



## Article

# Ultrasound-Guided Interphalangeal Injection (US-IPI) of Muroid Cysts as a Non-Surgical Option: Technical Notes and Clinical Efficacy

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**Abstract:** Digital mucous cysts (DMCs) are common soft tissue tumors affecting interphalangeal joints. Various treatment options exist, with surgical excision being the standard. Ultrasound-guided cortisone (CC) injection into the distal interphalangeal (DIP) joint has been proposed as a therapeutic alternative. This study aims to assess the technical success and clinical efficacy of US-IPI in terms of swelling resolution and pain control. Fifty-two patients with DMCs underwent CCs DIP joint ultrasound-guided infiltration. Eighty-three percent of patients exhibited a positive response to US-IPI, with a significant reduction in NRS pain scores ( $p < 0.01$ ). Persistent pain in 17% of patients was effectively managed with marked improvement after a secondary infiltration. Joint swelling was reduced in 68% of patients within 1 month, with complete resolution by 3 to 6 months. No recurrence was reported at the 6-month follow-up. Pain assessment using the Numeric Rating Scale and joint swelling evaluation were conducted at follow-ups of 2 weeks, 1, 3, and 6 months. Statistical analysis was performed to compare pre- and post-procedure NRS pain scores. Here, we show that US-IPI of DMCs is an effective therapeutic option that provides immediate pain relief and long-term aesthetic improvement, resulting in an alternative option to surgical excision.

**Keywords:** DMCs; muroid cysts; treatment; US-guided injection; pain reduction; swelling reduction



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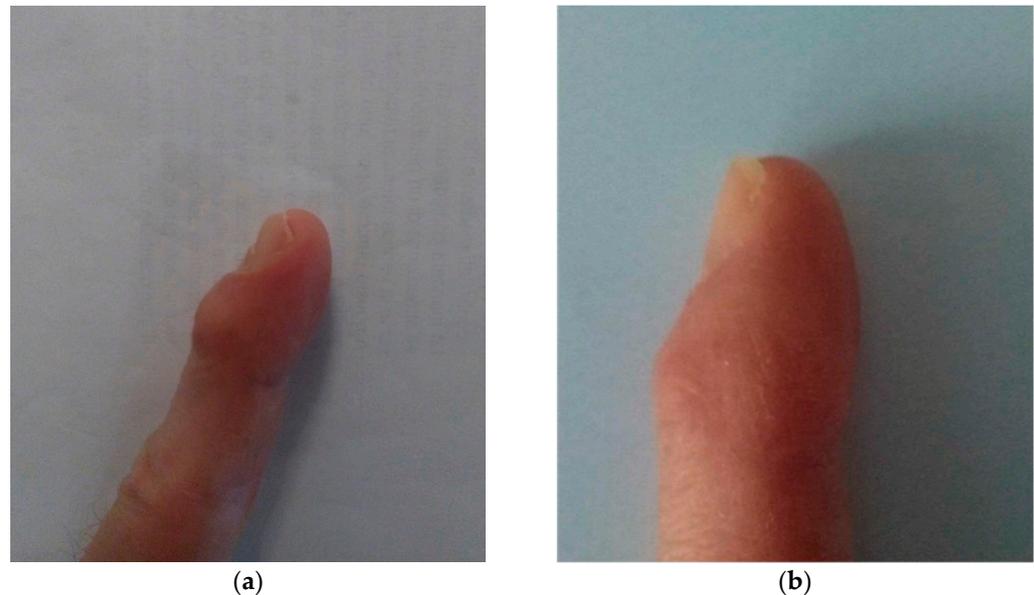
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## 1. Introduction

Digital mucous cysts are the most prevalent soft tissue tumors affecting the hand, with a predilection for women and typically occurring between the second and fourth decades of life [1]. These cysts originate from the dorsum of the distal interphalangeal joint (DIP joint) and are commonly associated with underlying joint osteoarthritis [1,2] (Figures 1 and 2).

Initial treatment for digital mucous cysts can involve conservative management, starting with observation, especially for small cysts. If the skin is thinning over the cyst or if there is a painful nail deformity, more invasive treatment may be considered. Digital mucous cysts are often associated with osteoarthritis of the distal interphalangeal (DIP) joint, and patients should be aware that pain may persist even after cyst excision due to underlying osteoarthritis. Patients who prefer to avoid surgery may opt for cyst aspiration, but there is a high recurrence rate of around 50%. Among these, surgical excision stands as the conventional standard treatment for DMCs. Surgical management is often chosen to minimize the risk of recurrence or following the failure of conservative treatments.

During surgery, the cyst's stalk is excised, the dorsal capsule is removed, and any present osteophytes are addressed [2]. For surgical excision, a meticulous technique is necessary to avoid damaging the germinal matrix, which is often near or beneath the cyst. Removing osteophytes during surgery can also reduce the recurrence rate to less than 10%. If there is concern about skin thickness after removal, the surgeon might consider using a full-thickness graft from the thenar crease of the palm, a local advancement flap, or a rotational flap. Bipedicled flap transfers are also possible but can lead to donor site morbidity.



**Figure 1.** (a) Digital mucous cyst (DMC) located on the dorsal region of the distal interphalangeal (DIP) joints of the index finger adjacent to the proximal nail fold. (b) Subsequent imaging conducted at the 6-month follow-up reveals a reduction in joint swelling and a notable improvement in nail deformity, indicative of treatment efficacy and favorable clinical outcomes.



**Figure 2.** Digital mucous cysts (DMCs), commonly observed on the dorsal-lateral aspect of the distal interphalangeal (DIP) joints or the proximal nail fold, present as translucent lesions. They typically arise in this region, are often associated with underlying osteoarthritis, and are characterized by their distinctive appearance.

DIP joint arthrodesis is another surgical option that offers a lower recurrence rate compared to other treatments. However, it carries significant risks, including pin tract infections, hardware prominence, dorsal skin necrosis, size mismatch, and the potential for implant breakage [3]. Various techniques exist for distal interphalangeal (DIP) joint

arthrodesis for osteoarthritis. Kirschner wires have high fusion rates but carry the risk of pin-track infection. Interosseous wires, with or without supplemental Kirschner wire fixation, demonstrate high union rates but may result in implant prominence. Headless compression screws provide stable fixation without implant prominence but can be challenging for achieving flexion arthrodesis and may cause complications such as nail deformity, screw cutout, and breakage. Headed screws also achieve high union rates but are associated with prominent screw heads. Percutaneous screw arthrodesis using headless compression screws shows promising results, particularly in patients with compromised soft tissue. The choice of fixation method depends on patient-specific factors such as bone quality, joint alignment, and the presence of inflammatory arthritis [3].

In addition to these treatments, other invasive therapies are available, including cryotherapy and CO<sub>2</sub> laser therapy [4,5]. Cryotherapy involves puncturing the cyst wall to drain its contents and removing as much of the covering skin as possible. Liquid nitrogen is then applied to a plastic film over the pseudocyst wall or directly to the wall using prechilled forceps or a probe. The freezing time is about 5 s, repeated three to five times per treatment [4]. CO<sub>2</sub> laser therapy for digital mucous cysts involves puncturing the cyst with a carbon dioxide laser (CO<sub>2</sub> laser, 5–10 Watts) and squeezing out its contents. The laser is then used to vaporize the entire cyst, ensuring the underlying nail matrix is protected to prevent permanent nail deformity. The area is cleansed with hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) to check for any remaining cystic space, and vaporization continues until the cyst is completely removed [5]. However, these methods are associated with a high recurrence rate and a significant likelihood of post-treatment nail deformity.

Given the synovial origin of muroid cysts, cortisone (CCs) DIP joint ultrasound-guided infiltration has emerged as a potential therapeutic avenue. The primary aim of our study is to assess both the technical success and clinical efficacy of this treatment approach, specifically focusing on the resolution of swelling and local pain control to mitigate recurrence.

Despite various treatment options available for digital mucous cysts, there is still a need to explore novel therapeutic approaches that can effectively manage symptoms and reduce the likelihood of recurrence. Our study aims to contribute to the existing literature by evaluating the outcomes of ultrasound-guided corticosteroid injections in the treatment of digital mucous cysts.

## 2. Materials and Methods

As previously mentioned, articular infiltrative techniques have long been established for their efficacy and safety in various joint districts such as the hip, knee, and shoulder [6–18]. Within this context, our study examines the clinical effectiveness and the technique of corticosteroid joint infiltration for the treatment of muroid cysts in the interphalangeal joints.

The statistical analyses were conducted utilizing the Statistical Package for the Social Sciences (SPSS) software (v.22). The study was conducted in strict adherence to the guidelines outlined in the Declaration of Helsinki. Due to the retrospective nature of the study, ethical review and approval were waived. A total of fifty-two patients (comprising 16 males and 36 females, with ages ranging from 45 to 73 years and a median age of 53 years) diagnosed with digital mucous cysts were enrolled in the study. These patients underwent ultrasound-guided infiltration of the DIP joint with corticosteroids (CCs) between January 2020 and March 2023. Inclusion criteria encompassed joint swelling, progressive dimensional increase, and chronic pain persisting for more than 3 months, while the exclusion criterion was the presence of an underlying infection. The ultrasound-guided cyst infiltration procedure was carried out utilizing a 26-gauge needle and Triamcinolone acetonide (Kenacort) on an outpatient basis at our interventional radiology clinics (Table 1).

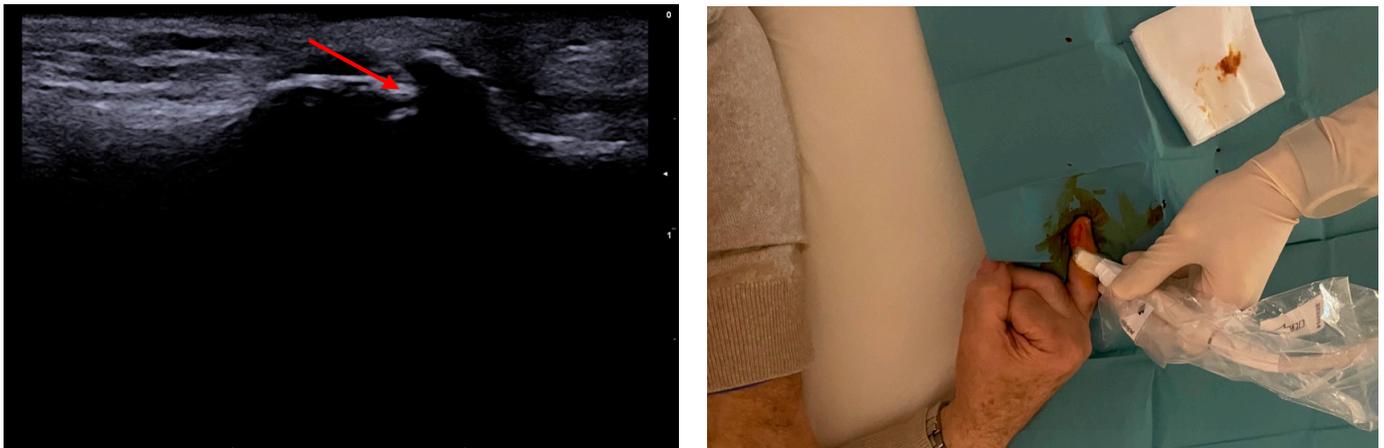
**Table 1.** Characteristics of patients.

Characteristic	Value
Total Patients	52
Gender	16 males, 36 females
Age Range	45–73
Median Age	53 years
Diagnosis	Digital mucous cysts
Procedure	Ultrasound-guided DIP joint infiltration with corticosteroids
Study Period	January 2020 to March 2023
Inclusion Criteria	Joint swelling, progressive dimensional increase, chronic pain > 3 months
Exclusion Criteria	Presence of an underlying infection

Visual assessment of joint swelling and pre- and post-treatment pain using the Numeric Rating Scale (NRS) was performed at 2 weeks 1, 3, and 6 months follow-ups.

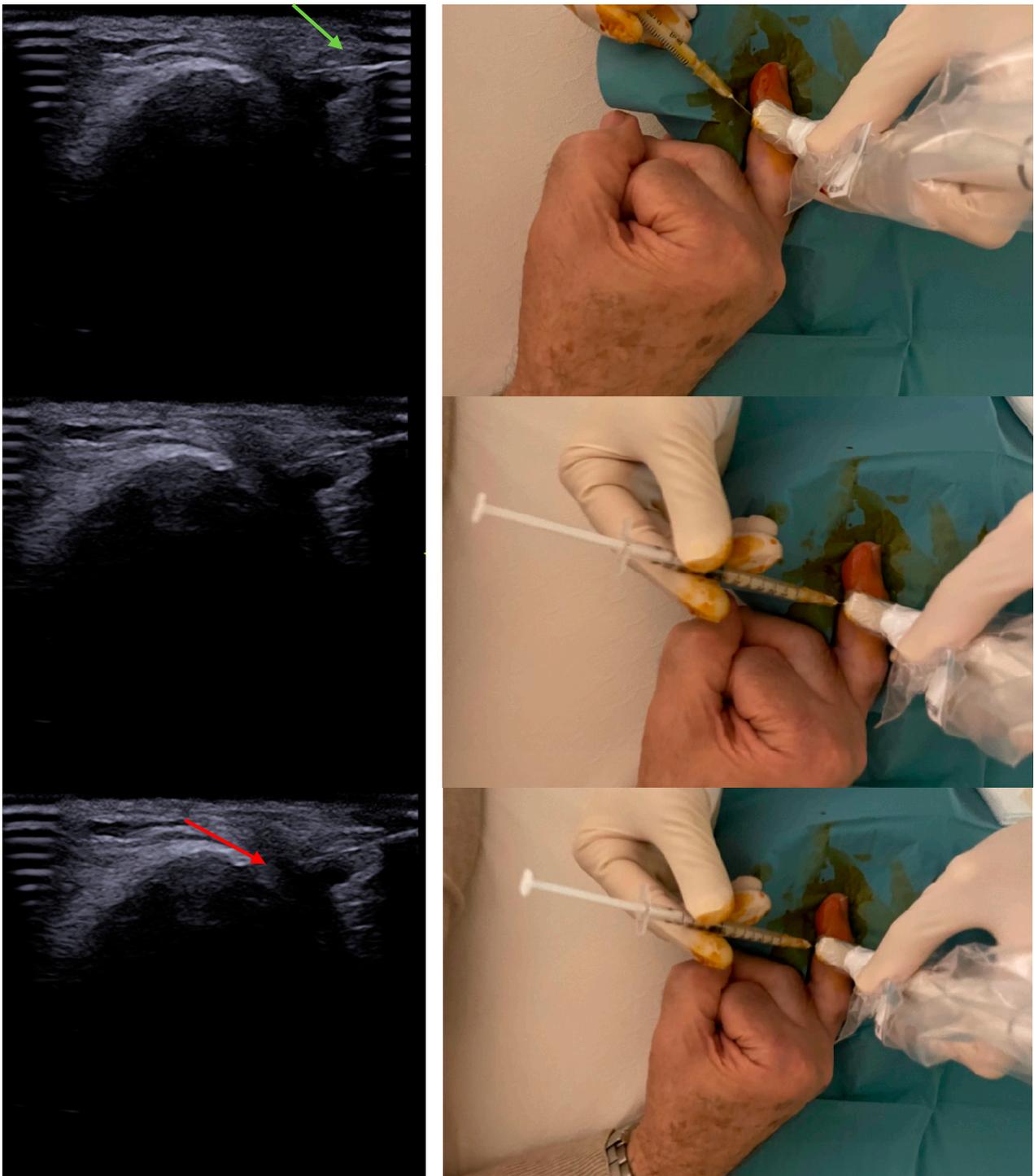
#### *Technique Description*

During the preliminary ultrasound examination, meticulous attention is given to identifying the cystic lesion and delineating the interphalangeal joint space. By gently flexing the distal phalanx, the extent of the joint space is carefully evaluated (Figure 3).



**Figure 3.** The process of identifying the cystic lesion in the interphalangeal region involves the manipulation of the distal phalanx to assess the maximal width of the joint space. This maneuver allows visualization of both the joint space and the opposing articular surfaces. Furthermore, the presence of a coarse articular osteophyte, indicated by the arrow, can be observed, contributing to a reduction in the joint space.

Under the precise guidance of ultrasound imaging, a radial approach is employed for the insertion of a 26 G needle, which is then advanced toward the articular surface of the joint. The needle is steadily advanced until it makes contact with the distal surface of the middle phalanx. Following this, the needle is meticulously aligned in a vertical orientation before being introduced into the joint space. Subsequently, a volume of 0.02 mL of Triamcinolone acetonide (Kenacort) is injected. Injection is halted upon the patient experiencing discernible pressure on the nail bed (Figures 4 and 5).



**Figure 4.** Using ultrasound (US) guidance via a radial approach, a 26-gauge (26 G) needle (green arrow) is inserted and directed toward the joint's articular surface. The needle is advanced until it reaches the distal surface of the middle phalanx (red arrow).



**Figure 5.** Subsequently, the needle is positioned to attain maximum vertical alignment, and 0.02 mL of Triamcinolone acetonide (Kenacort) is injected.

### 3. Results

Evaluation of the Numeric Rating Scale (NRS) pain scores [19] before and after the procedure involved employing a paired *t*-test to ascertain whether the post-procedure NRS pain scores exhibited statistically significant reductions compared to the pre-procedure scores (assessed at 2 weeks, 1, 3, and 6 months). A significance threshold of  $p < 0.05$  was applied for statistical significance determination.

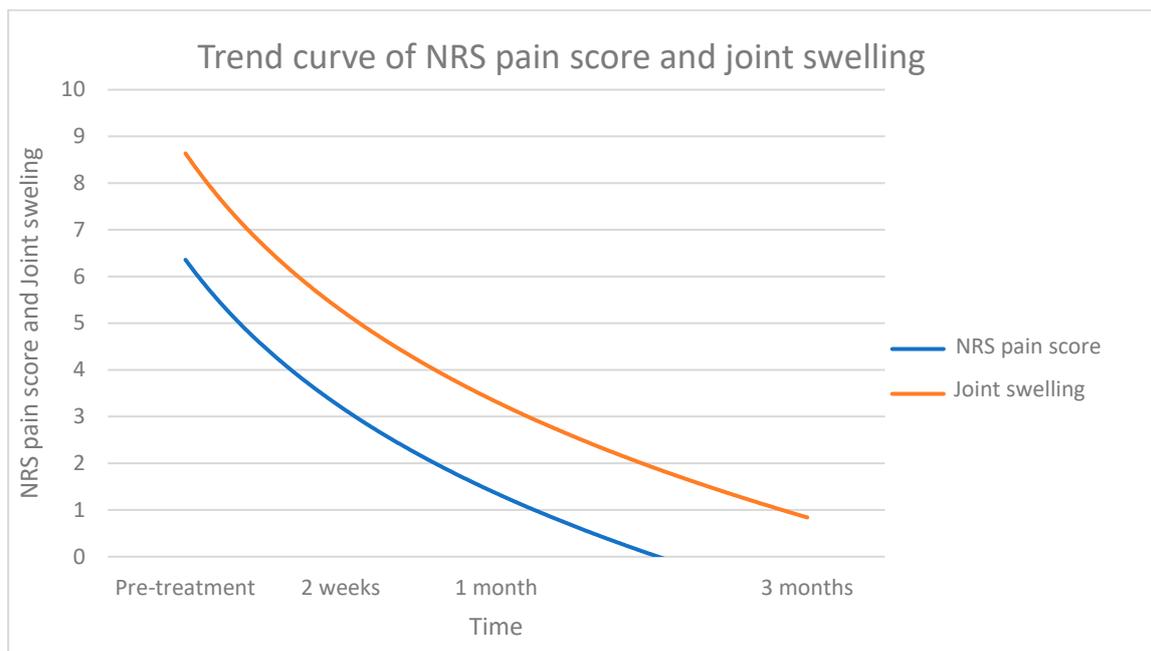
The median pre-procedure NRS pain score, ranging from 0 to 10, was determined to be 6.8. Among the total cohort of patients ( $n = 52$ ), a favorable treatment response was observed in 83% (43 individuals). Following the procedure, the average post-procedural NRS pain score recorded at the two-week follow-up was 3.2 ( $p$ -value  $< 0.01$ ), subsequently declining to 0 at the one-month follow-up ( $p$ -value  $< 0.01$ ).

In contrast, 17% (9 patients) reported persistent pain symptoms subsequent to the initial infiltration, with an average NRS pain score of 6.2. Following a secondary infiltration performed one month after the initial intervention, patients demonstrated significant improvements, with the average NRS score decreasing to 3.5 at the two-week follow-up ( $p < 0.01$ ). This reduction persisted, with the average NRS score reaching 0 at the one-month follow-up post-injection ( $p < 0.01$ ).

Regarding joint swelling, 68% (35 patients) experienced a 50% reduction in swelling within the subsequent month, ultimately achieving complete resolution by the 3-month follow-up post-injection. Conversely, 32% (17 patients) demonstrated an initial reduction in joint swelling at the 3-month post-treatment follow-up, with complete resolution occurring by 6 months post-injection (Figure 1).

Remarkably, none of the patients reported any recurrence at the 6-month follow-up assessment (Figure 6).

In summary, our study demonstrated that ultrasound-guided infiltration of digital mucous cysts with corticosteroids resulted in significant reductions in Numeric Rating Scale (NRS) pain scores post-procedure. The median pre-procedure NRS pain score of 6.8 decreased to an average score of 3.2 at two weeks and reached 0 by one month, indicating effective pain relief following the intervention ( $p < 0.01$ ). Persistent pain symptoms, reported by 17% of patients post-initial infiltration, were successfully managed with a secondary intervention, resulting in an average NRS score reduction from 6.2 to 3.5 at two weeks and to 0 by one month ( $p < 0.01$ ). Moreover, joint swelling showed marked improvement, with 68% of patients achieving a 50% reduction within one month and complete resolution by three months post-injection. The remaining 32% demonstrated initial reduction at three months, with complete resolution by six months. Importantly, no recurrence of symptoms was reported by any patient at the six-month follow-up assessment.



**Figure 6.** Trend curve of NRS pain score and joint swelling.

#### 4. Discussion

Our study aims to comprehensively describe the technique of ultrasound (US)-guided infiltration targeting digital mucous cysts (DMCs), focusing on its clinical efficacy in reducing both pain and swelling. Through meticulous evaluation, we seek to assess post-treatment pain and swelling dynamics and investigate the sustained resolution of associated signs and symptoms over an extended period. By elucidating these aspects, we aim to provide valuable insights into the efficacy and long-term outcomes of US-guided infiltration as a therapeutic approach for managing DMCs. This analysis contributes to the broader understanding of treatment modalities for DMCs, informing clinical practice and potentially improving patient outcomes.

Digital mucous cysts (DMCs) are benign growths commonly observed on the fingers, frequently linked with an underlying osteoarthritis. Typically, DMCs manifest on the dorsal-lateral area of the distal interphalangeal (DIP) joints or the proximal nail fold, presenting as translucent lesions [20] (Figure 2). Females are more likely to be affected, with a rate of three times as many as males [21]. A gross examination of a digital mucous cyst reveals a multilobulated cystic structure. Microscopically, the cyst consists of numerous layers of randomly oriented collagen fibers that form the outer cyst wall. This structure is predominantly acellular and comprises mesenchymal cells and fibroblasts [22]. The inside of a mucous cyst is composed of viscous mucin [23].

Digital mucous cysts of the hand commonly manifest as discernible masses situated dorsally on the distal interphalangeal (DIP) joint, typically characterized by a gradual increase in size within the subcutaneous tissue [2]. Upon physical examination, these masses often exhibit restricted mobility, are amenable to transillumination, and possess a palpable firmness. These cysts typically adopt a rounded or dome-shaped morphology and may display variability in their dimensions [23]. Their positioning slightly off-center from the DIP joint is attributed to displacement by the extensor tendon while still maintaining attachment via a stalk [22]. Nail abnormalities may ensue if the cyst exerts pressure on the nail bed, potentially resulting in the formation of longitudinal grooves [22,24].

Furthermore, a comprehensive evaluation of the overlying skin is essential to assess thickness and ascertain the potential requirement for skin grafting during surgical intervention. It is important to note that skin ulceration is frequently observed, with cysts sometimes presenting as open wounds with drainage, suggestive of potential infection [2].

Our therapeutic approach to the treatment of interphalangeal mucous cysts is based on the evidence that these cysts are in communication with the joint. It has been hypothesized that mucous cysts may originate from an outpouching of the synovial membrane of a joint. De Berker and Lawrence reported a connection between DMCs and the joint, illustrating this link in over 80% of patients by injecting methylene blue into the joint during surgery [25,26]. However, the absence of communication between the cyst and the joint upon injecting the dye into the cyst implies the potential presence of a one-way valve, allowing fluid to flow from the joint but not back into it [21].

Intra-articular injection techniques have long been recognized for their effectiveness and safety in various joint regions, including the knee [6–9], shoulder [10–14] and hip [15–18].

Recent studies have explored the use of intra-articular injection techniques for joint pathology in the interphalangeal and metatarsophalangeal joints [27,28].

Ultrasound guidance in radiological procedures still enables precise targeting of the intended site [16,29–42], as well as new imaging guidance techniques [43–51].

Under ultrasound guidance, identification of the cystic lesion in the interphalangeal region is facilitated (Figure 3). By manipulating the distal phalanx, the maximal width of the joint space is assessed. Employing a radial approach, a 26 G needle is inserted and guided toward the articular surface. Its advancement continues until it reaches the distal surface of the middle phalanx. Subsequently, precise vertical alignment of the needle is achieved before insertion into the joint, allowing the injection of 0.02 mL of Triamcinolone acetonide (Kenacort). Ceasing the injection is prompted upon the patient experiencing pressure on the nail bed (Figures 4 and 5).

Using an US-guided approach and employing intra-articular corticosteroid injections, our study involving a cohort of 52 patients revealed an encouraging response rate of 83% to the treatment regimen. Following the procedure, the mean post-intervention Numeric Rating Scale (NRS) pain score among responders was 3.2 after two weeks, progressively reaching a score of 0 by the one-month follow-up. However, 17% of the participants experienced persistent pain symptoms after the initial infiltration, reporting an average NRS pain score of 6.2. Following a secondary infiltration administered one month post the initial intervention, these patients exhibited marked improvements. The mean NRS score recorded during the two-week follow-up after the second injection was 3.5, showing a subsequent decline to 0 at the one-month follow-up. These findings underscore the potential efficacy of a secondary intervention in managing persistent pain symptoms, highlighting its role in achieving significant pain relief among patients unresponsive to the initial treatment.

The requirement for a secondary infiltration in 17% of cases to attain the desired therapeutic effect can be attributed to patients presenting with excessive arthrosis, resulting in a considerable reduction in joint space. The initial administration of cortisone was inadequate in achieving the intended outcome due to this condition. Subsequent infiltration allowed the medication to penetrate the restricted joint space, reaching a therapeutic threshold and thereby facilitating pain alleviation.

Among 68% of the patients, there was a 50% reduction in joint swelling within the subsequent month, eventually resolving entirely by the 3-month follow-up after the injection. Conversely, 32% experienced an initial reduction in joint swelling at the 3-month post-treatment follow-up, achieving complete resolution of swelling by 6 months after the injection (Figure 1). These outcomes demonstrate the favorable response of digital mucous cysts to US-guided intra-articular corticosteroid injections, supporting the efficacy of this treatment approach in managing both pain and swelling associated with this condition.

The underlying biochemical mechanisms driving the activity of intra-articular corticosteroids in various human disease processes remain largely elusive or speculative. Cortisone exerts a rapid influence on synovial nociceptive sensitivity, thereby eliciting a swift analgesic response, a phenomenon corroborated by our study findings. Furthermore, the reduction in swelling and subsequent aesthetic recovery follow a more gradual

trajectory, occurring subsequent to the definitive resolution of inflammation within the interapophyseal joint and synovial cavity.

It is not uncommon for patients (approximately 53%) to present with a bluish-red discoloration of the skin at the injection site shortly after receiving corticosteroid infiltration, typically occurring within the initial 15 min post-procedure. This adverse reaction, characterized by its transient nature, typically resolves spontaneously within the ensuing 24 h. The bluish-red hue observed on the skin subsequent to an intra-articular cortisone injection may be attributed to the body's reaction to the procedure, potentially stemming from minor bleeding within the subcutaneous tissue. Consequently, this localized bleeding can manifest as a bluish or purplish discoloration, resembling a hematoma [52].

Despite these unwanted effects, corticosteroids were administered as infiltrative therapy in our study, primarily due to their potent anti-inflammatory properties. Steroids, being highly lipophilic, are believed to exert their effects by binding to the cell's nucleus, thereby modifying transcription. Intra-articular administration of steroids has been shown to diminish the population of lymphocytes, macrophages, and mast cells, subsequently reducing phagocytosis, lysosomal enzyme release, and the production of inflammatory mediators. This cascade of events ultimately results in a reduction in inflammation, particularly through the suppression of interleukin-1, leukotrienes, and prostaglandins, thereby alleviating pain symptoms. Unlike oral steroids, which can induce systemic effects such as muscle weakness, skin thinning, peptic ulceration, and exacerbation of diabetes, intra-articular steroid injections predominantly exert their therapeutic effects locally, thus mitigating systemic complications [53].

In the initial stages of percutaneous management of distal interphalangeal ganglion cysts, various strategies have been explored, with one such approach involving aspiration followed by infiltration. Goldman et al. delved into this method in their investigation, where they addressed 41 cases. Their approach entailed combining aspiration with intralesional triamcinolone injection, yielding notable outcomes but with a significant recurrence rate of 68% [54]. In a similar vein, Dodge et al. conducted a study focusing on cyst aspiration followed by corticosteroid injection, which resulted in a recurrence rate of 36% over a follow-up period averaging 6.2 years [55]. Additionally, Rizzo's research involved a different technique, employing multiple punctures using a 25-gauge needle without aspiration, followed by lidocaine and betamethasone injection. Despite this approach, a recurrence rate of 40% was observed at the 2-year mark, with 2 out of 80 patients experiencing infection [56].

In their investigation, Vanmierlo et al. reported a 20% local recurrence at 6 months using a non-ultrasound-guided approach, performing an aspiration followed by corticosteroid injection in patients with DMCs without underlying arthritis [57].

Conversely, Patel et al. proposed the non-ultrasound-guided infiltration of the joint utilizing a dorsal non-transstendinous approach for DMC treatment, achieving an 84% resolution of pain, but observed a 60% recurrence within the subsequent three years post-treatment [58].

In 2019, Weinheimer et al. proposed a technique involving volar intra-articular corticosteroid injections guided by radiographic imaging. However, this method poses certain limitations, particularly in achieving precise targeting of the cyst due to the radiographic-guided approach utilized. The reported success rate stands at merely 52.2%, with 47.8% of patients showing no improvement and two (8.7%) experiencing persistent cysts with only cosmetic symptoms and no pain. This approach, utilizing radiographic guidance, exposes patients to ionizing radiation, necessitating careful assessment of associated risks [59].

These studies highlight the diverse approaches and varying success rates in managing distal interphalangeal ganglion cysts, underscoring the importance of considering different techniques and their outcomes in clinical practice.

In our investigation, utilizing a lateral approach ultrasound-guided infiltration technique, a noteworthy observation emerged: all enrolled patients reported sustained absence of pain and swelling at the 6-month follow-up mark. The reliability and effectiveness of

our treatment protocol are underscored by the meticulous ultrasound-guided placement of intra-articular needles, ensuring optimal cortisone administration within the joint space and homogeneous distribution within the mucoid cyst. However, it is imperative to acknowledge a significant limitation inherent in our study: the absence of extended follow-up beyond the initial one-year post-treatment period. Moving forward, our research endeavors should encompass longitudinal assessments exceeding one year to comprehensively evaluate treatment longevity and recurrence rates. Furthermore, prospective investigations should incorporate comparative analyses involving alternative therapeutic modalities to delineate efficacy and safety profiles, alongside exploring potential prognostic indicators for treatment response.

## 5. Conclusions

In conclusion, the ultrasound-guided injection of digital mucous cysts (DMCs) has demonstrated itself as a highly effective and reliable therapeutic approach, offering immediate pain relief and long-lasting aesthetic improvements. The precision and accuracy afforded by ultrasound guidance ensure comprehensive symptom alleviation, enhancing patient outcomes significantly. As experts in the field, we have meticulously considered the theoretical underpinnings and practical applications of this technique, highlighting its potential to redefine current treatment paradigms for DMCs. Future research should explore the long-term outcomes and recurrence rates associated with this procedure, as well as compare its efficacy with other emerging treatments such as cryotherapy and laser therapy. Additionally, further development of the methodology, including larger multicenter studies, will be essential to validate these findings and expand their generalizability. By addressing these aspects, we can deepen our understanding and continue to refine and optimize the treatment of DMCs, ultimately improving patient care and quality of life.

**Author Contributions:** Conceptualization, D.S. and E.F.; methodology, E.V.; software, E.V.; validation, E.V., D.S. and E.F.; formal analysis, E.V.; investigation, A.B.; resources, V.P.; data curation, E.F.; writing—original draft preparation, E.V.; writing—review and editing, B.B.Z.; visualization, G.P.; supervision, R.F.G.; project administration, E.F.; funding acquisition, D.S. All authors have read and agreed to the published version of the manuscript.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

**Data Availability Statement:** The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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