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Original Research Article

A Randomized Controlled Trial of the Reciprocating Procedure Device for Intraarticular Injection of Corticosteroid versus Conventional Syringe

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Abstract

Introduction: Physiatrist, Rheumatologists and Orthopaedic Surgeons will either inject the corticosteroid suspension directly into the joint, or to be safer and more accurate, will use a separate syringe to first place the needle in an intraarticular position, drain any synovial fluid (SF), exclude infection, and then inject the corticosteroid intraarticularly.

Aims: The study aims to compare the efficacy and safety of the Reciprocating Procedure Device (RPD) versus the conventional syringe for intra-articular corticosteroid injections, focusing on procedure time, patient-reported pain, and physician satisfaction.

Materials & Methods: This is a randomized controlled trial (RCT), an interventional prospective study conducted over 1 year, from 1st July 2023 to 31st June 2024, with a total sample size of 80 patients.

Result: In 80 patients, the Reciprocating Procedure Device (RPD) group had significantly shorter procedure time (1.28 ± 1.08 vs. 1.86 ± 1.26 minutes), lower patient pain (VAS 2.40 ± 2.17 vs. 4.73 ± 3.39), and fewer experiencing moderate to severe pain (17% vs. 55%) compared to the Conventional Syringe group. Physician satisfaction was higher with RPD (VAS 9.12 ± 0.80 vs. 5.59 ± 1.28), all statistically significant ($p < 0.01$).

Conclusion: We concluded that in this RCT of 80 patients, baseline characteristics were comparable between groups. The Reciprocating Procedure Device (RPD) showed superior outcomes, with shorter procedure times, lower patient pain, fewer cases of moderate-to-severe pain, and higher physician satisfaction, demonstrating its clear advantage over the Conventional Syringe for intra-articular corticosteroid injections.

Keywords: Corticosteroid, Conventional syringe, Physician satisfaction, Rheumatoid arthritis.

Introduction

A significant alternative for the treatment of degenerative and inflammatory arthritis is the intraarticular injection of corticosteroids [1]. To be safer and more accurate, Physiatrists, Rheumatologists and Orthopaedic Surgeons will inject the corticosteroid suspension directly into the joint or, using a different syringe, insert the needle intraarticularly, drain any synovial fluid (SF), rule out infection, and then inject the corticosteroid [2]. Most Physiatrists, Rheumatologists and Orthopaedic Surgeons believe that patients have little pain during intraarticular injection techniques, which are usually regarded as safe. Formal pain investigations, however, do not support the idea that needle procedures on the joints are inherently painful; in fact, the pain of these procedures is sufficient to warrant the use of local or even general anaesthetic [3]. More than 50% of patients report moderate to severe pain following needle procedures on their joints, according to formal pain studies [4]. Although the exact reasons of pain during syringe treatments on joints are unknown and not well understood, they seem to be related to the patient's inherent characteristics, the presence of pain-sensitive tissues, incorrect needle positioning, and the doctor's inconsistent control of the syringe and needle. Experienced doctors frequently misdirect the needle into non-target extraarticular tissues when utilizing a typical syringe with the palpation method, which can lead to increased discomfort and an unsuccessful injection operation, as numerous cadaveric and imaging investigations have shown. Inaccurate needle placement during the extraarticular medication injection is likely to make the process more uncomfortable and reduce the therapy's effectiveness [5]. In comparison to conventional syringes, 3-ring control syringes, syringe pistols, syringes with plunger locks, and other specialized one-handed or two-handed procedure syringes, recent research has shown that doctors can use the reciprocating procedure device (RPD) more

precisely. Our hypothesis was that the RPD would enhance the effectiveness of intraarticular corticosteroid treatment as well. Study aims to compare the efficacy and safety of the Reciprocating Procedure Device (RPD) versus the conventional syringe for intra-articular corticosteroid injections, focusing on procedure time, patient-reported pain, and physician satisfaction.

Materials and Methods

Type of Study: Randomized Controlled Trial (RCT) an interventional, prospective study

Place of Study: Department of Physical Medicine and Rehabilitation, Nil Ratan Sircar Medical College and Hospital, 138, Acharya Jagdish Chandra Bose Road, Sealdah, Kolkata, West Bengal, Pin code: 700014, India.

Study Duration: 1 year from 1st July 2023 to 31st June 2024.

Sample Size: 80 patients.

Inclusion Criteria

- Adult patients aged ≥18 years requiring intra-articular corticosteroid injection.
- Diagnosed with osteoarthritis, rheumatoid arthritis, or other inflammatory joint conditions suitable for corticosteroid injection.
- Patients with pain or functional limitation in one or more joints warranting intra-articular therapy.
- Able to provide informed consent and willing to comply with study procedures.
- Joints accessible for injection using standard techniques

Exclusion Criteria

- Patients younger than 18 years.
- Active joint infection or systemic infection.
- History of allergy or hypersensitivity to corticosteroids or local anaesthetics.
- Bleeding disorders or patients on anticoagulant therapy that cannot be safely paused.
- Pregnant or lactating women.
- Prior joint surgery or prosthesis in the target joint that would interfere with injection.

Study Variables

- Age
- Sex
- Diagnosis
- Joint involved
- Type of device used

Statistical Analysis: Data were entered into Excel Sheet and analyzed using SPSS and Graphpad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-Sample T-Tests were used to compare independent groups, while paired T-Tests accounted for Correlations in Paired Data. Chi-Square Tests (Including Fisher's Exact Test for Small Sample Sizes) were used for Categorical Data Comparisons. P-Values ≤ 0.05 were considered Statistically Significant.

Result

Table 1: Characteristics of study patients in 80 corticosteroid injections of large to intermediate-size joints

Characteristic	Conventional Syringe	Reciprocating Procedure Device (RPD)	p-value
Patient age, yrs	51.49 ± 14.45	52.13 ± 13.69	> 0.05
No. of individual subjects	40	40	> 0.05
Men	6	8	> 0.05
Women	34	32	> 0.05
No. of corticosteroid injections	60	56	> 0.05
Large joints (hip, knee)	33	38	> 0.05
Intermediate joints (shoulder, wrist, elbow, ankle)	27	19	> 0.05
Knee	28	33	> 0.05
Hip	5	5	> 0.05
Wrist	11	8	> 0.05
Elbow	2	3	> 0.05
Ankle	5	1	> 0.05
Shoulder	8	7	> 0.05
Rheumatoid arthritis	33	32	> 0.05
Systemic lupus erythematosus	6	6	> 0.05
Idiopathic mono-arthritis	4	3	> 0.05
Acute gout	2	3	> 0.05
Reactive arthritis	3	3	> 0.05
Osteoarthritis	12	12	> 0.05

Table 2: Randomized, controlled trial of the Reciprocating Procedure Device (RPD) in corticosteroid injection of large to intermediate-size joints

Measure	Conventional Syringe	RPD	p-value
No. of procedures	40	40	–
Procedure time, min	1.86 ± 1.26	1.28 ± 1.08	< 0.01
Patient pain, VAS	4.73 ± 3.39	2.40 ± 2.17	< 0.001
Patients with moderate to severe pain (VAS ≥ 5)	55% (22/40)	17% (7/40)	< 0.01
Physician satisfaction, VAS	5.59 ± 1.28	9.12 ± 0.80	< 0.001

Table 3: Randomized, controlled trial of the Reciprocating Procedure Device (RPD) in corticosteroid injection of large joints (hip and knee)

Measure	Conventional Syringe	RPD	p-value
No. of procedures	40	40	–
Procedure time, min	1.86 ± 1.26	1.28 ± 1.08	< 0.02
Patient pain (VAS)	4.73 ± 3.39	2.40 ± 2.17	< 0.01
Patients with moderate to severe pain	51% (20/40)	16% (6/40)	< 0.01
Physician satisfaction (VAS)	5.59 ± 1.28	9.12 ± 0.80	< 0.001

Table 4: Randomized, controlled trial of the Reciprocating Procedure Device (RPD) in corticosteroid injection of intermediate joints (shoulder, wrist, ankle)

Measure	Conventional Syringe	RPD	p-value
No. of procedures	40	40	–
Procedure time, min	1.54 ± 1.21	1.07 ± 0.97	< 0.1
Patient pain (VAS)	4.54 ± 3.53	2.37 ± 3.52	< 0.04
Patients with moderate to severe pain	57% (23/40)	19% (8/40)	< 0.001
Physician satisfaction (VAS)	5.71 ± 1.67	9.04 ± 0.72	< 0.01

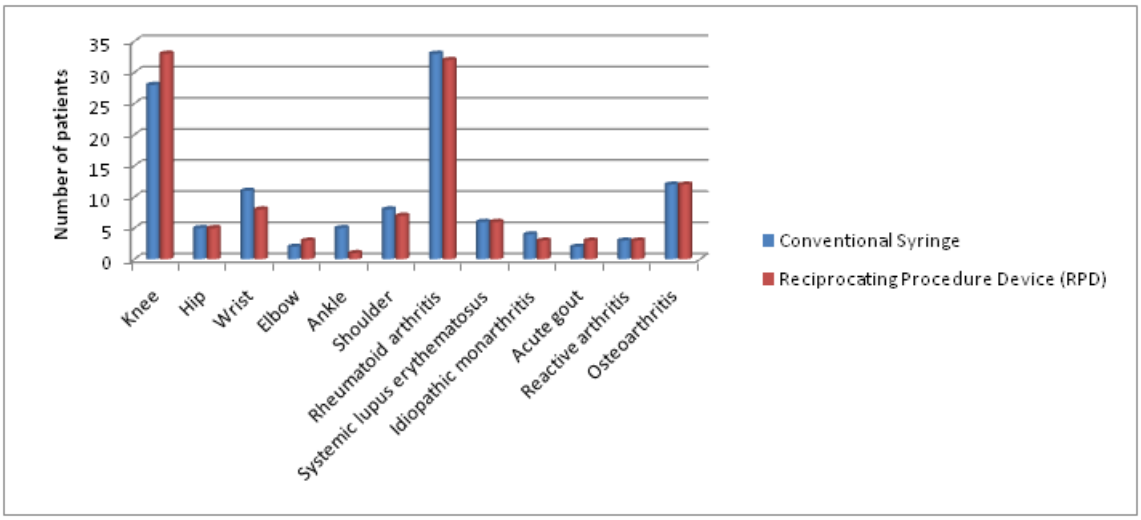

Figure 1: Intermediate joints

The mean age was 51.49 ± 14.45 years in the Conventional Syringe group and 52.13 ± 13.69 years in the RPD group. Each group included 40 subjects, with men comprising 6 (15%) vs. 8 (20%) and women 34 (85%) vs. 32 (80%) in the Conventional Syringe and RPD groups, respectively. The total number of corticosteroid injections was 60 vs. 56. Large joints (hip, knee) received 33 (55%) vs. 38 (67.9%), and intermediate joints (shoulder, wrist, elbow, ankle) 27 (45%) vs. 19 (32.1%). Disease distribution was similar, with rheumatoid arthritis in 33 (55%) vs. 32 (57.1%), SLE 6 (10%) vs. 6 (10.7%), idiopathic mono-arthritis 4 (6.7%) vs. 3 (5.4%), acute gout 2 (3.3%) vs. 3 (5.4%), reactive arthritis 3 (5%) vs. 3 (5.4%), and osteoarthritis 12 (20%) vs. 12 (21.4%). All differences were not statistically significant (p >0.05). In the Conventional Syringe group (n = 40), the mean procedure time was 1.86 ± 1.26 minutes, and the mean patient pain score was 4.73 ± 3.39 on the visual analogue scale (VAS). Moderate to severe pain (VAS ≥ 5) was reported by 22 patients (55%). Physician satisfaction was lower, with a mean VAS score of 5.59 ± 1.28. In the Reciprocating Procedure Device (RPD) group (n = 40), the mean procedure time was significantly

shorter at 1.28 ± 1.08 minutes, and the mean patient pain score was also lower at 2.40 ± 2.17. Only 7 patients (17%) experienced moderate to severe pain. Physician satisfaction was significantly higher, with a mean VAS score of 9.12 ± 0.80. All differences between groups were statistically significant ($p < 0.01$ or $p < 0.001$), favouring the RPD group. In the Conventional Syringe group, the mean procedure time was 1.86 ± 1.26 minutes, and the mean patient pain score was 4.73 ± 3.39 on the visual analogue scale (VAS). Moderate to severe pain (VAS ≥ 5) was reported by 20 patients (51%). Physician satisfaction was relatively low, with a mean VAS score of 5.59 ± 1.28. In the Reciprocating Procedure Device (RPD) group (n = 40), the procedure time was significantly shorter, averaging 1.28 ± 1.08 minutes ($p < 0.02$), and patient pain was lower at 2.40 ± 2.17 ($p < 0.01$). Only 6 patients (16%) experienced moderate to severe pain ($p < 0.01$). Physician satisfaction was significantly higher, with a mean VAS of 9.12 ± 0.80 ($p < 0.001$). In the Conventional Syringe group, the mean procedure time was 1.54 ± 1.21 minutes, and the mean patient pain score was 4.54 ± 3.53 on the visual analogue scale (VAS). Moderate to severe pain (VAS ≥ 5) was reported by 23 patients (57%). Physician satisfaction was lower, with a mean VAS score of 5.71 ± 1.67. In the Reciprocating Procedure Device (RPD) group, the procedure time was slightly shorter at 1.07 ± 0.97 minutes ($p < 0.1$), and patient pain was significantly lower at 2.37 ± 3.52 ($p < 0.04$). Only 8 patients (19%) reported moderate to severe pain ($p < 0.001$). Physician satisfaction was significantly higher, with a mean VAS score of 9.04 ± 0.72 ($p < 0.01$).

Discussion

We found that both the Conventional Syringe and Reciprocating Procedure Device (RPD) groups were comparable in baseline characteristics. The mean age was 51.49 ± 14.45 years in the Conventional Syringe group and 52.13 ± 13.69 years in the RPD group. Each group included 40 patients, with men comprising 15% vs. 20% and women 85% vs. 80%, respectively. The total number of injections was 60 vs. 56, and the distribution of large joints (hip, knee) was 55% vs. 67.9%, while intermediate joints (shoulder, wrist, elbow, ankle) were 45% vs. 32.1%. Disease distribution was similar, with rheumatoid arthritis in 55% vs. 57.1%, osteoarthritis 20% vs. 21.4%, SLE 10% vs. 10.7%, and smaller proportions of idiopathic mono-arthritis, acute gout, and reactive arthritis. All differences were not statistically significant ($p > 0.05$). We observed that procedure-related outcomes favoured the RPD group. The mean procedure time was shorter with RPD (1.28 ± 1.08 vs. 1.86 ± 1.26 minutes; 1.07 ± 0.97 vs. 1.54 ± 1.21 minutes). Patient-reported pain was lower in the RPD group, with mean VAS scores of 2.37–2.40 compared to 4.54–4.73 in the Conventional Syringe group. The proportion of patients experiencing moderate to severe pain (VAS ≥ 5) was also reduced in RPD (16–19%) versus Conventional Syringe (51–57%). We showed that physician satisfaction was significantly higher with RPD, with mean VAS scores of 9.04–9.12 compared to 5.59–5.71 in the Conventional Syringe group. All differences in procedure time, patient pain, and physician satisfaction were statistically significant ($p < 0.01$ to $p < 0.001$). Rahmadian et al. [6] (2025) conducted a dose-focused meta-analysis of randomized controlled trials and found that intra-articular injections, particularly with the RPD, are considered a safer and simpler method, avoiding complications related to surgical implantation. Similarly, Benzon et al. [7] (2025) reviewed the use and safety of corticosteroid injections in joints and concluded that the RPD enhances the safety and efficacy of intra-articular injections, corroborating our findings of improved procedural outcomes. Collectively, these studies support the evidence that the RPD improves patient comfort, procedural efficiency, and physician satisfaction compared to conventional syringes.

Conclusion

We concluded that the baseline demographics, joint involvement, and illness distribution of the 80 patients in this randomized controlled study were similar for the Conventional Syringe and Reciprocating Procedure Device (RPD) groups. However, the RPD was obviously preferred by the procedural results. Significantly quicker procedure times, lower patient-reported pain scores, and fewer patients with moderate to severe pain were also observed in the RPD group. Additionally, physician satisfaction with the RPD was significantly greater. There was statistical significance in these differences. According to the study's overall findings, the RPD is a useful tool in routine joint injection practice because it provides better patient comfort, increased procedural efficiency, and greater clinician satisfaction than the traditional syringe for intra-articular corticosteroid injections.

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