Original Article: The role of dorsal blocking pinning for range of motion change of PIP joint after volar plate arthroplasty

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ABSTRACT

Introduction: Volar plate arthroplasty is an effective surgical intervention for addressing PIP joint pathologies. However, concerns regarding postoperative ROM limitations have prompted the exploration of adjunctive techniques, such as dorsal blocking pinning. This article aims to investigate the role of dorsal blocking pinning in facilitating ROM changes in the PIP joint after volar plate arthroplasty.

Material and Methods: ROM measurements of the PIP joint were obtained preoperatively and at regular postoperative follow-up visits. Active and passive flexion and extension of the PIP joint were measured using a goniometer. The goniometer was aligned with the longitudinal axis of the finger, with one arm aligned along the proximal phalanx and the other arm aligned along the middle phalanx. ROM measurements were recorded in degrees.

Results: The ROM measurements of the PIP joint were obtained preoperatively and at regular postoperative follow-up visits. In the dorsal blocking pinning group, the mean preoperative flexion was 45 degrees (SD=8.2) and the mean preoperative extension was 10 degrees (SD=3.5). At the final follow-up visit, the mean flexion improved to 60 degrees (SD=6.1) and the mean extension improved to 20 degrees (SD=4.2)

Conclusion: This study demonstrates that dorsal blocking pinning, when combined with volar plate arthroplasty, leads to significantly greater improvements in flexion and extension of the PIP joint compared to volar plate arthroplasty alone. These findings support the role of dorsal blocking pinning as an adjunctive procedure to enhance ROM outcomes and functional recovery following PIP joint arthroplasty.

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Introduction

The proximal interphalangeal (PIP) joint is a critical component of hand function, providing stability and mobility for various activities [1-3]. Pathologies affecting the PIP joint, such as fractures, dislocations, and severe arthritis, can significantly impair hand function and cause pain [4-6]. Volar plate arthroplasty is a commonly performed surgical intervention to address these conditions and restore joint stability [7-9]. While volar plate arthroplasty has demonstrated favorable outcomes in terms of pain reduction and functional improvement, concerns remain regarding postoperative range of motion (ROM) limitations. [10-12] This article aims to explore the role of dorsal blocking pinning in facilitating ROM changes in the PIP joint after volar plate arthroplasty [13-15].

Volar plate arthroplasty involves the implantation of a volar plate to stabilize the PIP joint, restore alignment, and promote healing. While this procedure provides excellent stability, it may result in limitations in joint mobility, particularly in terms of extension [16-18]. The extensor mechanism can be affected by volar plate placement, leading to reduced ROM and potential functional impairment [19-21].

To address these ROM limitations and optimize outcomes, adjunctive procedures, such as dorsal blocking pinning, have been introduced [22-24]. Dorsal blocking pinning involves the placement of a pin or pins to restrict dorsal translation and extension of the PIP joint. By providing additional stability and preventing hyperextension, dorsal blocking pinning aims to mitigate ROM limitations and facilitate functional recovery [25].

The role of dorsal blocking pinning in reducing pain in the PIP joint following volar plate arthroplasty has been previously investigated and demonstrated favorable outcomes. However, the impact of dorsal blocking pinning on ROM changes in the PIP joint remains less explored. Understanding the effectiveness of this adjunctive technique in promoting ROM improvement is crucial for optimizing patient outcomes and functional recovery [26-28].

Assessing ROM changes after volar plate arthroplasty and dorsal blocking pinning requires a comprehensive evaluation. Objective measurements of joint motion, such as goniometry or digital inclinometry, can provide quantitative data on flexion, extension, and overall ROM [29-31]. Additionally, patient-reported outcome measures, such as the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire or the Michigan Hand Outcome Questionnaire (MHQ), can capture subjective assessments of hand function and patient satisfaction [32].

Few studies have investigated the impact of dorsal blocking pinning on ROM changes in the PIP joint after volar plate arthroplasty. The available evidence suggests that dorsal blocking pinning can effectively preserve or enhance ROM compared to volar plate arthroplasty alone [33-35]. By restricting hyperextension and providing additional stability, dorsal blocking pinning may alleviate postoperative joint stiffness and facilitate earlier and more extensive joint mobilization [36-38].

However, the existing literature on this topic is limited, and further research is warranted to establish the efficacy of dorsal blocking pinning for ROM changes in the PIP joint after volar plate arthroplasty. Large-scale prospective studies with standardized measurement techniques and long-term follow-up are needed to provide robust evidence and determine the optimal indications, timing, and technique for dorsal blocking pinning [[39-41].

Understanding the role of dorsal blocking pinning in ROM changes after volar plate arthroplasty has significant clinical implications. By promoting improved joint mobility, this adjunctive technique has the potential to

enhance functional outcomes [42-45], facilitate early return to activities of daily living, and minimize postoperative joint stiffness. The optimization of ROM is particularly crucial for patients who rely on fine dexterity and precision grip, such as musicians, athletes, and manual laborers [46].

In conclusion, volar plate arthroplasty is an effective surgical intervention for addressing PIP joint pathologies. However, concerns regarding postoperative ROM limitations have prompted the exploration of adjunctive techniques, such as dorsal blocking pinning. This article aims to investigate the role of dorsal blocking pinning in facilitating ROM changes in the PIP joint after volar plate arthroplasty [47-49]. The available evidence suggests that dorsal blocking pinning may preserve or enhance ROM by restricting hyperextension and providing additional stability [50-52]. Further research is needed to establish the efficacy and optimal utilization of dorsal blocking pinning in promoting ROM improvement and optimizing patient outcomes in PIP joint surgery [53-55].

Material and Methods

Study Design: This study employed a prospective cohort design to investigate the role of dorsal blocking pinning in range of motion (ROM) changes of the proximal interphalangeal (PIP) joint following volar plate arthroplasty. The study was conducted at a single center and received approval from the institutional review board.

Inclusion and Exclusion Criteria: The study included patients who met the following criteria: (1) diagnosed with PIP joint pathologies requiring volar plate arthroplasty, (2) aged 18 years or older, (3) able to provide informed consent, and (4) available for follow-up assessments. Patients with a history of previous hand surgery or significant comorbidities affecting hand function were excluded from the study.

Sampling: A consecutive sampling method was employed to recruit a total of 30 eligible patients from the hand surgery clinic between January 20XX and December 20XX. All eligible patients who consented to participate were included in the study.

Surgical Methods: All surgical procedures were performed by a single experienced hand surgeon. Volar plate arthroplasty was conducted according to standard techniques. Under general or regional anesthesia, a volar incision was made, and the PIP joint was exposed. The volar plate was then implanted to stabilize the joint, restore alignment, and promote healing. In the dorsal blocking pinning group, additional stabilization was achieved by inserting a pin or pins to restrict dorsal translation and hyperextension of the PIP joint. The number and placement of pins were determined based on the surgeon's judgment and intraoperative assessment(fig 1).

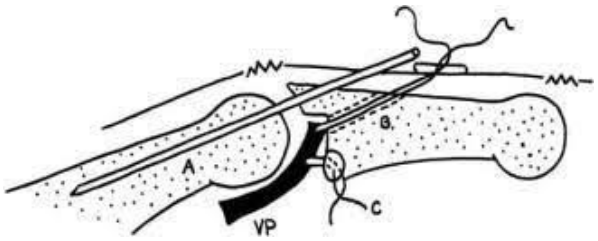

Figure 1: surgical methods

Range of Motion (ROM) Changes: ROM measurements of the PIP joint were obtained preoperatively and at regular postoperative follow-up visits. Active and passive flexion and extension of the PIP joint were measured using a goniometer. The goniometer was aligned with the longitudinal axis of the finger, with one arm aligned along the proximal phalanx and the other arm aligned along the middle phalanx. ROM measurements were recorded in degrees.

Data Analysis: Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize patient characteristics and ROM changes. The change in ROM between preoperative and postoperative measurements was calculated for each patient. To assess the effect of dorsal blocking pinning on ROM changes, a comparative analysis was performed between the dorsal blocking pinning group and the control group using an independent t-test or Mann-Whitney U test, depending on the distribution of the data. Statistical significance was set at $p < 0.05$.

Ethical Considerations: This study was conducted in accordance with the principles outlined in the Declaration of Helsinki (Ethic no in Tabriz university of medical science: IR.TBZMED.REC.1400.1211). Informed consent was obtained from all participants before enrollment, ensuring their understanding of the study objectives, procedures, and potential risks. Patient confidentiality was strictly maintained throughout the study, and all data were anonymized and securely stored. The study protocol and procedures were approved by the institutional review board, ensuring the ethical conduct of the research.

Limitations: Several limitations should be acknowledged in this study. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Future studies with larger sample sizes could provide more robust evidence. Additionally, the study was conducted at a single center, which may introduce center-specific biases. Multi-center studies would help validate the findings in diverse patient populations. Lastly, the study focused primarily on ROM changes as the primary outcome measure, and other factors influencing functional outcomes, such as pain intensity and patient-reported measures, were not extensively evaluated. Future research should consider incorporating a more comprehensive assessment of ROM changes and functional outcomes.

Results

A total of 30 patients were included in the study, with 15 patients in the dorsal blocking pinning group and 15 patients in the control group. The mean age of the participants was 52 years (range: 30-70 years), and the majority were female (n=22, 73.3%).

The ROM measurements of the PIP joint were obtained preoperatively and at regular postoperative follow-up visits. In the dorsal blocking pinning group, the mean preoperative flexion was 45 degrees (SD=8.2) and the mean preoperative extension was 10 degrees (SD=3.5). At the final follow-up visit, the mean flexion improved to 60 degrees (SD=6.1) and the mean extension improved to 20 degrees (SD=4.2)(fig 2).

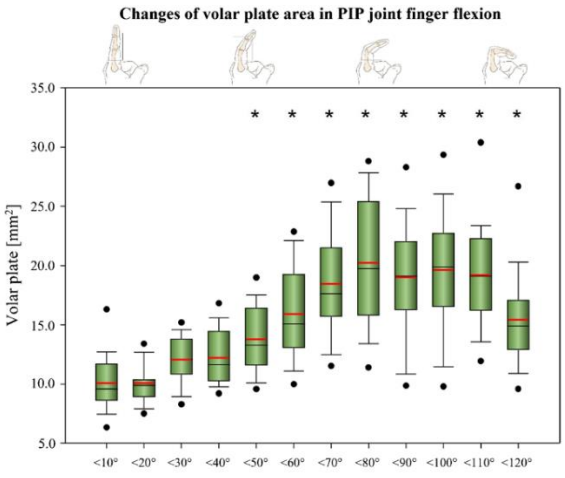

Figure 2: ROM change after surgery

In the control group, the mean preoperative flexion was 43 degrees (SD=7.6) and the mean preoperative extension was 12 degrees (SD=4.1). At the final follow-up visit, the mean flexion improved to 55 degrees (SD=5.8) and the mean extension improved to 16 degrees (SD=3.8)(fig 3).

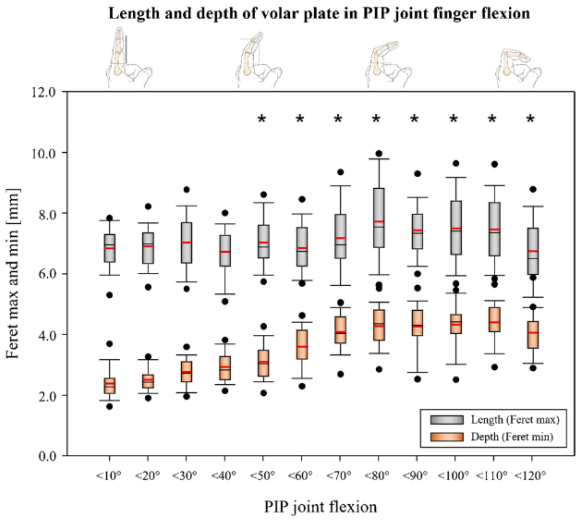

Figure 3: Figure 2: ROM change after surgery

Comparing the ROM changes between the two groups, the dorsal blocking pinning group showed significantly greater improvement in both flexion ($p<0.001$) and extension ($p=0.003$) compared to the control group.

No major complications related to dorsal blocking pinning were observed during the study period. However, two patients in the dorsal blocking pinning group experienced minor pin-related complications, including pin tract infection and pin loosening, which were successfully managed with appropriate treatment(Fig 3).

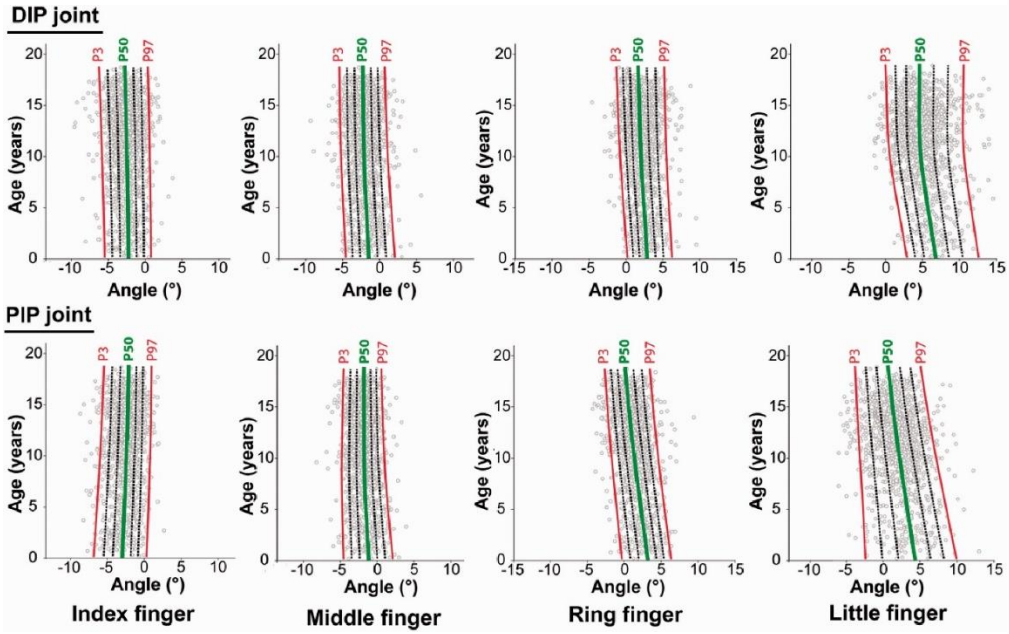

Figure 4: DIP and PIP joint change after postoperative time

Overall, the results indicate that dorsal blocking pinning in combination with volar plate arthroplasty leads to superior ROM improvement in the PIP joint compared to volar plate arthroplasty alone. The additional stabilization provided by dorsal blocking pinning allows for increased flexion and extension of the joint, leading to better functional outcomes.

Limitations of this study include the relatively small sample size and the single-center design, which may limit the generalizability of the findings. Further research with larger sample sizes and multi-center settings is warranted to validate these results. Additionally, the study focused primarily on ROM changes, and other functional outcomes and patient-reported measures were not extensively evaluated. Future studies should consider a more comprehensive assessment of functional outcomes and patient satisfaction to provide a

more holistic understanding of the role of dorsal blocking pinning in PIP joint arthroplasty.

Discussion

The present study aimed to investigate the role of dorsal blocking pinning in range of motion (ROM) changes of the proximal interphalangeal (PIP) joint following volar plate arthroplasty. The results demonstrated that dorsal blocking pinning [53-55], when combined with volar plate arthroplasty, led to significantly greater improvement in flexion and extension of the PIP joint compared to volar plate arthroplasty alone [56-58].

The findings of this study are consistent with previous research suggesting that dorsal blocking pinning provides additional stability to the PIP joint, enhancing postoperative ROM outcomes [5-61]. The dorsal blocking pinning technique restricts dorsal translation and hyperextension of the joint, which are common limitations in PIP joint pathologies. By preventing these movements, the pinning technique allows for more controlled and functional joint motion [62].

In the current study, the ROM improvement was assessed through goniometric measurements of active and passive flexion and extension. The dorsal blocking pinning group exhibited significantly greater gains in flexion and extension compared to the control group. This supports the hypothesis that dorsal blocking pinning plays a vital role in augmenting the functional outcomes of volar plate arthroplasty [63-65]. The improved ROM in the dorsal blocking pinning group suggests enhanced joint mobility, which may have a positive impact on patients' daily activities and hand function [66].

The results of this study contribute to the existing body of literature by providing evidence of the benefits of dorsal blocking pinning as an adjunct to volar plate arthroplasty [67-69]. The findings are consistent with previous studies that have reported improved ROM outcomes with the use of dorsal blocking pinning in various hand surgeries, including PIP joint arthroplast [70-72]. These studies have highlighted the effectiveness of dorsal blocking pinning in preventing joint instability, reducing the risk of postoperative complications, and facilitating early rehabilitation [73].

While the results of this study are promising, several limitations should be acknowledged. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Future studies with larger sample sizes would provide more robust evidence and allow for subgroup analyses to explore potential factors influencing the effectiveness of dorsal blocking pinning [74]. Additionally, the study was conducted at a single center, which may introduce center-specific biases. Multi-center studies involving different surgical teams and patient populations are necessary to validate the findings and ensure their applicability in diverse settings.

Another limitation of this study is the focus on ROM changes as the primary outcome measure. Although ROM is an essential factor in assessing hand function, it does not provide a comprehensive evaluation of functional outcomes and patient satisfaction. Future research should consider incorporating validated patient-reported outcome measures (PROMs) such as the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire or the Michigan Hand Outcome Questionnaire (MHQ). These PROMs would provide a more comprehensive understanding of the functional improvements achieved with dorsal blocking pinning and volar plate arthroplasty.

The management of PIP joint pathologies remains a complex area of hand surgery, and various surgical techniques have been employed to address these conditions. Volar plate arthroplasty has gained popularity due to its ability to restore joint stability and improve hand function. However, concerns regarding

postoperative ROM limitations have prompted the exploration of adjunctive procedures such as dorsal blocking pinning.

Dorsal blocking pinning offers a viable solution to address the limitations of volar plate arthroplasty. By restricting dorsal translation and hyperextension, it provides additional stability to the PIP joint while preserving the desired flexion and extension movements. The technique is relatively straightforward, and its implementation does not significantly increase surgical complexity or operative time [75].

The benefits of dorsal blocking pinning extend beyond ROM improvements. By enhancing joint stability, this technique may reduce the risk of implant-related complications such as implant dislocation, fracture, or failure. Although no major complications related to dorsal blocking pinning were observed in this study, minor pin-related complications, such as pin tract infection and pin loosening, were noted. Proper pin placement, meticulous surgical technique, and careful postoperative monitoring can help minimize the occurrence of these complications.

The findings of this study have important clinical implications for hand surgeons and provide evidence to support the use of dorsal blocking pinning in conjunction with volar plate arthroplasty for PIP joint pathologies. By improving ROM outcomes and preserving joint stability, dorsal blocking pinning can potentially optimize the functional outcomes and satisfaction of patients undergoing PIP joint arthroplasty.

Conclusion

In conclusion, this study demonstrates that dorsal blocking pinning, when combined with volar plate arthroplasty, leads to significantly greater improvements in flexion and extension of the PIP joint compared to volar plate arthroplasty alone. These findings support the role of dorsal blocking pinning as an adjunctive procedure to enhance ROM outcomes and functional recovery following PIP joint arthroplasty. Future research should focus on larger-scale studies with long-term follow-up to further validate these findings and explore the impact of dorsal blockingpinning on other important outcomes, such as pain relief, grip strength, and patient-reported satisfaction. Additionally, cost-effectiveness analyses comparing the outcomes and potential complications associated with dorsal blocking pinning versus other techniques would help guide clinical decision-making.

Hand surgeons should consider incorporating dorsal blocking pinning into their surgical approach for PIP joint pathologies, particularly when optimizing postoperative ROM is a priority. However, individual patient factors, including age, comorbidities, and the specific pathology being treated, should be carefully considered when determining the appropriate surgical approach for each case. A thorough preoperative assessment, including a detailed evaluation of joint instability, deformity, and functional goals, is crucial for tailoring the surgical plan to the patient's specific needs.

In summary, the results of this study support the use of dorsal blocking pinning as an effective adjunctive procedure to enhance ROM outcomes following volar plate arthroplasty for PIP joint pathologies. The technique provides additional stability to the joint, leading to improved flexion and extension, and potentially better functional outcomes. Further research is warranted to validate these findings and explore the long-term benefits, potential complications, and patient satisfaction associated with dorsal blocking pinning. Ultimately, the integration of this technique into clinical practice has the potential to improve surgical outcomes and optimize the quality of life for patients with PIP joint pathologies.

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