Some studies' assessment process took a longer time to measure effectiveness.
3. The majority of the studies conducted trials on adults and gave less consideration to child patients.
4. One of the main limitations of the professor's studies are the learning effects and conflicting survey scores due to a limited number of trials as well as cleanliness, smells, and a lack of mechanical and water resistance of splints.

CHAPTER III: METHODOLOGY

3.1 Study Question, Aim & Objective:

3.1.1 Question:

What are the patient's opinion of using 3D-printed splints in Bangladesh?

3.1.2 Aim:

To identify patient's opinion about using 3D-printed splints in Bangladesh.

3.1.3 Objectives:

i. To know the patient's perception towards the 3D-printed splint.

ii. To understand the patient's opinion about splint-related services (splint wearing information, follow-up services).

iii. To identify the affordability of the 3D-printed splint for the patient.

iv. To identify whether the patients are benefited from using 3D-printed splints or not.

3.2 Study Design:

3.2.1 Method: Qualitative study.

Qualitative research entails delving deeper into and investigating real-world issues. As with quantitative research, qualitative research generates hypotheses and aids in the further investigation and understanding of quantitative data, but it does not gather numerical data points or intervene or add treatments. Participants' experiences, viewpoints, and behaviors are gathered for qualitative research. Rather than providing a number or amount, it addresses the hows and whys. Either a stand-alone study using only qualitative data or a mixed-methods study using both qualitative and quantitative data could be the format of this one. The present review aims to familiarize readers with fundamental notions,

terminologies, and applications related to qualitative research (Tenny et al., 2017).

Qualitative research is the process of gathering and interpreting non-numerical data (such as text, video, or audio) in order to better comprehend concepts, opinions, or experiences. It can be utilized to acquire detailed insights into a problem or develop new concepts for study. The goal of qualitative research is to identify and comprehend the significance that people or groups give to social or human circumstances. Creating research questions and methods, gathering data in the participant's surroundings, inductive data processing that progresses from granular details to overarching themes, and the researcher's opinion of the findings' relevance are all steps in the study process (Creswell & Poth, 2018).

3.2.2 Approach:

The phenomenological approach is a qualitative research method that aims to identify and characterize a phenomenon's universal essence. The methodology suspends the researchers' prior beliefs about the phenomenon in order to explore people's everyday experiences. In simple terms, phenomenology research investigates lived events to learn more about how individuals interpret those experiences.

Phenomenological research design is particularly beneficial for issues that require the researcher to delve deeply into the audience's thoughts, feelings, experiences, perceptions, and beliefs in order to understand the basis of the phenomenon under examination. In simple terms, researchers employ phenomenological research designs to better comprehend the universal nature of a phenomenon by investigating the perspectives of people who have experienced it. This method is commonly used to investigate lived experience, obtain a greater understanding of how people think, and broaden a researcher's knowledge of a subject.

3.3 Study Setting and Period:

3.3.1 Study setting:

The researcher collected data from those people who are using 3D-printed splints from the Hand Therapy Unit of CRP, Savar, Dhaka & the participant's house.

3.3.2 Study Period:

The study period was from May 2023 to February 2024 and the data collection period was December 2023.

3.4 Study Participants:

3.4.1 Study Population:

Patients who are using 3D-printed splints provided by Hand Therapy Unit of CRP, Savar, Dhaka, Bangladesh.

3.4.2 Sampling Technique:

The Researcher used purposive sampling to select the sample group.

3.4.3 Inclusion Criteria:

Included participants matched the following criteria-

- Both males and females were included.
- Age range: at any age (children's opinion will be taken from their parents).
- Patients with orthopedic conditions and have used 3D-printed splints.

Exclusion Criteria:

- Patients who have used conventional splints.

3.4.4 Participant overview:

In this study total 10 participants, where five are male and five are female. They all are adults. The student researcher completed her participants' interview face to face.

Table 3.1

Participant Overview

Name	Age	Sex	Occupation	Type of injury	Types of splints	Duration of injury	Duration of wearing splint
Niharika	55 years	Female	Service	Stroke	Oval 8	8 months	3 months
Asad	26 years	Male	Service	Post # complication	Oval 8	1.5 months	1 month
Zabid	32 years	Male	Job	Trigger finger	Oval 8	2 months	3 weeks
Misba	28 years	Male	Job	Spiral # of	Ring finger	4 weeks	1 month
Bakul	52 years	Female	Housewife	Trigger finger	Oval 8	1.5 months	4 months
Rahim	35 years	Male	Service	Cut injury	Oval 8	3 months	2 months
Shajid	50 years	Male	Business	Trigger finger	Oval 8	7 weeks	4 weeks
Ekra	25 years	Female	Job	Trigger finger	Oval 8	6 weeks	3 weeks
Shoile	24 years	Female	Job	Soft tissue injury	Oval 8	2 weeks	4 weeks
Tafse	39 years	Female	Teacher	Soft tissue injury	IP blocker	5 weeks	3 weeks

3.5 Ethical Considerations:

The ethics were maintained by the World Medical Association Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects (*World Medical Association Declaration of Helsinki, 1964-2013*)

3.5.1 Ethical approval from IBR:

The ethical clearance has been approved by the Institutional Review Board of BHPI explaining the purpose of the research, through the Department of Occupational Therapy, Bangladesh Health Professions Institute (BHPI). The IRB number: CRP-BHPI/IRB/10/2023/761 (See Appendix A for details). Permission from the Hand Therapy Unit of Occupational Therapy Department was taken before taking the participant's information.

3.5.2 Informed consent:

The participants were informed about the purpose and other details of the study through the information sheet and for those who felt willing to participate, their data was collected. Written consent was taken from the participants (See Appendix B for details).

3.5.3 Right of refusal to participate or withdraw:

In this study, participation was fully voluntary, and they had the right to withdraw consent at any time (See Appendix B for details).

3.5.4 Unequal relationship:

The researcher did not have any unequal relationship with the participants.

3.5.5 Risk and beneficence:

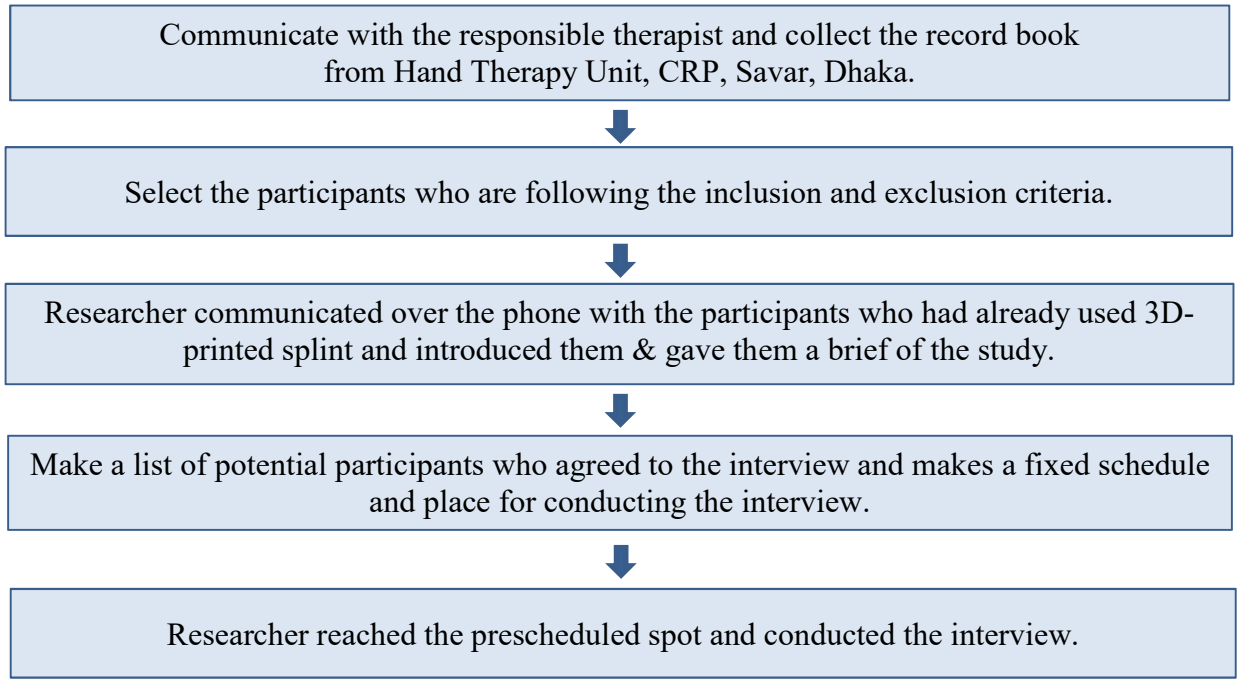
The Participants did not have any risk from this study. Moreover, social distancing and safety have been maintained and did not provide any monetary benefit to the participants.

3.5.6 Confidentiality:

The researcher ensured and maintained the confidentiality of the participants. Only the researcher and her supervisor had access to the interview, and this was clearly stated in the information sheet. The researcher also took the signature in the consent form of the participants. The participants were also informed that their identity would remain confidential for future use, such as report writing, publication, conference, or any other written materials and verbal discussion.

3.6 Data Collection Process:

3.6.1 Participant Recruitment Process:



3.6.2 Data collection method:

At first, the researcher introduced herself to the participants before data collection. The researcher also verbally presented the details of the study, for example- the aim, objectives, and purpose of the study, then the researcher was to allow the participant to ask related questions if they had any. A quiet place was selected for the interview to avoid distraction and environmental noise. So, the participant could feel comforted and give adequate attention to the interview. Before starting recording the formal interview researcher built rapport with the participants and made them comfortable for the interview. By building rapport, participants easily understand the interview and showed interest in talking for the interview. After that data was collected through a Semi-structure face-to-face open-ended questionnaire to conduct the interview. The researcher made a Bangla interview guide and interviewed Bangla because the participants were Bangladeshi. The average time for the interview was 25-30 minutes. The interview was recorded by mobile recorder.

3.6.3 Data collection Instrument:

A self-developed interview guide was used to conduct the interviews with patients who had used 3D-printed splints as part of their Hand Therapy Intervention. Typically, the interviewer follows a written interview guide. Self-developed interviews with open-ended questions may result in conversations that diverge from the interview guide. The researcher created a guide for semi-structured interviews that was made in both Bengali and English.

3.6.4 Field test:

Before starting the collection of data the researcher accomplished the field test with two participant. During the interview, the researcher informed the participants about the aim and objectives of the study. This test was performed to find out the difficulties that exist in the questioners. Through this test, the researcher remodeled her questionnaires for those participants so they could understand the voice that the researcher wanted to get from them.

3.7 Data Management & Analysis

The researcher used Qualitative content analysis (QCA). When presenting qualitative data in a categorized manner, the investigator carries out a content analysis. The procedure followed: data are collected, and coded by theme or category; finally, coded data are analyzed and presented. One method of analyzing the data is to search the whole data set for the categories and make comparisons between each as appropriate.

The researcher analyzed the data by qualitative content analysis. In this type of analysis, coding categories are derived from the text data. At the beginning of the data analysis, the researcher listened to the recorded data several times. The recorded data were then transcribed into Bengali. The researcher started the data analysis by reading all data repeatedly to achieve immersion and obtain a sense of overall opinion of the 3D-printed splints and then the researcher read the data word by word to derive the code. Codes were then sorted into categories. Categories are used to organize and generate themes. At first, the Researcher systematically organized the transcripts of interviews and other associated materials to ensure the research question was addressed. The data was effaced through transcription from the interviews of audio recordings. After formulating the transcription, the researcher confirmed the accuracy of the data. After that, the researcher read it several times to recognize what the participants wanted to say.

All data was analyzed using three stages: question analysis, content analysis, and analysis of enough themes. Data was coded into broad categories as dictated by the research question. The content analysis starts when the researcher notes the answers of the participants according to every question and determines the codes from these answers. Finally, analysis of interview data was done by analyzing text from the categorized data and coded themes.

3.8 Trustworthiness and Rigor:

Trustworthiness was maintained by methodological and interpretive rigor (Fossey et al., 2002).

3.8.1 Methodological rigor

Congruence: For the research, qualitative content analysis was used since it best suited the goals and objectives.

Responsiveness to social context: A face-to-face interview was held by manual convenience in a suitable location. The researcher learns about the context through conversation with the participant.

Appropriateness and adequacy: The study uses purposeful sampling to determine who will participate. In-person interviews were used to gather data, and ten participants were chosen for the study based on a set of inclusion and exclusion criteria.

Transparency: The investigator collected and reviewed information. Because the supervisor actively participated in each stage of the data analysis process, there was no chance of bias.

3.8.2 Interpretive Rigor:

Authenticity: Original quotes from the participants were used to maintain the presentation of the findings and interpretation. The student researcher then verbally verified that the participants had understood the information once they had finished speaking.

Coherence: Data was adjusted to meet the goals and purpose. After listening to the audio in Bengali, the researcher translated the data into English by transcribing it accurately. After

hearing the audio recording, the esteemed supervisor reviewed each transcription once again, and the researcher started to work analyzing the information.

Reciprocity: The original data hadn't been changed as the researcher translated the data accurately. There was no discussion of data analysis with participants.

Typicality: "Typicality" refers to the degree to which the findings are transferable to other situations (Fossey et al., 2002). The researcher provided a detailed description of the study's context for the reader's clear understanding.

Permeability of the researchers: The researcher's goals, assumptions, values, or favored hypotheses were upheld by closely following the ethical guidelines. To maintain the study's objectivity, the researcher checked and discussed each research strategy with the supervisor before completing it all.

CHAPTER IV: RESULTS & DISCUSSION

Based on the study involving 10 individuals experienced with 3D-printed splints, the research outcome can be summarized into 8 categories. Therefore, patients' responses to the 10 questions have been assessed to identify their opinion of 3D printed splints. Here's a general overview of these categories:

Summary of Data Analysis and Results:

Objective	Question	Category	Theme
To know the patient's perception about the 3D printed splint.	Question No- 1,2,3	1. Patient's understanding of the 3D-printed splint. 2. Patient's point of view of the safety while using the 3D-printed splint.	Patient has good understanding of 3D-printed splints.
To understand the patient's opinion about splint- related services (splint wearing information, follow-up services)	Question No- 9,10	1. Patients' were informed about how to wear 3D-printed splints. 2. Patients' feedback on follow up services.	Patients were satisfied with 3D-printed splint related service.
To identify the affordability of the 3D printed splint for the patient.	Question no- 7,8	1. Patients think that the 3D-printed splint is reasonable.	Patients found 3D-printed splints is affordable.
To identify whether the patients are benefited from using 3D-printed splints or not.	Question no- 4,5,6	1. Patient's feedback on whether they benefited from using a 3D-printed splint. 2. The patient has any problem or discomfort using a 3D-printed splint. 3. The patient will share their experience with other patients to use 3D-printed splints.	Patients hand function improved after having 3D-printed splint.

4.1 Theme 01: Patient has good understanding of 3D-printed splints.

This theme describes the perception of patients who used 3D printed splints to get cured from their injuries. Every participant shared their understanding about 3D printed splints. Many patients do understand the positive impact of using 3D printed splints. The understanding of positive impact of 3D printed splints among patients reflect the growing acceptance and adaption of this technology in healthcare sector. The set of questionnaire are being used to get response on their level of understating about 3D printing splints.

4.1.1 Category 01: Patient's understanding of the 3D-printed splint

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Light	√	√	√	√	√	√	√	√	√	√	10

[Here P1= Participant no. 1, P2= Participant no. 2, P3= Participant no. 3, P4= Participant no. 4, P5= Participant no. 5, P6= Participant no. 6, P7= Participant no. 7, P8= Participant no. 8, P9= Participant no. 9, P10= Participant no. 10]

Most of the participants mentioned that 3D-printed splints are light to use. Moreover, it is also thin and comfortable. They can continue their natural movement wearing 3D-printed splints. Most of the participants also said that because of the 3D-printed splint lighter, they could carry it very well from one place to another.

Ekra, 25 years female participant mentioned- ‘‘No, it's not so heavy, it's light.’’

One of the study finding state that, patients appreciate 3D-printed splints for their lightweight, understanding that the intricate design provides support without unnecessary bulk, enhancing comfort and ease of movement (Schlégl et al., 2022).

4.1.2 Category 02: Patient's point of view of the safety while using the 3D-printed splint.

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Safe	√			√	√		√		√	√	6
Very safe		√	√					√			3
Neutral						√					1

Most of the participants mentioned that 3D-printed splints are very safe and easy to carry. However, one participant told that using 3D printed splint is not difficult, rather it's quite okay.

Bakul, 52 years female participant described- ''yes it was comfortable. It was a little difficult at first, but later it was fine. It was safe and a good support for me''

Tafsee, 39 years female participant mentioned- 'it was quite good and safe as well. It did not cause any harm to me''

From the patient's perspective, the 3D-printed splint is considered safe due to its customized fit, reduced material weight and ability to meet specific anatomical requirements, contributing to a secure and comfortable experience (Surucu et al., 2022).

The safety of 3D-printed splints lies in their personalized fit, lightweight design, and material compatibility, ensuring secure support without compromising comfort for the users (Copeland et al,. 2022).

4.2 Theme 02: Patients were satisfied with follow-up services.

Effective follow up care is essential for ensuring that patients receive the support they need throughout their recovery process. Patients satisfaction can be addressed as customization and adjustments, continued monitoring, education & guidance and finally communication & feedback. Overall, the satisfaction of the patients with follow up services involving 3D printed splints underscores the importance of personalized, comprehensive care in promoting successful rehabilitation outcomes. This theme mainly describes whether the patients are satisfied with 3D printing splints and follow up services.

4.2.1 Category 01: Patients' were informed about how to wear 3D-printed splints

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Yes	√	√	√	√	√	√	√	√	√	√	10

Most of the patients said that they were satisfied with using 3D-printed splints. They got the proper introduction on how to use 3D printed splints. They also mentioned how to wear a 3D-printed splint, it should not be taken in heat, and heat should be avoided. They got this information from the professionals.

Ekra, 25 years female participant, described- ‘‘Yes Of course. He instructed me, how to use it and what kind of rules to follow before and after use, these things are given to me. He gave me the complete information.’’

Bakul, 52 years female participant mentioned- ‘‘Yes, the therapists told me, gave me good advice on how to use 3D-printed splint.’’

The lightweight nature of many 3D-printed materials enhances wearability, making splint more tolerable for extended periods. Avoid getting the splint wet unless specifically instructed otherwise, as moisture can damage the material or compromise its effectiveness; avoid applying excessive pressure or force to the splint, as this could cause it to break or deform;

avoid exposing the splint to extreme temperatures or direct sunlight as this could also affect its integrity (Surucu et al., 2022).

4.2.2 Category 02: Patients' feedback on follow up services

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Satisfied	√	√	√	√	√	√	√	√	√	√	10

Most of the participants are also satisfied with the 3D-printed splint follow-up service after using 3D-printed splints.

Niharika, 55 years female participant said- ‘‘She broke and lost her 3D-printed splint later she went for re-splinting and received good service and she satisfied with the follow-up service.’’

Patients often expressed high satisfaction with the use of 3D-printed splints. The customization capabilities of 3D printing enable a tailored fit that conforms precisely to the individual's anatomy, providing enhanced comfort and support, protect injured or vulnerable body parts from external forces, reducing the risk of additional injury, provide support to weakened muscles or ligaments and holding them in proper alignment. This personalization not only promotes better adherence to wearing the splint but also contributes to improved overall satisfaction (Irani & Ozelie, 2023).

4.3 Theme 03: Patients found 3D-printed splints is affordable

The affordability of 3D printed splints can be a significant benefit for patients. Traditional splints and orthotic devices can often be expensive, especially if they require customization or frequent replacement. However, 3D printing technology offers a more cost effective solution for producing splints. This theme explains the affordability of patients on having 3D printed splints. The theme has been incorporated to understand whether the cost of 3D printed splints are under reach of the patients.

4.3.1 Category 01: Patient thinks that the 3D-printed splint is reasonable.

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Yes	√	√	√	√	√	√	√	√	√		9
No										√	1

Most of the patients said that the price of the 3D-printed splint is affordable.

Tafsee, 39 years female & Misba, 28 years male participant mentioned that ‘‘they have bought 3D printed splint. However, they also told that it would be better if the price was a little lower & if it is a little more durable then it will be better.’’

09 participants said that the 3D-printed splints were much less expensive than the amount of service and benefit it provided and they could afford it.

The cost of 3D-printed splints can be relatively low compared to traditional alternatives, with prices often influenced by factors like material choice and design complexity. Generally, 3D-printing allows for the cost-effective production of personalized splints, making them a more affordable option for patients in need of customized orthopedic solutions. It has been said that a 3D-printed splints is a low-cost therapy option for patients (Chhikara et al., 2023).

4.4 Theme 04: Patients hand function improved after having 3D-printed splint.

This theme describes the feedback of patients after using 3D printed splints. The benefit of 3D printed splints often include improved comfort, better fit and enhanced support compared to traditional splints. Additionally, the customization capabilities of 3D printing allow for a ore tailored approach to addressing each patients specific needs, which contribute to better outcomes, It was assessed whether they had any pain or problem or had to take any medicine while using 3D printed splints.

4.4.1 Category 01: Patients' feedback on whether they benefited from using a 3D-printed splint.

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Benefited	√	√	√	√	√	√	√	√	√	√	10

Most of the patients said that they benefitted from using the 3D-printed splint. They mainly used the splint to recover from hand injuries and improve their hand function to continue daily living activities.

Ekra, 25 years female participant mentioned- ‘‘Yes, I have been benefited greatly from using the 3D-printed splint. Earlier, I was worried about my hand function, but after using 3D printed splint, my hand function improved and I am able to do regular activities now’’

Patients often report benefits from 3D- printed splints, citing improved comfort and enhancing support tailored to their unique needs, contributing to a positive overall experience (Copeland et al., 2022).

The benefits of 3D-printed splints include personalized fit, lightweight design, improved comfort and targeted support, addressing individual patient's need more effectively than traditional splints (Oud et al., 2021).

4.4.2 Category 02: The patient has any problem or discomfort using a 3D-printed splint

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Minimum discomfort			√								1
Have no problem	√	√		√	√	√	√	√	√	√	9

Most of the patients addressed that they did not have any major problems while using 3D-printed splint. However, patients mentioned that they faced a bit of difficulty getting adjusted to carrying a 3D-printed splint, where they noticed some typical scars on the splints carrying parts of the hand.

Shoile, 24 years female participant described- ‘‘No, it wasn't that much of a problem, it was a bit sore at times due to being after it for a long time. Then it would have been better to keep it open for some moments and wear it again.’’

Rahim, 35 years male participant said that ‘‘He had a minimal discomfort at initial stage of using 3D printed splint, but later on he felt better.’’

09 of them did not have any discomfort while using 3D printed splint and gradually, they found it convenient to use.

Using 3D-printed splints typically don’t encounter issues related to taking medicine. The splints primarily focuses on providing support and comfort for physical conditions, while medication administration remains separate from the splint usage. A low-quality study on pain revealed minimal positive effects on satisfaction. There are no benefits seen in research on joint contracture and muscle weakness (Oud et al., 2021).

4.4.3 Category 03: The patient will share their experience with other patient to use the 3D-printed splint.

Codes	Niharika	Asad	Jabid	Misba	Bakul	Rahim	Shajid	Ikra	Shoile	Tafse	Total
Yes	√	√	√	√	√	√	√	√	√	√	10

Most of the patients mentioned that they would share their experience with other patients to use 3D printed splints because they found the splint was very useful. They want other injured people to get the benefit of using 3D-printed splints in a much faster way.

Asadul, 26 years male participant mentioned- ‘‘yes, of course I will share my experience with other people who have injuries to their hand function and is in need of 3D printed splints. I have got speedy recovery in my hand function using 3D printed splint’’.

The majority of the participants said that the 3D-printed splint is safe, easy to apply, easy to carry from one place to another, and effective that’s why they want others to use it and get their deformity or other injuries fixed by this 3D-printed splint.

Patients often recommend 3D-printed splints to others due to the customized fit, comfortable and targeted support they provide, contributing to an overall positive experience and improved therapeutic outcomes. The usefulness of 3D-printed splints lies in their ability to offer a tailored and precise fit, support and improved functionality for patients with specific orthopedic needs (Arulmozhi et al., 2018).

CHAPTER V: CONCLUSION

6.1 Strengths & Limitations

6.1.1 Strengths

- This was the first study among participants with hand injuries who benefited from using 3D-printed splints.
- The study was time-effective as a self-developed questionnaire was used to conduct face-to-face interviews with the patients.
- In this study, every participant enthusiastically responded to the specific questions which helped the researcher to get an in-depth understanding of the opinion of patients on 3D printed splints.
- Since the interviews were taken face to face, it was great scope to build rapport with the respondents.

6.1.2 Limitations

There are some limitations of the study, they are:

- The participants were based on a specific rehabilitation centre which made the participants of the study very limited.
- In this study, only face-to-face interview was considered, otherwise with telephonic conversation patient's opinion could have been taken from a larger number of participants.

6.2 Practice Implication

Currently, 3D-printed splints are being supplied from the CRP- Hand Therapy Unit of Savar, Bangladesh. The manufacturing of 3D-printed splints requires lower men's power, hence the authority should give more focus on increasing the supply of 3D-printed splints as the researcher found that most of the participants were satisfied with using 3D-printed splints to get rid of their injuries.

6.2.1 Recommendation for Future Practice

- ✓ An Occupational Therapist can design 3D printed splints with precise dimensions & features to optimize functionality and comfort and prevent from further injuries.
- ✓ An Occupational Therapist can identify the nature of injuries of the patient who is using a 3D-printed splint, and dive deep into the recovery time of patients.

6.2.2 Recommendation for Future Researcher

- ✓ Explore more research work by extending the number of participants while taking feedback from patients about their opinion of 3D-printed splints.
- ✓ Consider patients with different age levels to get into consolidated findings.

6.3 Conclusion

3D printed splints have many advantages over conventional splints in clinical settings, which encourages further use and intervention. Occupational Therapist may modify the design's characteristics to maximize functioning and fit, enhancing patient comfort and treatment results. Patients' participation and satisfaction with the treatment can be improved by involving them in the design process and considering their input and preferences. With its

existing interpretation of the intervention plan, 3D printed splints help patients and occupational therapist communicate and work together. As per each patient's response, this real-time input can assist Occupational Therapist tailor the treatment plan and guide future intervention efforts. The extensive use of 3D printed splints in clinical settings opens up new paths for investigation and advancement. There are several advantages to using 3D printed splints in healthcare settings, such as increased personalization, quick prototyping, patient involvement, and chances for research and development. To enhance treatment results and patient satisfaction, additional involvement may involve refining design parameters, investigating innovative materials and manufacturing processes, and incorporating sophisticated sensing and monitoring capabilities. According to patient feedback, these splints are lighter, more comfortable, and possibly more adjustable than conventional splints. Moreover, 3D printing technology enables quicker production and customization to meet the needs of specific patients. But it's important to consider things like affordability, strength, and effectiveness when compared to traditional splints. Long-term studies and more research may shed more light on the efficacy and patient satisfaction with 3D printed splints.

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APPENDICES

Appendix A: Approval/ Permission Letter

Approval Letter:

বাংলাদেশ হেল্‌থ প্রফেশন্স ইনস্টিটিউট (বিএইচপিআই)
Bangladesh Health Professions Institute (BHPI)
(The Academic Institute of CRP)

BANGLADESH HEALTH PROFESSIONS INSTITUTE

Ref: CRP-BHPI/IRB/10/2023/761

Date: 18.10.2023

To
Fahmida Khanam
4th Year B.Sc. in Occupational Therapy
Session: 2018-2019 Student ID: 122180332
Department of Occupational Therapy
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

Subject: Approval of the thesis proposal **"Patient's Opinion about using 3D-Printed Splints in Bangladesh"** by ethics committee.

Dear Fahmida Khanam,
Congratulations.
The Institutional Review Board (IRB) of BHPI has reviewed and discussed your application to conduct the above mentioned dissertation, with yourself, as the principal investigator and Khadija Akter Lily as thesis supervisor. The Following documents have been reviewed and approved:

Sr. No.	Name of the Documents
1	Dissertation/thesis/research Proposal
2	Questionnaire (English & / or Bengali version)
3	Information sheet & consent form.

The purpose of the study is to identify patient's opinion of using 3D-printed splint in Bangladesh. The study involves use of semi-structure interview guide to achieve the aim & objectives that may take about 25 to 30 minutes and there is no likelihood of any harm to the participants and no economical benefits for the participants. The members of the Ethics committee have approved the study to be conducted in the presented form at the meeting held at 08.30 AM on 23rd September 2023 at BHPI 38th IRB Meeting.

The institutional Ethics committee expects to be informed about the progress of the study, any changes occurring in the course of the study, any revision in the protocol and patient information or informed consent and ask to be provided a copy of the final report. This Ethics committee is working accordance to Nuremberg Code 1947, World Medical Association Declaration of Helsinki, 1964 - 2013 and other applicable regulation.

Best regards,
MUHAMMAD MILLAT HOSSAIN
Associate Professor, Project & Course Coordinator, MRS
Member Secretary, Institutional Review Board (IRB)
BHPI, CRP, Savar, Dhaka-1343, Bangladesh

সিআরপি-চাপাইন, সাভার, ঢাকা-১৩৪৩, বাংলাদেশ। ফোন: +৮৮ ০২ ২২৪৪৪৫৪৬৪-৫, +৮৮ ০২ ২২৪৪৪১৪০৪, মোবাইল: +৮৮ ০১৭৩০ ০৫৯৬৪৭
CRP-Chapain, Savar, Dhaka-1343, Bangladesh. Tel: +88 02 224445464-5, +88 02 224441404, Mobile: +88 01730059647
E-mail : principal-bhpi@crp-bangladesh.org, Web: bhpi.edu.bd

Permission Letter:

Date: 21 October 2023
To
The Head of the Department
Centre for the Rehabilitation of the Paralysed (CRP)
CRP-Chapain, Savar, Dhaka- 1343

Subject: **An application for seeking permission to collect data for the research project.**

Sir,

With due respect to state that, I am a student of 4th year B. Sc. in Occupational Therapy department of Bangladesh Health Professions Institute (BHPI). In 4th year, I have to submit a research project to the University of Dhaka in partial fulfilment of recruitments of the degree of Bachelor of Science in Occupational Therapy. My research title is **"Patient's Perception about using 3D Printed Splint in Bangladesh"** which is supervised by Khadija Akter Lily, Lecturer of Occupational Therapy Department, Bangladesh Health Professions Institute (BHPI), CRP-Savar, Dhaka-1343, Bangladesh. The purpose of the study is to identify patients' perception about using 3D printed splint in Bangladesh. Now I am looking for your kind approval to start my data collection and I would like to assure that anything of my research period will not be harmful for the participants.

I therefore pray and hope that you would be kind enough to give me the permission for collectingthe data and oblige thereby.

Sincerely

Fahmida

Fahmida Khanam
4th year, B.Sc in Occupational Therapy
Session: 2018- 19; Student ID: 122180332
Bangladesh Health Professions Institute (BHPI)
CRP, Savar, Dhaka- 1343, Bangaldesh

Signature and comments of head of the department

Sk. Monirruzaman 21/10/2023
Associate Professor
Head of the Department of Occupational Therapy
Bangladesh Health Professions Institute (BHPI)
CRP, Savar, Dhaka- 1343, Bangladesh

21/10/2023
Tauhidul Islam
Jr. Consultant & Acting Head
Department of Occupational Therapy
Centre for the Rehabilitation of the Paralysed (CRP)
CRP, Savar, Dhaka- 1343, Bangladesh

Appendix B: Information Sheet & Consent Form (English)

Information Sheet:

I am Fahmida Khanam 4th year student of B.Sc. in Occupational Therapy in Bangladesh Health Professions Institute (BHPI), an Academic Institute of Center for Rehabilitation of Paralytics (CRP). The study was titled **"Patient's Opinion about using 3D-Printed Splints in Bangladesh."**

Your participation in this study is voluntary. You can withdraw your participation at any time and contact this phone number: 01675193670. There is no remuneration for this participation. This study will not harm you. This study will help occupational therapy practitioners to get detailed information about the perception of patients using 3D-printed splints, and future researchers can focus on developing 3D-printed splints for those who need this product. Occupational therapy will be instrumental in upgrading occupations and rehabilitation strategies to ensure a country with productive resources. All records will be kept confidential. Information collected from you will not be disclosed anywhere except to researchers and supervisors. The name of the research participant will not be disclosed anywhere. If you have any questions regarding the study, please refer below Feel free to ask for contact information:

Fahmida Khanam
4th year student
B.Sc. in Occupational Therapy
Department of Occupational Therapy
Bangladesh Health Professions Institute (BHPI)
Center for Rehabilitation of Paralyzed (CRP), Chapin, Savar, Dhaka-1343

Consent Form:

Research Title: Patient's Opinion about using 3D-Printed Splints in Bangladesh.

Fahmida Khanam (researcher) is a 4th-year student of B.Sc. in Occupational Therapy Department 2018-19 session, Bangladesh Health Professions Institute (BHPI), Academic Institute of Center for the Rehabilitation of the Paralyzed (CRP). This study is a part of the curriculum of the Department of Occupational Therapy. Research Supervisor Khadija Akter Lily, Lecturer, Department of Occupational Therapy, Bangladesh Health Professions Institute (BHPI). All participants were informed about the purpose and nature of the study. After knowing all the information, the participants will decide to participate in the study-

- The researcher will obtain permission from the participants to participate in the study.
- Participants will not be harmed for participating in the study.
- The researcher will be available to answer any questions participants may have regarding this study.
- Participants refused to answer any questions during the interview.
- The researcher will maintain the confidentiality of the participants.
- Participants could withdraw from the study at any time.

I am_____ a participant in this study. The aim of the study is communicated. I am voluntarily participating in this study. I have the right to withdraw my name from this study at any time and am under no obligation to answer to anyone.

Signature:

Signature of Participant:	Date:
Signature of Investigator:	Date:
Signature of Witness	Date:

Withdrawal Form:

Can you withdraw from this study?

You may opt out of the information I collect for this research project at any time. Participants should specify in the withdrawal form whether the data can be used after cancellation or not.

Participant Name:

Reason for withdrawal:

-
-
-
-

Whether to allow use of previous data?
Yes/No

Participant Signature:

Date:

Appendix B: Information Sheet & Consent Form (Bangla)

তথ্য পত্র

আমি ফাহমিদা খানম, বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট (বিএইচপিআই) এর ছাত্রী যা পক্ষাঘাতগ্রস্তদের পুনর্বাসন কেন্দ্র (সিআরপি) এর একটি শিক্ষা প্রতিষ্ঠান। আমি অকুপেশনাল থেরাপি বিভাগের বি.এস.সি. ইন অকুপেশনাল থেরাপির ৪র্থ বর্ষে অধ্যায়নরত আছি। এই কোর্সের অংশ হিসাবে চূড়ান্ত বর্ষে আবশ্যকভাবে একটি গবেষণা কর্ম সম্পন্ন করতে হয়। আমি আপনাকে এই গবেষণায় অংশগ্রহন করার জন্য আমন্ত্রণ করছি।। গবেষণাটির শিরোনাম **"বাংলাদেশে থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহারের বিষয়ে রোগীদের ধারণা।"**

এই গবেষণায় অংশগ্রহন সম্পূর্ণ আপনার ইচ্ছাকৃত। আপনি যেকোনো সময় আপনার অংশগ্রহণ প্রত্যাহার করতে এবং এই ফোন নম্বরে যোগাযোগ করতে পারেন: ০১৬৭৫১৯৩৬৭০ । গবেষণায় অংশগ্রহণের জন্য কোনো উপহারের ব্যবস্থা নেই।। এই গবেষণায় আপনার কোন ক্ষতি হবে না । এই গবেষণাটি অকুপেশনাল থেরাপি অনুশীলনকারীদের থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করা রোগীদের ধারণা সম্পর্কে বিস্তারিত তথ্য পেতে সাহায্য করবে এবং ভবিষ্যতে গবেষকরা থ্রিডি প্রিন্টেড স্প্লিন্টগুলি তৈরি করার দিকে মনোনিবেশ করতে পারবেন ও যাদের এই স্প্লিটটির প্রয়োজন তাদের জন্য গবেষণাটি সহায়ক হবে। সমস্ত রেকর্ডের গোপনীয়তা বজায় রাখা হবে। আপনার কাছ থেকে সংগৃহীত তথ্য গবেষক এবং তার তত্ত্বাবধায়ক ছাড়া কোথাও প্রকাশ করা হবে না। অধ্যয়ন সংক্রান্ত আপনার কোন প্রশ্ন থাকলে, আমাকে দ্বিধাহীনভাবে জিজ্ঞেসা করতে পারেন। গবেষণা বিষয়ক সকল প্রশ্নের উত্তর দেবার জন্য আমি সচেষ্ট থাকব।

ফাহমিদা খানম
৪র্থ বর্ষের ছাত্রী
বিএসসি ইন অকুপেশনাল থেরাপি
অকুপেশনাল থেরাপি বিভাগ
বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট (বিএইচপিআই)
পক্ষাঘাতগ্রস্তদের পুনর্বাসন কেন্দ্র (সিআরপি), চাপাইন, সাভার, ঢাকা- ১৩৪৩

সম্মতি পত্র:

গবেষণার শিরোনাম: বাংলাদেশে থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার সম্পর্কে রোগীদের ধারণা।

ফাহমিদা খানম (গবেষক) একজন বিএসসি ইন অকুপেশনাল থেরাপি বিভাগের ২০১৮-১৯ সেশনের ৪র্থ বর্ষের ছাত্রী, বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট (বিএইচপিআই), সেন্টার ফর দ্য রিহ্যাবিলিটেশন অফ দ্য প্যারালাইজডের একাডেমিক ইনস্টিটিউট (সিআরপি) । এই অধ্যয়নটি অকুপেশনাল থেরাপি বিভাগের পাঠ্যক্রমের একটি অংশ। এই গবেষণার তত্ত্বাবধায়ক খাদিজা আক্তার লিলি, অকুপেশনাল থেরাপি বিভাগের প্রভাষক, বাংলাদেশ হেলথ প্রফেশনস ইনস্টিটিউট (বিএইচপিআই)। সমস্ত অংশগ্রহণকারীদের গবেষণার উদ্দেশ্য এবং প্রকৃতি সম্পর্কে অবহিত করা হয়। সমস্ত তথ্য জানার পর, অংশগ্রহণকারীরা গবেষণায় অংশগ্রহণ করার সিদ্ধান্ত নেবে-

- গবেষক অংশগ্রহণকারীদের কাছ থেকে গবেষণায় অংশ নেওয়ার অনুমতি পাবেন।
- অধ্যয়নে অংশগ্রহণের জন্য অংশগ্রহণকারীর ক্ষতি হবে না।
- গবেষক অংশগ্রহণকারীদের এই গবেষণার সাথে সম্পর্কিত যেকোন প্রশ্নের উত্তর দিতে উপলব্ধ থাকবে।
- অংশগ্রহণকারীরা সাক্ষাৎকারের সময় যেকোনো প্রশ্নের উত্তর প্রত্যাখ্যান করতে পারবেন।
- গবেষক অংশগ্রহণকারীদের গোপনীয়তা বজায় রাখবেন।
- অংশগ্রহণকারীরা যে কোনো সময় অধ্যয়ন থেকে প্রত্যাহার করতে পারবেন।

আমি _____ এই গবেষণার একজন অংশগ্রহণকারী। গবেষণার লক্ষ্য সম্পর্কে স্পষ্টভাবে অবহিত করা হয়। আমি এই গবেষণায় স্বেচ্ছায় অংশগ্রহণ করছি। আমার এই গবেষণা থেকে যেকোনো সময় আমার নাম প্রত্যাহার করার অধিকার আছে এবং আমি এর জন্য কাউকে উত্তর দিতে বাধ্য নই।

স্বাক্ষর:

অংশগ্রহণকারীর স্বাক্ষর:	তারিখ:
গবেষকের স্বাক্ষর:	তারিখ:
সাক্ষীর স্বাক্ষর:	তারিখ:

প্রত্যাহার পত্র:

আপনি এই গবেষণা থেকে প্রত্যাহার করতে পারেন?

আপনি যেকোনো সময় এই গবেষণা প্রকল্পের জন্য আমার সংগ্রহ করা তথ্য বাতিল করতে পারেন। বাতিল করার পর তথ্য ব্যবহার করা যাবে কি না তা অংশগ্রহণকারীদের উল্লেখ করতে হবে।

অংশগ্রহণকারীর নাম:

প্রত্যাহারের কারণ:

-
-
-
-
-

আগের তথ্য ব্যবহারের অনুমতি দেওয়া হবে কিনা?

হ্যাঁ/ না

অংশগ্রহণকারী স্বাক্ষর:

তারিখ:

Appendix C: Questionnaire (English)

Questions for the participants:

Name: Occupation:

Age: Diagnosis:

Sex: Duration of injury:

1. The 3D-printed splint you are using how comfortable is it?
2. Does the 3D-printed splint you are using feel too heavy?
3. How safe do you think the 3D-printed splint you are using is for you? Why?
4. Whether using the 3D-printed splint has benefited or whether the splint meet your needs?
5. Have you had any problems using the 3D-printed splint? If so, what is it?
6. If someone has an injury like yours, would you share your opinion to using 3D-printed splints?
7. Did you purchase 3D-printed splint?
8. Do you find 3D-printed splint you used cost-effective?
9. Did you get the appropriate information from the professionals on how to "use" the 3D-printed splint after you received it?
10. Whether you are satisfied with the follow-up service after you take 3D-printed splint?

Appendix C: Questionnaire (Bangla)

অংশগ্রহনকারীদের জন্য প্রশ্নপত্র

অংশগ্রহনকারীর নাম-

অংশগ্রহণকারীর পেশা-

অংশগ্রহণকারীর বয়স-

রোগের ধরন-

লিঙ্গ-

রোগের সময়কাল-

১. আপনি যেই থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করছেন সেটা কতটা আরামদায়ক?

২. আপনি যেই থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করছেন সেটা কি বেশি ভারী মনে হয়েছে?

৩. আপনি যেই থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করছেন সেটি আপনার জন্য কতটা নিরাপদ বলে আপনি মনে করছেন? কেন?

৪. থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করে উপকার হয়েছে কিনা বা স্প্লিন্টটি আপনার চাহিদা পূরন করেছে কিনা এবং কিভাবে?

৫. থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করতে আপনার কোন সমস্যা হয়েছে কিনা? যদি হয় তাহলে সেটা কি-

৬. যদি কারো আপনার মতো এমন ইঞ্জুরি হয় তাহলে কি আপনি তাকে থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করার উৎসাহ দিবেন?

৭. থ্রিডি প্রিন্টেড স্প্লিন্ট আপনি ক্রয় করেছিলেন?

৮. আপনি যেই থ্রিডি প্রিন্টেড স্প্লিন্ট ব্যবহার করেছেন সেটা আপনি সাশ্রয়ী বলে মনে করছেন কি না?

৯. আপনি থ্রিডি প্রিন্টেড স্প্লিন্ট পাওয়ার পরে কীভাবে "ব্যবহার" করবেন সে সম্পর্কে পেশাদারদের কাছ থেকে সঠিক তথ্য পেয়েছেন?

১০. আপনি থ্রিডি প্রিন্টেড স্প্রিন্টটি নেওয়ার পরবর্তী সেবা বা ফলো-আপ নিয়ে আপনি সন্তুষ্ট কিনা?

Bangladesh Health Professions Institute
Department of Occupational Therapy
4th Year B. Sc in Occupational Therapy
OT 401 Research Project

Thesis Supervisor- Student Contact; face to face or electronic and guidance record

Title of thesis: Patient's ~~Perception~~ Opinion about using 3D-printed splints in Bangladesh.

Name of student: Fahmida Khanam

Name and designation of thesis supervisor: Khadija Akter Lily
Lecturer
Department of Occupational Therapy, BHPI, CRP.

Appointment No	Date	Place	Topic of discussion	Duration (Minutes/ Hours)	Comments of student	Student's signature	Thesis supervisor signature
1	09.08.23	Library Building	Introduction, Research Title, Aim & Objective	2.00 hrs 45 min	Effective discussion about research.	Fahmida	
2	16.08.23	"	Research Methods, Qualitative research	1 hrs 45 min	Discussion about methods & qualitative design	Fahmida	
3	19.08.23	"	Methodology, sampling, Proposal guideline	2 hrs 50 min	Effective discussion about methodology, sampling & proposal	Fahmida	

4	11.09.23	Library Building	Research Proposal submit & discussion	1 hrs 45 min	write on research proposal	Fahmida	
5	12.09.23	"	Research Proposal feedback + Presentation guideline	2 hrs 45 min	Effective discussion on presentation & proposal write up	Fahmida	
6	21.09.23	"	Research Proposal Presentation feedback	2 hrs	Helpful feedback	Fahmida	
7	20.12.23	"	Field test related sharing & data collection feedback	1 hrs 45 min	write up background and justification	Fahmida	
8	08.01.24	"	Background & Justification submission + Discussion	2 hrs	write up Literature review + methodology	Fahmida	
9	15.01.24	"	Feedback on background & Justification, Literature review + Methodology submission	2 hrs 15 min	write up 1st draft	Fahmida	
10	27.01.24	"	Feedback on Literature review + Methodology.	3 hrs	write up existing 1st draft and correction according to feedback	Fahmida	
11	11.02.24	"	Feedback on 1st draft	3 hrs	Giot helpful feedback on 1st draft	Fahmida	
12	20.02.24	"	Guideline for abstract writing, 1st draft correction checking.	2 hrs	Correction 1st draft	Fahmida	
13	29.02.24	"	Guideline on ~~trea~~ data analysis, check transcription and instruction on abstract	2 hrs	write on abstract and analysis, code, theme	Fahmida	
14	12.03.24	"	Feedback on translation, analysis, check coding, category, theme.	2 hrs 45 min	Correction according to feedback	Fahmida	

15	16.03.24	Library Building	Feedback on 2nd draft (full)	3 hrs	correction according to feedback	Fahmida	
16	19.03.24	"	Feedback on abstract, result, discussion	2 hrs 45 min	Correction according to feedback	Fahmida	
17	23.03.24	"	Guideline on powerpoint presentation	45 min	Effective guideline.	Fahmida	
18	02.04.24	"	Feedback on result, discussion	2 hrs 45 min.	correction according to feedback	Fahmida	
19	15.04.24	"	Feedback on defence presentation.	1 hrs	Effective feedback	Fahmida	
20							

Note:

1. Appointment number will cover at least a total of 40 hours; applicable only for face to face contact with the supervisors.
2. Students will require submitting this completed record during submission your final thesis.