Current Pain and Headache Reports (2021) 25: 34
https://doi.org/10.1007/s11916-021-00942-7

CHRONIC PAIN MEDICINE (O VISWANATH, SECTION EDITOR)

Does Choice of Steroid Matter for Treatment of Chronic Low Back Pain with Sacroiliac Joint Injections: a Retrospective Study

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Accepted: 12 February 2021 / Published online: 24 March 2021

Abstract

Purpose of Review Prevalence of chronic low back pain (cLBP) is increasing. Sacroiliac joint (SIJ) is a common source of cLBP, but data behind its diagnosis and treatment is controversial. There is moderate quality evidence for effectiveness of therapeutic SIJ injections. However, there are no studies comparing the two most common steroid preparations, methylprednisolone (MTP) and triamcinolone (TAC) in SIJ injections.

Recent Findings After institutional IRB approval, a retrospective chart review was conducted to evaluate the effectiveness of SIJ injections in terms of pain relief at 1-month follow-up and compare MTP versus TAC. All injections were performed by a single pain physician with fluoroscopic guidance.

Results Sixty-five percent of patients in the MTP group and 57% patients in the TAC group had >50% pain relief at 1-month follow-up, with no statistical difference between the two groups. Patients in the TAC group had significantly greater BMI and consisted of higher proportion of smokers (72% patients in TAC group versus 39% patients in the MTP group, *p*-value 0.004). Other sources of pain such as facet joints were unmasked post-procedurally after SIJ injections, with this unmasking being significant for the TAC group. Opiate use decreased in the MTP group from 35% pre-procedurally to 20% post-procedurally, and this difference did not reach statistical significance.

Summary Both MTP and TAC are effective in providing pain relief for SIJ pain at 1-month follow-up, with no statistical difference between the two types of steroids. Although not statistically significant, there is a modest reduction in opiate use in the MTP group.

Keywords SI joint injections · Sacroiliac joint steroid injections · Methylprednisolone versus triamcinolone · Chronic low back pain treatment

Background

Chronic low back pain (cLBP) is one of the most common complaints among patients seen in primary care. The prevalence of cLBP is difficult to elucidate, given the lack of a single diagnostic criteria. A recent systematic review by Meucci et al. [1] estimated the prevalence of cLBP to be 19.6% between the ages of 20 and 59, increasing linearly from the third decade of life, and being more prevalent in women. Several studies have shown that the prevalence of cLBP may in fact be increasing [2, 3]. cLBP can be a difficult condition to treat and a multidisciplinary approach to treatment including multimodal medical, psychological, physical, and interventional approaches is recommended [4]. The sacroiliac joint (SIJ) is a common cause of cLBP, but its diagnosis and treatment are controversial [5, 6]. The prevalence of SIJ dysfunction is similarly difficult to elucidate given the differences in selection criteria and diagnostic modality. Several recent studies have shown a prevalence ranging from 10 to 45%, as identified with diagnostic blocks and associated pain relief [7].

Given the increasing prevalence of cLBP, with SIJ being a common source of axial back pain, the number of interventions for SIJ pain has also increased substantially in recent years. Data from 2000 to 2013 in fee-for-service Medicare beneficiaries shows an annual average growth of 13.5% for facet joint and SIJ blocks, when controlled for growth in this population over time [8].

This article is part of the Topical Collection on *Chronic Pain Medicine*

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Corticosteroid injections have been used in managing low back pain with or without radiculopathy as well as joint pain, where most research demonstrates positive short-term outcomes in pain and function following injections. SIJ steroid injections are typically performed for SIJ pain related to osteoarthritis, enthesis/ligamentous sprain, primary enthesopathy, and sacroiliitis associated with inflammatory spondyloarthropathies [9]. In addition, ligamentous, tendinous, or fascial attachments and other cumulative soft tissue injuries posterior to the SIJ could be causative and treated with SIJ steroid injections. A few randomized controlled trials examining the use of steroid injections in spondyloarthropathies [9] have reported mixed results, again depending on the methodology used and inclusion criteria [7].

Despite exponential growth in the number of steroid injections over the last several years, there is a paucity of randomized controlled trials on the efficacy of SIJ steroid injections for other diagnoses, including pain not associated with a spondyloarthropathy. A recent systematic review by Kennedy et al. [10••] reports the overall quality of evidence to be moderate for the effectiveness of therapeutic SIJ injections based on two randomized controlled trials and some observational studies. In addition, there is extreme interprovider variability in the type of steroid used for different steroid injections.

Among the common steroid preparations available, methylprednisolone (MTP) and triamcinolone (TAC) are the two most common particulate steroids used in clinical practice. Both types of steroids seem to be similar in efficacy in epidural steroid injections and intra-articular hip and knee injections, with minor differences seen in specific studies. Larger doses may last longer but need to be balanced with the systemic effects from higher doses. The volume has not been studied extensively. A recent systematic review has examined the effect of steroid type, dose, and volume on clinical outcomes in small to intermediate joints afflicted with osteoarthritis or rheumatoid arthritis and found very few studies that showed TAC to be superior to MTP (Interphalangeal joints). Due to heterogeneity in study types, subject populations, and outcomes, it has not been possible to identify a single defining trend for a superior type, dose, or volume of steroids. Future prospective studies examining these factors have been suggested to better reveal the optimum regimen for each injection location [11].

To our knowledge, no studies have been performed comparing the efficacy of MTP versus TAC for SIJ steroid injections. Given extreme inter-provider variability for the type of steroid used for SIJ injections, we sought to perform a retrospective chart review to compare the two different steroid preparations in terms of pain relief at 1-month follow-up. In addition, we also reviewed pain relief overall and pre- and post-procedure exam findings and medication usage for all SIJ injections. All injections were performed by a single pain physician using fluoroscopic guidance at a large tertiary academic center, and intra-articular injection was guaranteed by arthrogram.

Methods

Design

Institutional review board approval was obtained prior to the study. This was a retrospective chart review of patients who received SIJ steroid injections between December 1, 2017, and Dec 31, 2018, performed at a tertiary academic medical center by a single interventional pain physician (KR) with over 5 years of experience in clinical practice. All SIJ injections were performed using fluoroscopic guidance using a standard approach with confirmation of intra-articular position of the needle with a contrast arthrogram (unless contrast use was contraindicated due to a severe allergic reaction). The injectate mixture used was a combination of 0.25% bupivacaine mixed with 40 mg of MTP or 40 mg of TAC. Data was obtained from the electronic health record of Yale New Haven Hospital system (Epic Inc.). Customized reporting and data analysis were carried out by the Joint Data Analytics Team (JDAT) at Yale Center for Clinical Investigation.

Data Points Collected

All patients who received SIJ injections by KR between December 1, 2017, and December 31, 2018, were identified using the billing CPT code 27096. Baseline demographic data including age, gender, BMI, and smoking status were recorded. Initial consult notes were reviewed to record duration of symptoms of back pain, average, best, and worst pain scores using the numerical rating scale (NRS), previous back surgery, previous interventions such as epidural steroid injections, facet joint injections, and trigger point injections, as well as use of opiates, NSAIDs, muscle relaxants, and neuropathic agents. In addition, exam findings such as facet loading, straight leg raise (SLR), FABER (Flexion/ABduction/External Rotation) test, significant motor weakness (<4/5 muscle strength in lower extremities), and loss of sensation to light touch were recorded. Although not always recorded, patients approved for SIJ steroid injections also had a positive Finger Fortin test (where patients identify the source of pain by pointing to the posterior superior iliac spine). The date of procedure was recorded for each individual patient. The type of steroid (TAC versus MTP) injected during the procedure was recorded, in addition to reported pain score before and immediately following the procedure. Charts were reviewed to determine percentage of pain relief at 1-month follow-up appointment. Success was defined as 50% or greater pain relief at 1-month follow-up. In addition, analgesic use (more, less or the same) and physical exam findings (positive FABER test, positive facet load, positive straight leg raise) were recorded at the 1-month follow-up.

Statistical Analysis

Descriptive statistics were calculated for all measures, including patient demographics, baseline characteristics, outcomes, exam findings, and medication usage. Data were presented as mean (standard deviation: SD) or median (interquartile range: IQR) for continuous variables, and frequency (percentage) calculated for categorical variables.

The statistical comparison of two groups for the primary outcome, i.e., "success" of injection at 1-month follow-up, was performed using the Chi-square test, which was also used to compare the other categorical variables including smoking status, pre and post-procedure exam findings, and medication usage for NSAIDs, opiates, and muscle relaxants. When data were sparse, Fisher's exact test was used instead. To compare the continuous variables BMI and age, two-sample t-test or Wilcoxon rank sum test was used as appropriate. To make comparisons for the various medication related and physical examination variables before and after procedure within the same group, the McNemar's test was used.

All statistical analyses were performed using the statistical software SAS, version 9.4 (Cary, MC). A two-sided p-value less than 0.05 was considered to indicate statistical significance, if not otherwise noted.

Results

A total of 108 SIJ steroid injections were performed between December 2017 and December 2018. Four patients were excluded from analysis due to loss of follow-up.

MTP was used in 23 patients and TAC was used in 81 patients. Most of the MTP injections were performed between December 2017 and June 2018 as the practitioner built her practice in the first half of the year. A change in clinic policy mid-year led to the use of TAC for all SIJ injections from June onwards. The increase in the number of TAC injections in the second half of the year correlated with practice growth in that time period.

Descriptive Variables

As shown in Table 1, the mean age of patients overall was 56 years old, with no statistically significant difference found between the two groups ($p = 0.69$). Most patients were female (73%), with the majority of patients (85%) having had symptoms for years. Most patients had no prior history of back surgery (67%). Compared to patients in the MTP group, patients in the TAC group had significantly higher BMI ($p = 0.007$) and were more frequently smokers (72% versus 39%, $p = 0.004$). Bilateral SIJ injections were performed in 53% of cases with no significant difference between the two groups ($p = 0.08$).

As shown in Table 2, the primary outcome defined as 50% or greater pain relief at 1-month follow-up, showed no significant difference between the MTP and TAC groups ($p = 0.51$). Notably, 55% (12/22) of the patients in the MTP group and 58% (46/79) in the TAC group had >50% reduction in pain immediately post-procedure ($p = 0.76$). At 1-month follow-up, 65% of patients in the MTP group (N=13/23) and 57% of patients in the TAC group (N=42/81) had a "successful injection" with >50% pain relief.

Pre- and Post-Procedure Exam Findings

While SIJ injection reportedly provided pain relief in 65% of patients in MTP group and 57% in the TAC group, there was no significant difference in exam findings pre- and post-injection. As shown in Table 3, FABER was positive in 86% and 82% of patients in the MTP and TAC groups pre-procedurally. FABER remained positive in 65% (previously 86%) of MTP patients and 78% (previously 82%) of TAC patients at the follow-up visit (Fig. 1). No statistically significant difference was found pre- and post-procedure (McNemar's test p = 0.083, 0.248 for MTP and TAC, respectively). A subgroup analysis of patients who were responders (only patients with >50% relief at 1 month) showed similar results. Nine of the thirteen MTP responders had a positive FABER pre-procedure and 7/13 MTP responders had a positive FABER post-procedure (Table 4). Similarly, 31/42 TAC responders (patients with pain relief >50% at 1 month) had a positive FABER pre-procedure and 28/42 TAC responders had a positive FABER post-procedure (Table 4).

The two groups were similar in terms of other pre-procedure exam findings suggestive of radicular irritation with a relative absence of straight leg raise test and motor or sensory disturbances. Eighty-seven of all patients demonstrated a negative straight leg raise test, 97% had no sensory loss, and 98% had no motor weakness (Table 3).

While facet loading was positive in 72% (61% in MTP group and 76% in TAC group) of all patients before an SIJ injection, this number increased to 87% (83% in MTP and 88% in TAC group) in the post-procedure period (Fig. 2). The significant change of positive facet loading (pre versus post) was only found in the TAC group (p =0.020). In the subgroup analysis, 70% of all responders (54% in MTP group and 76% in TAC group) displayed a positive facet load pre-procedurally, with this number increasing to 84% of all responders (75% in MTP group and 88% in TAC group) post-procedurally (Table 4). No significant change of positive facet loading was found in any subgroup of responders.

Table 1 Patient characteristics methylprednisolone versus triamcinolone groups

Characteristics	MTP (n = 23)	TAC (n = 81)	Total (n = 104)	p-value
Age	57.2 (13.1)	56.0 (12.7)	56.3 (12.7)	0.69
BMI	27.2 (25.4–28.9)	31.4 (26.4–36.5)	29.8 (26.2–35.1)	0.007
Gender				
Female	18 (78%)	58 (72%)	76 (73%)	0.53
Male	5 (22%)	23 (28%)	28 (27%)	
Smoking status				
Smokers	14 (61%)	23 (28%)	37 (36%)	0.004
Non-smokers	9 (39%)	58 (72%)	67 (64%)	
Duration of pain, time				
Months	2 (9%)	10 (12%)	12 (12%)	0.32
Weeks	2 (9%)	2 (2%)	4 (4%)	
Years	19 (83%)	69 (85%)	88 (85%)	
Procedure				
Bilateral SI joint	08 (035%)	47 (058%)	055 (053%)	0.08
Left SI joint	09 (039%)	15 (019%)	024 (023%)	
Right SI joint	06 (026%)	19 (023%)	025 (024%)	
Previous interventions				
Previous back surgery	7 (30%)	27 (33%)	34 (33%)	0.79
Previous epidural steroid injections	8 (35%)	22 (27%)	30 (29%)	0.48
Previous facet joint injections	2 (9%)	9 (11%)	11 (11%)	1.00
Previous lumbar trigger point injections	3 (13%)	13 (16%)	16 (15%)	1.00

Note: Data are presented as mean (SD), median (IQR), or n (%)

Medication Usage

As shown in the Table 3, pre-procedurally, opiate use was similar between the two groups, 35% of patients in the MTP group and 42% of patients in the TAC group (p=0.53). Post-procedurally, no difference was observed between the groups in their opiate usage, 20% of patients in the MTP group and 40% of patients in the TAC group continued to be on opiates (p=0.10). Although the use of opiates in the MTP group reduced from 35% pre-procedurally to 20% post-procedurally, this difference did not reach statistical significance (p= 0.153, Fig. 3). Similar findings of opiate use were also found in the sub-group of patients who were considered "responders" (Table 4).

Muscle relaxants were used by 41% of patients pre-procedurally, with 26% in MTP group and 46% in TAC group using muscle relaxants, with no significant difference between groups (p = 0.09, Table 3). Interestingly this number increased to 44% in the post-procedure period for both groups combined (30% in MTP group and 48% in TAC group), but again, this increase was not statistically significant in either group. Similarly, the use of neuropathic agents for both groups was not significantly different at both pre-and post-procedure period nor did the change post- procedure versus pre-procedure reach statistical significance (Table 3).

For NSAIDs, we observed a significant reduction in use post-procedurally in the TAC group in the univariate analysis (p = 0.03, Table 3). However, this difference could be

Table 2 Pain scores pre- and post-procedure, with pain relief (>50% relief) at 1-month follow-up

Pain scores and pain relief pre- and post-procedure	MTP group	TAC group	Total	p-value
Previous average pain score	7.22 (1.35)	7.07 (1.93)	7.11 (1.81)	1.00
Pain score post-procedure	2.91 (2.94)	2.76 (2.95)	2.79 (2.93)	0.80
Number of patients with >50% pain relief				
At 1-month follow-up	13 (65%)	42 (57%)	55 (59%)	0.51
Immediately post-procedure	12 (55%)	46 (58%)	58 (57%)	0.76

Note: Data are presented as mean (SD) or n (%)

Table 3 Comparison of pre- and post-injection medication usage and physical exam findings for all patients

	Pre-injection				Post-injection			
	MTP	TAC	Total	*p*-value	MTP	TAC	Total	*p*-value
Use of medications								
Muscle relaxants	6 (26%)	37 (46%)	43 (41%)	0.09	6 (30%)	36 (48%)	42 (44%)	0.15
Neuropathic agents	12 (52%)	31 (38%)	43 (41%)	0.23	10 (50%)	30 (40%)	40 (42%)	0.42
Opiates	8 (35%)	34 (42%)	42 (40%)	0.53	4 (20%)	30 (40%)	34 (36%)	0.10
NSAIDS	15 (65%)	39 (48%)	54 (52%)	0.15	14 (70%)	32 (43%)	46 (48%)	0.03
Physical exam findings								
Positive FABER	18 (86%)	60 (82%)	78 (83%)	1.00	11 (65%)	42 (78%)	53 (75%)	0.34
Positive facet loading	14 (61%)	56 (76%)	70 (72%)	0.17	15 (83%)	52 (88%)	67 (87%)	0.69
Positive SLR	3 (16%)	9 (13%)	12 (13%)	0.71	3 (17%)	9 (17%)	12 (17%)	1.00
Loss of sensation	0 (0%)	3 (4%)	3 (3%)	1.00	1 (5%)	1 (1%)	2 (2%)	0.39
Loss of motor function (<4/5)	0 (0%)	2 (2%)	2 (2%)	1.00	0 (0%)	0 (0%)	0 (0%)	1.00

related to the confounding effects of covariates such as BMI, smoking status, and pre-procedure NSAIDs use. To control for confounders, multivariable logistic regression was performed, with the response variable being post-procedure use of NSAIDs. We found that patients in the MTP group were expected to use NSAIDS post-procedurally 5.42 (95% CI: 0.74–39.48) times more than those in the TAC group, while holding the other variables constant in the multivariable logistic model. However, the corresponding *p*-value for this variable was 0.095; we therefore concluded that the observed difference in univariate analysis for post-procedure NSAID use failed to reach statistical significance after adjusting for the aforementioned covariates.

Discussion

Cortisone and its derivatives are glucocorticoids that affect inflammation and glucose metabolism. Corticosteroids readily cross cell membranes and enter the cytoplasm, where they bind glucocorticoid receptors, which cause changes at the level of DNA [11]. By regulating the transcription of several genes, corticosteroids inhibit prostaglandin synthesis, decrease the circulation of leukocytes in inflamed tissues, and decrease edema by altering capillary permeability [11]. Corticosteroids further decrease inflammation by inhibiting pro-inflammatory transcription factors [12]. Within the joint, corticosteroids cause reduced synovial blood flow, reduced local inflammatory modulation, and altered local collagen

Table 4 Comparison of pre-and post-injection medication usage and physical exam findings for responders (55 patients with >50% pain relief at 1-month follow-up)

	Pre-injection				Post-injection			
	MTP	TAC	Total	*p*-value	MTP	TAC	Total	*p*-value
Use of medications								
Muscle relaxants	4 (31%)	17 (40%)	21 (38%)	0.75	4 (31%)	20 (48%)	24 (44%)	0.28
Neuropathic agents	7 (54%)	16 (38%)	23 (42%)	0.31	7 (54%)	16 (38%)	23 (42%)	0.31
Opiates	4 (31%)	17 (40%)	21 (38%)	0.75	2 (15%)	16 (38%)	18 (33%)	0.18
NSAIDS	10 (77%)	22 (52%)	32 (58%)	0.12	9 (69%)	18 (43%)	27 (49%)	0.10
Physical exam findings								
Positive FABER	9 (75%)	31 (82%)	40 (80%)	0.69	7 (58%)	28 (88%)	35 (80%)	0.09
Positive facet loading	7 (54%)	28 (76%)	35 (70%)	0.17	9 (75%)	29 (88%)	38 (84%)	0.36
Positive SLR	2 (18%)	2 (5%)	4 (8%)	0.21	1 (8%)	2 (7%)	3 (7%)	1
Loss of sensation	0 (0%)	2 (5%)	2 (4%)	1	0 (0%)	1 (1%)	1 (2%)	1
Loss of motor function (<4/5)	0 (0%)	2 (5%)	2 (4%)	1	0 (0%)	0 (0%)	0 (0%)	1

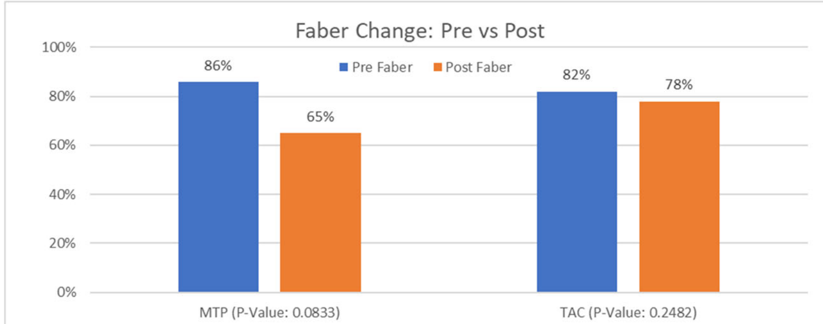

Fig. 1 Comparison of pre-procedure prevalence of positive FABER on physical exam versus post-procedure prevalence of positive FABER on physical exam for each steroid group

synthesis [13]. The branched esters of cortisone most commonly used today have a decreased aqueous solubility that prolongs their residence time in the joint, which promotes a longer duration of clinical effect [14]. The most commonly used agents include triamcinolone hexacetonide/acetonide, methylprednisolone acetate, betamethasone acetate/sodium phosphate, and dexamethasone sodium phosphate [14–16]. Clinically, insoluble steroids have a longer duration of action and a higher incidence of cutaneous side effects. In the USA, methylprednisolone acetate (Depo-Medrol) is the most commonly used intra-articular steroid, followed by triamcinolone hexacetonide and triamcinolone acetonide [16]. Many physicians empirically use triamcinolone hexacetonide (for its low solubility, and longer duration of action) for intra-articular injections, and betamethasone (high solubility, shorter duration of action, fewer cutaneous side effects) for soft tissue injections.

Although frequently used in the management of chronic low back pain, there is no uniformity regarding indications, choice of preparation, and maximum dose of steroid to be injected. In a survey of interventional pain physicians from CT Society of Anesthesiologists, steroid preference was MTP (82%) or TAC (13%), and most providers added local anesthetic to their steroid preparation, but there was no data regarding efficacy of different steroids or their dosage [17]. Some studies have compared different preparations of steroids to saline or local anesthetic (without steroids) for transforaminal epidural steroid injections, with short-term benefit in subjective and objective indices of pain when steroids were used. Outcomes studied include VAS (visual analog score) scores, Leg VAS scores, walking distance, Oswestry disability scores, and the Beck depression inventory [18, 19, 20•, 21–24]. Even fewer studies have been done comparing the different available steroid preparations. No difference in outcomes has been reported between various steroid preparations for epidural injections [19, 20•, 22]. No studies have compared different steroid preparations in facet joint injections. Fuchs et al. [25] compared hyaluronate versus TAC in facet joint injections with both treatments equally efficacious at 3- and 6-month follow-ups. Schulte et al. [26] similarly compared facet joint injections with steroid, lidocaine, and 5% phenol with no difference in pain relief.

This single-center retrospective study is one of the first studies to compare the effectiveness of MTP with TAC for SIJ steroid injections. For our primary outcome, no statistical difference was observed between the two types of steroids, even though the approximate duration of action of TAC (14 days) is longer than MTP (8 days), given greater insolubility of the former agent [13]. The average duration of benefit from different formulations of particulate steroids has been reported to be 21 to 90 days for triamcinolone hexacetonide, 14 to 66 days for triamcinolone acetonide, and 8 to 56 days for methylprednisolone acetate [27]. Particulate steroids, such as methylprednisolone acetate and triamcinolone acenotide, are composed of microcrystals ranging from 3 to 15 times the size of erythrocytes. Triamcinolone acenotide, considered the least soluble steroid with the greatest potency, has densely packed particles that vary in size ranging from 15 to 60 μm. In comparison, methylprednisolone acetate has uniformly sized, densely packed particles ranging from 0.5 to 26 μm in size,

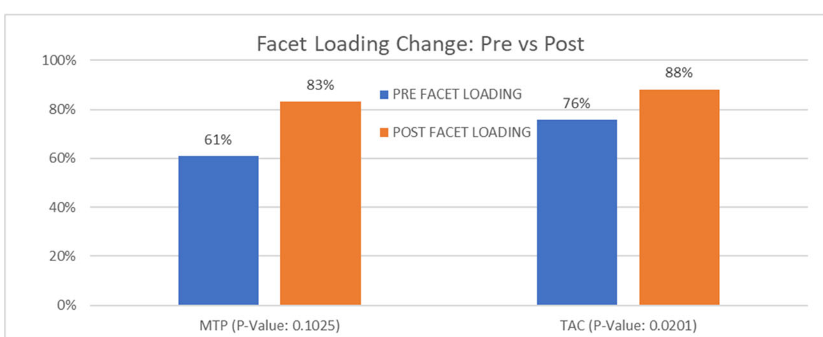

Fig. 2 Comparison of pre-procedure prevalence of facet loading on physical exam versus post-procedure prevalence of facet loading on physical exam for each steroid group

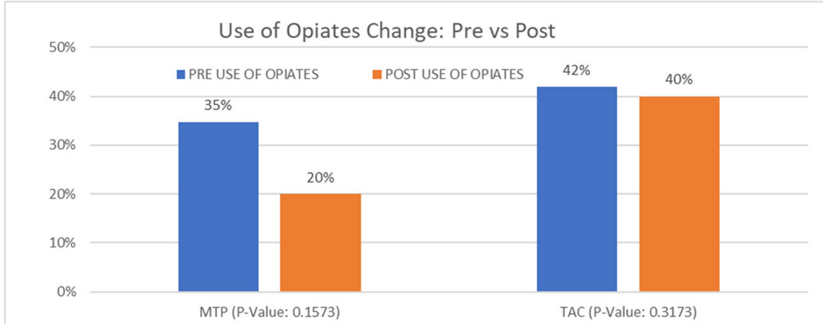

Fig. 3 Use of opiates by patients pre- and post-injection for each steroid group

with <5% of particles >50 μm in diameter that do not form many aggregations [28]. The duration of action seems to be related to the varying degree of aqueous solubility related to the difference in microcrystalline structure of various particulate steroids. The risk of subcutaneous fat atrophy or dermal hypopigmentation is higher for TAC compared to MTP; MTP is therefore recommended for use in superficial soft tissue injections and small joints, whereas MTP or TAC could be used for deeper sites and medium or large joints [28].

Our findings of no statistical difference between MTP and TAC is in line with similar studies comparing the two different types of steroids in the epidural space, with no significant difference in pain relief at short-term follow-up. In contrast, the orthopedic literature shows more conflicting results, especially when different large joints (hips, knees, shoulders) are considered. Table 5 summarizes the important studies in orthopedics that compare different steroid formulations and their respective benefits. This list is not exhaustive, and a full review of the orthopedic literature is beyond the scope of the current article. When synthesized together, some of the studies in the orthopedic world, especially for upper extremity joints, tend to favor TAC over MTP due to improved pain relief and outcomes (Table 5).

The overall quality of evidence for the effectiveness of therapeutic SI joint injections is reported to be moderate in a recent systematic review by Kennedy et al. [10••]. This evidence is based on two randomized controlled trials and some observational studies. In our study, 59% of all patients in both groups combined had >50% relief at the 1-month follow-up visit. The highest reported success rate from image-guided intra-articular SIJ injections was demonstrated in an explanatory randomized controlled trial (RCT) on 13 joints in patients with ankylosing spondyloarthropathy [38] and in an observational study on 17 patients with ankylosing spondylitis. Both of these studies were small and did not utilize diagnostic blocks to select patients, but they did show statistically and clinically significant improvements with the injection of a corticosteroid. The Maugars study showed decreased mean pain scores, decreased NSAID usage, and longer duration of relief with steroid over saline. The Karabacakoglu study also showed decreased NSAID usage after an injection [39]. A second RCT was a pragmatic trial [40] that compared 25 patients that received steroids with 23 patients that received prolotherapy [39]. All patients (steroids and prolotherapy) had a >50% reduction in pain at 2-week follow-up, but only the prolotherapy group had sustained pain relief at 6-month follow-up. Our study therefore adds to the available body of evidence in support of use of SI joint injections for short-term pain relief. Although short term, it is possible that the afforded pain relief could contribute to improved compliance with other conservative measures such as regular home exercise program and weight loss. Due to loss to follow-up, we did not have data to evaluate functional outcomes and quality of life in the long term, which is one of the limitations of the study. However, our study did show a slight reduction in opiate usage in the MTP group, without reaching statistical significance.

One of the limitations of studying the effectiveness of therapeutic interventions for chronic low back pain is its multifactorial nature, with several possible pain generators. Our study reinforces this observation since a majority of our patients who were selected for SIJ injections demonstrated positive findings to suggest facet mediated pain in addition to the strongly positive SIJ provocative maneuvers at the pre-procedure visit. Moreover, there was an unmasking of facet-mediated pain at the follow-up visit with an increase in facet load on exam findings. This could have confounded our outcome at 1-month follow-up and possibly explains the relatively lower success rate of 59% overall. In addition, SIJ provocative maneuvers continued to remain positive even in patients who did report pain relief at the 1-month follow-up visit, perhaps pointing toward ongoing inflammation. Although no single physical exam maneuver is predictive of patients that will respond to a diagnostic injection, the presence of multiple positive provocative tests increases the sensitivity and specificity of diagnosis of SIJ pain, when compared with single diagnostic injections. Since it is also not clear if image-guided intra-articular diagnostic injections of a local anesthetic predict a positive response to a therapeutic agent [10••], in our clinical practice, SIJ pain is diagnosed and treated preemptively based on clinical features and multiple provocative tests, without necessarily performing diagnostic blocks.

Table 5 Orthopedic studies comparing different types of steroid injections

Joint	Authors	Study comparators	Results
Knee joints	Pyne et al. [29]	20-mg TAC versus 40-mg MTP in knee OA	TAC more effective at 3 weeks, no difference at 8 weeks
	Blyth et al. [30]	TAC acetonide versus TAC hexacetonide in knee OA	TAC hexacetonide better than TAC acetonide at 12 weeks (59% versus 44% responders)
	Jain and Jain [31]	80-mg MTP versus 40-mg TAC	80-mg MTP better than 40-mg TAC at 8 weeks for pain (0.7 point) and function (WOMAC, 27 points)
	Valtonen et al. [32]	6-mg betamethasone versus 20-mg TAC hexacetonide for Knee OA	57% of those who received 6-mg betamethasone versus only 24% of patients who received 20-mg TAC hexacetonide needed additional treatment
	Yavuz et al. [33]	3-mg betamethasone versus 40-mg MTP acetate versus 40-mg TAC acetonide.	All patients better than placebo for VAS (2 points) and Lequesne Functional Index score improvement (4 points) through 12 weeks. MTP better than TAC acetonide and betamethasone through 6 weeks (1 point on the VAS)
Hip Joint OA	Krych et al. [34]	MTP acetate 40 mg/mL (n = 35) versus TAC 40 mg/mL (n = 17)	No difference in pain reduction at 2 weeks
Shoulder joint	Sakeni and Al-Nimer [35]	Glenohumeral joint injection of TAC acetonide versus MTP acetate in patients with adhesive capsulitis	Greater proportion of responders (patient-perceived effect of "complete recovery" or "improvement") in TAC acetonide (77% success rate; 95% confidence interval [CI] = 65–86%) compared to the MTP acetate group (58% success rate; 95% CI = 46–70%) at 8 weeks
	Chavez-Lopez et al. [36]	Subacromial space injection of 40-mg MTP acetate versus 40-mg TAC acetonide for rotator cuff impingement	At 2 weeks, 92% (95% CI = 62–100%) of participants in the MTP group reported a pain reduction of 50% or greater compared to only 50% (95% CI = 21–79%) of the participants in the TAC acetonide group (p = .02). At 2 months, there was no significant difference. No differences were identified between groups for VAS scores or range of motion improvement at any time point
	Plafki et al. [37]	10-mg TAC acetonide versus dexamethasone 21-palmitate versus control group in patients with impingement syndrome	The control group treatment was stopped early due to inadequate pain relief compared to the 2 steroid groups. The 2 steroids groups demonstrated equivalent outcomes in a Patte score which includes "subjective estimation of pain, function, force, and overall handicap"

Assessing pain relief after an SI joint injection therefore (diagnostic local anesthetic block or therapeutic steroid injection) could be truly illustrative only if there were no other co-existing spinal pathology, which may not be true in the real world in large populations.

Limitations

Our study has a few limitations that we need to keep in mind while interpreting the results. This was a retrospective chart review, looking at previously reported outcomes. As such, the variability in reporting could have influenced the measured outcomes. Our pain scores were documented by healthcare professionals in subjective terms, and changes in physical exam were determined in part by how these maneuvers were performed by each individual. Reporting of pain scores and relief of pain after intervention also lends itself to observer bias given its subjective nature.

A majority of patients in this study were in the TAC group. This difference could have resulted in the lack of significance noted when comparing MTP and TAC. Other possible sources of confounding could be subjects who had other possible pathologies for LBP (as seen in their physical exam), subjects who had other interventional procedures prior to the initial consultation such as prior epidural steroid injections (35% patients overall), follow-up being greater than 1 month from initial intervention, and effectiveness of other interventions such as trigger point injections, medication changes, and physical therapy.

Our study also did not gather objective measures of functional improvement such as functional measures of mobility, which could have provided more evidence of clinical improvement from SIJ injection. Data was also lacking in the frequency of medication use, so while it is possible that patients continued to utilize the same medication, a decrease in use could have been clinically significant. Also, while we determined that >50% pain relief at 1-month follow-up would be the marker for a successful SIJ injection, it is quite possible that clinically any amount of pain relief would benefit patients, and repeat SIJ injections could be pursued in this setting. In some cases, we were also lacking data on duration of pain relief, which would be an important piece of information about the overall effectiveness of an intervention. Finally, our study looked at a single provider and single tertiary facility and as such may not be representative of general practice variability.

Conclusions

This retrospective chart review confirms that SIJ steroid injections provide short-term pain relief and adds to the existing body of evidence supporting the use of therapeutic injections. Chronic low back pain is multifactorial and pain relief from one pain generator may unmask other sources of pain that may need further treatment. There is no statistical difference between MTP and TAC with a slight non-significant reduction in opiate usage in the MTP group. In the healthcare system where this study was conducted, there was no significant price difference among the two steroids, and therefore one can effectively use either steroid in practice.

Larger prospective studies are warranted to evaluate the effectiveness of interventional pain procedures in reducing opioid consumption, especially in the current climate of opioid crisis. It may also be useful to assess not only pain relief but also other measures of quality of life and functional status, to truly determine the long-term efficacy and detect a difference between different types of steroids. It may be beneficial to differentiate the presumed etiology of SI joint pain prior to study initiation to determine if one type of treatment is more efficacious for certain underlying conditions, such as degenerative versus post-lumbar fusion versus inflammatory pathologies. Finally, this comparison of steroid efficacy could lend itself to a cross-over study to eliminate the confounding factor of underlying pathology (inflammatory versus arthritis), as well as factors such as patient perception of degree of pain relief and functional abilities.

Acknowledgements *Lisa Magestro APRN, Elisabeth Makubika APRN*

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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