# A COMPARITIVE STUDY OF FUNCTIONAL OUTCOME BETWEEN 3D PRINTED PATIENT SPECIFIC WRIST SPLINTS AND CONVENTIONAL SPLINTS IN PATIENTS WITH WRIST DROP.

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**ABSTRACT:**
**Background:** Wrist drop caused by radial nerve palsy results in significant functional impairment due to loss of active wrist and finger extension, affecting grip strength, dexterity, and activities of daily living. Conventional thermoplastic splints are commonly used for conservative management; however, they are often associated with poor ventilation, discomfort, bulkiness, skin irritation, and reduced patient compliance. Recent advances in additive manufacturing have enabled the development of patient-specific three-dimensional (3D) printed orthoses with improved customization and biomechanical properties.

**Aim:** To evaluate the functional outcome, comfort, compliance, and patient satisfaction of 3D-printed patient-specific wrist splints compared with conventional thermoplastic splints in patients with wrist drop.

**Materials and Methods:** This comparative prospective study was conducted in patients diagnosed with wrist drop secondary to radial nerve palsy. Participants were divided into two groups: a 3D-printed patient specific splint group and a conventional thermoplastic splint group. Customized 3D splints were fabricated using digital scanning, computer-aided design, and additive manufacturing techniques. Baseline demographic and clinical characteristics were recorded. Functional outcomes including wrist position, grip strength, daily activity performance, patient-reported comfort, compliance, usability, and device-related complications were assessed during follow-up. Statistical analysis was performed using SPSS software, and within-group as well as between-group comparisons were analysed.

**Results:** Patients treated with 3D-printed splints demonstrated superior comfort, improved ventilation, better anatomical conformity, and higher compliance compared to conventional splints. Functional outcomes including wrist positioning, grip efficiency, and return to daily activities showed significant improvement in both groups, with comparatively better patient satisfaction and usability scores in the 3D-printed splint group. Device-related complaints and adjustment requirements were lower among patients using customized 3D orthoses.

**Conclusion:** Patient-specific 3D-printed wrist splints are a feasible and effective alternative to conventional thermoplastic splints in the management of wrist drop. Improved comfort, aesthetics, anatomical fit, and compliance make them a promising advancement in orthotic rehabilitation and **Keywords:** Wrist drop, Radial nerve palsy, Three-dimensional (3D) printing, Patient-specific wrist splint, Functional outcome. Personalized patient care.

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## INTRODUCTION

Wrist drop is a clinically significant manifestation of radial nerve dysfunction characterized by the inability to actively extend the wrist, fingers, and thumb. The condition results from paralysis or weakness of the extensor muscles of the forearm due to interruption of radial nerve function, producing a characteristic flexed posture of the wrist. Radial neuropathy is among the most common peripheral mononeuropathies affecting the upper limb and may arise from traumatic, compressive, inflammatory, metabolic, congenital, or neoplastic causes. Functional impairment associated with wrist drop extends beyond the loss of wrist extension, affecting grip strength, dexterity, hand positioning, and performance of activities of daily living. Consequently, restoration of upper limb function remains a primary goal of treatment and rehabilitation.[1]

The radial nerve originates from the posterior cord of the brachial plexus (C5–T1) and courses through the posterior compartment of the arm in the spiral groove of the humerus before dividing into superficial sensory and deep motor branches near the lateral epicondyle. The deep branch continues as the posterior interosseous nerve, supplying the extensor muscles of the forearm responsible for extension of the wrist, fingers, and thumb. Clinical manifestations depend on the site of injury. Lesions proximal to the spiral groove may produce weakness of elbow extension and sensory deficits over the dorsum of the hand, whereas distal lesions generally spare triceps function but significantly impair wrist and finger extension. Understanding this anatomical distribution is essential for accurate localization and appropriate management.[2]

The pathophysiology of wrist drop involves interruption of motor conduction to the extensor musculature. Compression of the radial nerve, classically described as "Saturday night palsy," produces neurapraxia or axonotmesis due to prolonged external pressure, leading to transient conduction block, ischemia, and demyelination. Severe trauma associated with fractures, penetrating injuries, or surgical complications may result in neurotmesis requiring operative intervention. Although peripheral radial neuropathy accounts for the majority of cases, central nervous system disorders such as cortical infarction may occasionally present with isolated wrist drop, making careful neurological evaluation essential. Rare etiologies include neoplastic infiltration, congenital radial nerve palsy, postoperative compression injuries, and systemic neurological disorders.[1–4]

Patients with wrist drop typically present with inability to actively extend the wrist and metacarpophalangeal joints, causing the hand to assume a flexed posture. Grip strength is substantially reduced because effective finger flexion requires a stable wrist in extension. Depending on lesion level, weakness of thumb extension and sensory disturbances over the dorsolateral aspect of the hand may also occur. Clinical examination, nerve conduction studies, electromyography, and appropriate imaging assist in confirming the diagnosis and determining lesion severity. Differential diagnosis includes posterior interosseous nerve syndrome, cervical radiculopathy, brachial plexopathy, and cortical stroke, each requiring distinct therapeutic approaches.[3], [6], [9].

The prognosis of radial nerve palsy depends largely on the mechanism and severity of injury. Compressive neuropathies generally recover spontaneously over several weeks or months, whereas severe traumatic lesions may require surgical exploration, nerve repair, or tendon transfer. During the recovery period, prolonged muscle weakness predisposes patients to joint stiffness, contractures, muscle atrophy, and impaired hand function. Early rehabilitation therefore focuses on preserving joint alignment, maintaining soft tissue flexibility, preventing deformity, and facilitating functional use of the affected limb through physiotherapy, occupational therapy, electrical stimulation, and orthotic support.[1], [2], and [6].

Splinting represents one of the most important conservative interventions in managing wrist drop. The principal objective of a wrist splint is to maintain the wrist in functional extension, thereby optimizing the length-tension relationship of the finger flexor muscles and improving grasp efficiency. Conventional thermoplastic splints are fabricated manually by molding heated thermoplastic material directly onto the patient's limb. Although these splints effectively maintain wrist position, their fabrication is labour-intensive, highly operator-dependent, and often requires repeated modifications to achieve adequate comfort and fit. Problems such as poor ventilation, excessive weight, skin irritation, pressure sores, and limited cosmetic appeal may adversely affect patient compliance, particularly during prolonged rehabilitation. Standard prefabricated splints frequently fail to accommodate individual anatomical variations, resulting in suboptimal comfort and function.[6]

Recent advances in additive manufacturing have introduced three-dimensional (3D) printing as a promising alternative for customized orthotic fabrication. Three-dimensional printing enables layer-by-layer construction of patient-specific splints directly from digital computer-aided design models generated after scanning the affected limb. This technology allows production of lightweight, anatomically conforming, ventilated orthoses with complex lattice structures that improve comfort while maintaining adequate mechanical strength. Digital workflows also facilitate rapid modification, reproducibility, and efficient manufacturing with minimal material wastage compared with conventional fabrication methods.[7]

Clinical investigations have demonstrated encouraging outcomes with customized 3D-printed orthoses. Compared with conventional thermoplastic splints, patient-specific devices have shown improved comfort, fit, ventilation, aesthetics, and patient satisfaction while maintaining comparable immobilization and biomechanical support. The ability to customize splint geometry according to individual anatomy improves pressure distribution and reduces localized stress concentrations, thereby enhancing compliance during prolonged use. Advances in computer-aided design, finite element analysis, and material engineering have further optimized splint strength, flexibility, and durability, allowing clinicians to develop orthoses tailored to the functional requirements of each patient.[7,8]

Emerging technologies are further expanding the applications of patient-specific orthoses through integration of smart sensors and digital monitoring systems capable of assessing compliance, joint position, and rehabilitation progress. Such innovations support precision rehabilitation by providing objective feedback and enabling timely adjustments throughout recovery. Although widespread clinical implementation requires further validation and standardization, current evidence supports the feasibility and clinical potential of digitally manufactured customized splints for upper limb rehabilitation.[8]

Considering the diverse causes of wrist drop—including compressive neuropathy, traumatic injury, and postoperative nerve palsy, and central neurological disorders— treatment should be individualized according to the patient's anatomy, neurological status, and functional demands. Patient-specific 3D-printed splints offer several potential advantages over conventional orthoses, including superior anatomical conformity, improved comfort, enhanced ventilation, reduced weight, greater aesthetic acceptance, and rapid fabrication. These characteristics may improve patient compliance while maintaining appropriate wrist alignment during nerve recovery. Therefore, the present study titled "3D Printed Patient Specific Custom Made Splint for Wrist Drop" was undertaken to evaluate the clinical applicability of customized 3D-printed splints as an innovative rehabilitation strategy for patients with wrist drop, with the objective of improving comfort, functional recovery, and overall upper limb performance.[9]

**AIMS AND OBJECTIVES:**

**Aim:**

To design, develop, and clinically evaluate a 3D-printed patient-specific custom-made wrist splint for individuals with wrist drop and to compare its functional effectiveness, comfort, and compliance with conventional thermoplastic splints.

**Objectives**:

1. To design and fabricate a patient-specific wrist splint using 3D scanning and additive manufacturing technology for patients diagnosed with radial nerve palsy presenting as wrist drop.
2. To evaluate the biomechanical stability and anatomical conformity of the 3D-printed splint.
3. To assess functional improvement in wrist position, grip strength, and daily activity performance following splint application.
4. To compare patient comfort, compliance, and satisfaction between 3D-printed splints and conventional thermoplastic splints.
5. To analyse the cost-effectiveness and feasibility of implementing 3D-printed splints in a tertiary care hospital setting.

**Methodology**

**Study Design** A prospective comparative clinical study will be conducted over six months. Participants will be divided into two groups:

• Group A: Conventional thermoplastic splint
• Group B: 3D-printed patient-specific splint.

This will be a parallel-group comparative study.

**MATERIALS AND METHODS**:

Sample Size Based on feasibility within the study duration (6 months data collection), an estimated sample size of 60 patients will be included:

• 30 patients in conventional splint group
• 30 patients in 3D-printed splint group Sample size may be adjusted following pilot data variability assessment.

**Inclusion Criteria**:

• Age 18–65 years
• Diagnosed radial nerve palsy presenting with wrist drop
• MRC motor grade ≤ 3 for wrist extensors
• Ability to provide informed consent.

**Exclusion Criteria:**

• Open wounds or skin infection over wrist
• Severe contractures • Associated brachial plexus injury
• Central neurological causes (e.g., stroke)
• Cognitive impairment affecting compliance

**Ethical Considerations**:

• Institutional Ethics Committee approval obtained
• Written informed consent mandatory
• Non-invasive intervention
• Confidentiality maintained
• No financial burden to participants
• No compensation required (minimal risk study)

Intervention Protocol Participants will be allocated into groups using simple randomization.

Group A – Conventional Splint Thermoplastic splint fabricated using standard occupational therapy technique.

Group B – 3D Printed Splint Patient-specific 3D-printed splint fabricated as per Part 1 protocol.

Both groups will receive standardized physiotherapy including:

• Passive stretching
• Active assisted exercises
• Grip strengthening exercises
• Functional task training Splints will be worn for minimum 6 hours daily for 12 weeks.

Outcome Measures Assessments will be performed at: • Baseline • 4 weeks • 8 weeks • 12 weeks

Repeated measures ANOVA will assess improvement over time. Chi-square test will analyze categorical variables such as complication rates. A p-value < 0.05 will be considered statistically significant.

**RESULTS:**

**Table 1: Baseline age distribution of the study participants according to treatment group**

| Variable | 3D brace (n=75) | Conventional splint (n=75) | Test statistic | p value |
|---|---|---|---|---|
| Age (years), mean ± SD | 42.64 ± 12.82 | 43.11 ± 11.66 | t = -0.233 | 0.816 |

**Table 2: Baseline sex distribution of the study participants according to treatment group**

| Variable | 3D brace (n=75) | Conventional splint (n=75) | Test statistic | p value |
|---|---|---|---|---|
| Male | 49 (65.3%) | 47 (62.7%) | | |
| Female | 26 (34.7%) | 28 (37.3%) | $\chi^2 = 0.116$, df = 1 | 0.734 |

**Table 3: Within-group comparison of baseline and follow-up outcomes in the conventional splint group**

| Outcome | Baseline mean ± SD | Follow-up mean ± SD | Paired mean difference | Paired t (df=74) | p value |
|---|---|---|---|---|---|
| QuickDASH score | 60.51 ± 10.15 | 41.73 ± 11.28 | 18.7733 | 37.073 | <0.001 |
| 9-Hole Peg Test time (sec) | 44.08 ± 7.59 | 35.79 ± 8.22 | 8.2933 | 22.658 | <0.001 |
| Grip strength (kg) | 9.15 ± 3.43 | 13.97 ± 4.03 | -4.8267* | -20.015 | <0.001 |
| Wrist extension lag (degrees) | 30.69 ± 12.26 | 14.39 ± 12.67 | 16.3067 | 28.321 | <0.001 |
| Self-consciousness (0–10) | 7.03 ± 1.39 | 4.89 ± 1.47 | 2.1333 | 9.196 | <0.001 |

Negative paired mean difference reflects SPSS calculation of baseline minus follow-up for grip strength; clinically, this indicates an increase in grip strength.

**Table 4: Follow-up functional outcomes according to treatment group**

| Outcome at follow-up | 3D brace (n=75) | Conventional splint (n=75) | t value | p value |
|---|---|---|---|---|
| QuickDASH score, mean ± SD | 32.41 ± 14.13 | 41.73 ± 11.28 | -4.463 | <0.001 |
| 9-Hole Peg Test time (sec), mean ± SD | 31.08 ± 7.20 | 35.79 ± 8.22 | -3.732 | <0.001 |
| Grip strength (kg), mean ± SD | 16.31 ± 3.88 | 13.97 ± 4.03 | 3.612 | <0.001 |
| Wrist extension lag (degrees), mean ± SD | 8.09 ± 8.12 | 14.39 ± 12.67 | -3.623 | <0.001 |

**Table 5: Follow-up patient-reported outcomes according to treatment group**

| Outcome at follow-up | 3D brace (n=75) | Conventional splint (n=75) | t value | p value |
|---|---|---|---|---|
| Comfort (0–10), mean ± SD | 8.40 ± 0.89 | 6.51 ± 1.03 | 12.062 | <0.001 |
| Ease of donning/doffing (0–10), mean ± SD | 8.71 ± 0.65 | 6.91 ± 0.79 | 15.194 | <0.001 |
| Cosmetic satisfaction (0–10), mean ± SD | 8.80 ± 0.84 | 5.71 ± 0.78 | 23.333 | <0.001 |
| Social acceptance (0–10), mean ± SD | 8.51 ± 1.66 | 6.11 ± 2.04 | 7.903 | <0.001 |
| Self-consciousness (0–10), mean ± SD | 2.31 ± 1.07 | 4.89 ± 1.47 | -12.359 | <0.001 |
| Overall satisfaction (0–10), mean ± SD | 8.60 ± 1.66 | 6.40 ± 2.38 | 6.572 | <0.001 |

Patient-reported outcomes at follow-up clearly favoured the 3D brace group. Participants using the 3D brace reported significantly greater comfort, ease of use, cosmetic satisfaction, social acceptance, and overall satisfaction, along with significantly lower self-consciousness. These findings are particularly important because they reflect not only functional benefit but also patient-centred acceptability of the orthosis.

**Table 6: Adherence and compliance according to treatment group**

| Variable | 3D brace (n=75) | Conventional splint (n=75) | Test statistic | p value |
|---|---|---|---|---|
| Daily wear time (hours), mean ± SD | 8.11 ± 1.73 | 6.91 ± 1.34 | t = 4.755 | <0.001 |
| Wore brace >6 hours/day | Yes 64 (85.3%), No 11 (14.7%) | Yes 46 (61.3%), No 29 (38.7%) | $\chi^2 =$ 11.045, df = 1 | 0.001 |
| Missed use for ≥3 days/week | Yes 6 (8.0%), No 69 (92.0%) | Yes 17 (22.7%), No 58 (77.3%) | $\chi^2 =$ 6.214, df = 1 | 0.013 |
| Prefers to continue same brace | Yes 61 (81.3%), No 14 (18.7%) | Yes 29 (38.7%), No 46 (61.3%) | $\chi^2 =$ 28.444, df = 1 | <0.001 |

Adherence outcomes also favoured the 3D brace group. Participants in this group wore their brace for longer daily duration, were more likely to use it for more than 6 hours per day, were less likely to miss usage for 3 or more days per week, and were more willing to continue with the same brace after completion of the study. These results suggest that the 3D brace achieved better real-world acceptability and compliance.

**Table 7: Device-related complaints according to treatment group**

| Complaint | 3D brace (n=75) | Conventional splint (n=75) | Test statistic | p value |
|---|---|---|---|---|
| Bulkiness | Yes 5 (6.7%), No 70 (93.3%) | Yes 29 (38.7%), No 46 (61.3%) | $\chi^2 =$ 21.907, df = 1 | <0.001 |
| Excess sweating | Yes 8 (10.7%), No 67 (89.3%) | Yes 26 (34.7%), No 49 (65.3%) | $\chi^2 =$ 12.323, df = 1 | <0.001 |
| Appearance dissatisfaction | Yes 3 (4.0%), No 72 (96.0%) | Yes 27 (36.0%), No 48 (64.0%) | $\chi^2 =$ 24.000, df = 1 | <0.001 |
| Difficulty fastening | Yes 7 (9.3%), No 68 (90.7%) | Yes 18 (24.0%), No 57 (76.0%) | $\chi^2 =$ 5.808, df = 1 | 0.016 |
| Pressure marks | Yes 6 (8.0%), No 69 (92.0%) | Yes 11 (14.7%), No 64 (85.3%) | $\chi^2 =$ 1.659, df = 1 | 0.198 |

Device-related complaints were generally more frequent in the conventional splint group. Complaints of bulkiness, excess sweating, dissatisfaction with appearance, and difficulty in fastening were all significantly higher in the conventional splint group. Pressure marks were numerically more frequent in the conventional group as well, although this difference did not reach statistical significance.

## DISCUSSION

The present prospective comparative study evaluated the effectiveness of patient-specific three-dimensional (3D)-printed wrist splints compared with conventional thermoplastic splints in patients with wrist drop secondary to radial nerve palsy. The findings demonstrated that both splint types contributed to functional improvement during rehabilitation; however, patients treated with customized 3D-printed splints consistently achieved superior outcomes in terms of comfort, compliance, usability, cosmetic acceptance, and overall patient satisfaction. These findings support the growing evidence that additive manufacturing offers substantial clinical advantages in orthotic rehabilitation while maintaining the biomechanical objectives of conventional splinting.[13]

The baseline demographic characteristics were comparable between the two treatment groups with respect to age and sex distribution, indicating that the study groups were well matched before intervention. Such baseline homogeneity minimizes potential confounding factors and allows observed differences in follow-up outcomes to be attributed primarily to the type of orthotic intervention rather than demographic variation. Similar demographic distributions have been reported in previous studies evaluating upper limb orthoses, where radial nerve palsy predominantly affected young and middle-aged adults without significant sex-related differences in rehabilitation outcomes.[14]

Within-group analysis demonstrated significant improvement in wrist position, grip strength, and functional performance following splint application in both the conventional and 3D-printed splint groups. These findings confirm the established role of wrist splinting in maintaining the wrist in functional extension, thereby optimizing the length-tension relationship of the finger flexors and improving grasp efficiency during recovery. Conservative management with splinting remains an essential component of rehabilitation for radial nerve palsy, particularly in neurapraxic injuries where spontaneous neurological recovery is anticipated. The present findings therefore reinforce previous reports emphasizing that appropriate orthotic support prevents secondary deformity, reduces joint stiffness, and facilitates functional hand use during nerve regeneration.[15]

Although improvement occurred in both treatment groups, follow-up functional assessment consistently favoured the 3D-printed splints. Patients using customized splints demonstrated better wrist positioning, improved grip efficiency, and earlier return to activities of daily living. These advantages are likely attributable to the superior anatomical conformity achieved through digital limb scanning and computer-aided design. Unlike conventional thermoplastic splints, patient-specific orthoses closely match individual anatomical contours, thereby distributing pressure more evenly while maintaining stable biomechanical alignment. Earlier investigations have similarly reported that customized 3D-printed orthoses provide functional support comparable or superior to conventional devices because of their individualized design and improved mechanical characteristics.[16]

One of the most notable findings of the present study was the significantly higher patient-reported comfort associated with the 3D-printed splints. Comfort is a major determinant of orthotic acceptance because prolonged rehabilitation requires patients to wear splints for several hours each day. Participants using the customized splints reported better ventilation, reduced sweating, improved ease of application, and less discomfort during routine activities. The perforated lattice architecture characteristic of additive manufacturing allows greater airflow and reduced weight without compromising structural integrity. Similar observations have been documented in previous clinical studies where ventilated 3D-printed splints significantly improved patient comfort and reduced skin irritation compared with conventional thermoplastic orthoses.[17]

Cosmetic appearance and social acceptance were also significantly better among patients using 3D-printed splints. Conventional splints are frequently bulky, opaque, and visually unattractive, leading to self-consciousness and reluctance to use the device in public. In contrast, digitally fabricated splints are lightweight, aesthetically appealing, and can be customized in shape and design according to patient preference. Improved cosmetic satisfaction observed in the present study likely contributed to greater psychological acceptance and willingness to continue treatment. Previous investigations have similarly demonstrated that improved aesthetics enhance patient confidence and positively influence adherence to orthotic rehabilitation programmes.[18]

Compliance represents one of the most important determinants of successful conservative management. The present study demonstrated significantly greater adherence among patients treated with customized 3D-printed splints. Participants in this group wore their splints for longer daily durations, were less likely to discontinue treatment, and expressed greater willingness to continue using the same orthosis after completion of the study. Improved compliance is probably multifactorial, resulting from enhanced comfort, superior fit, reduced weight, improved ventilation, and greater cosmetic acceptability. Similar findings have been reported in systematic reviews indicating that patient-specific orthoses improve long-term adherence because users perceive them as more comfortable and functionally beneficial than conventionally fabricated devices.[19]

Device-related complaints were substantially lower among patients using customized splints. Complaints of bulkiness, excessive sweating, dissatisfaction with appearance, and difficulty in fastening occurred significantly more frequently with conventional thermoplastic splints. Although pressure marks were observed in both groups, they occurred less frequently in the 3D-printed group. These observations emphasize one of the principal advantages of digital customization, namely the ability to optimize splint geometry according to individual anatomy while minimizing localized pressure concentrations. Finite element modelling and computer-aided design permit refinement of splint architecture before fabrication, thereby reducing the need for repeated manual adjustments commonly required with conventional splints.[20]

The biomechanical advantages of additive manufacturing further explain the superior outcomes observed in the present study. Customized splints can be fabricated with controlled wall thickness, lattice density, and flexibility according to the patient's clinical requirements. Such design flexibility enables maintenance of adequate wrist extension while simultaneously reducing overall device weight. Furthermore, digital workflows facilitate rapid reproduction and modification of orthoses if neurological recovery or anatomical changes occur during rehabilitation. These characteristics support the concept of personalized orthotic management and represent a significant advancement over conventional fabrication techniques.[21]

The findings of the present study have important clinical implications. Patient-specific 3D-printed splints not only fulfil the traditional biomechanical objectives of immobilization and functional positioning but also address patient-centred outcomes such as comfort, satisfaction, and adherence. Improved compliance may ultimately translate into better long-term functional recovery because patients are more likely to wear comfortable orthoses for the recommended duration. As three-dimensional printing technology becomes increasingly accessible, customized orthoses may become a practical option in tertiary rehabilitation centres and specialized orthotic services. However, wider implementation requires investment in digital infrastructure, clinician training, standardized fabrication protocols, and cost-effectiveness evaluation.[22]

Certain limitations should be acknowledged. The study involved a relatively modest sample size and a follow-up period of twelve weeks, which may not fully capture long-term neurological recovery or orthotic durability. Cost analysis and objective biomechanical assessments were beyond the scope of the present investigation. Future multicentre randomized controlled trials with larger populations, extended follow-up, and comprehensive economic evaluation are required to establish definitive clinical guidelines for the routine use of patient-specific 3D-printed wrist splints.

Overall, the findings of this study demonstrate that while both conventional and customized splints effectively support rehabilitation in patients with wrist drop, patient-specific 3D-printed splints provide significant additional benefits in functional performance, comfort, cosmetic acceptance, compliance, and patient satisfaction. These results support the integration of additive manufacturing into contemporary orthotic practice as a promising step toward personalized rehabilitation and improved clinical outcomes for patients with radial nerve palsy.[22]

## CONCLUSION:

Patient-specific 3D-printed wrist splints are a safe, effective, and clinically superior alternative to conventional thermoplastic splints for the management of wrist drop. The 3D-printed splints provide better functional recovery, improved comfort, higher compliance, and greater patient satisfaction. Conventional thermoplastic splints remain effective but are associated with higher discomfort and lower compliance. Integration of 3D-printing technology into tertiary care orthotic services is feasible and aligns with principles of personalized and patient-centred care.

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