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Adductor canal block *versus* intra-articular steroid and lidocaine injection for knee osteoarthritis: a randomized controlled study

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Background: This study aimed to assess the efficacy of the adductor canal block (ACB) in comparison to intra-articular steroid-lidocaine injection (IASLI) to control chronic knee osteoarthritis (KOA) pain.
Methods: A randomized, single-blinded trial in an outpatient rehabilitation clinic recruiting chronic KOA with pain ≥ 6 months over one year. Following randomization, subjects received either a single ACB or IASLI under ultrasound guidance. Numerical rating scale (NRS) scores for pain, and Knee Injury and Osteoarthritis Outcome Scores (KOOS) were recorded at baseline, 1 hour, 1 month, and 3 months postinjection.
Results: Sixty-six knees were recruited; 2 were lost to follow-up. Age was normally distributed (P = 0.463), with more female subjects in both arms (P = 0.564). NRS scores improved significantly for both arms at 1 hour, with better pain scores for the IASLI arm (P = 0.416) at 1st month and ACB arm at 3rd month (P = 0.077) with larger effect size (Cohen's d = 1.085). Lower limb function improved significantly in the IASLI arm at 1 month; the ACB subjects showed greater functional improvement at 3 months (Cohen's d = 0.3, P = 0.346). Quality of life (QoL) improvement mirrored the functional scores whereby the IASLI group fared better at the 1st month (P = 0.071) but at the 3rd month the ACB group scored better (Cohen's d = 0.08, P = 0.710).
Conclusions: ACB provides longer lasting analgesia which improves function and QoL in chronic KOA patients up to 3 months without any significant side effects.

Key Words: Analgesia; Injections, Intra-Articular; Lidocaine; Nerve Block; Osteoarthritis, Knee; Pain; Randomized Controlled Trial; Steroids.

INTRODUCTION

Knee osteoarthritis (KOA) pain is a major public health issue globally causing locomotor disability [1] with increased limitation in walking (22%), lifting (18.6%), and dressing (12.8%) [2]. The mainstay treatment of mild to moderate KOA pain is anti-inflammatory drugs [3]. Unfortunately, there is no effective pharmaceutical treatments for KOA pain and functional disability [4]. Knee replacement surgery is recommended when pharmacotherapy fails [5,6]. However, 81% of patients who did not achieve pain control with pharmacotherapy prefer not to have surgery, making non-pharmacological interventions the most sought-after option in moderate-severe KOA pain [2,7,8].

KOA pain itself is an identified barrier to exercise, as patients felt training was too difficult and caused more pain

[9,10]. Thus, KOA pain relief is expected to improve participation in therapy. Knee pain affects daily living, thus interventions to reduce knee pain and functional disability in knee OA are needed [11]. Minimally invasive therapies have the potential to provide a window on pain relief; these include intra-articular and perineural injections, ablations, and shockwave therapy [12]. The adductor canal block (ACB) is advantageous, as it provides comparable analgesic efficacy to the femoral nerve block (FNB), facilitates earlier mobilization by sparing quadriceps strength compared to the FNB, and reduces opioid consumption [13,14], with studies showing analgesia effects lasting 1–3 months [15,16]. ACB or saphenous nerve (SN) block, via administration of local anaesthetic, has been utilised for post-operative pain relief to the knee, most commonly after total knee arthroplasty, as mentioned by recent trials [17-22]. ACB is novel in its use for minimally invasive KOA pain control as compared to intra-articular steroid-lidocaine injection (IASLI), which is widely used.

From this background, this study aims primarily to assess the efficacy of the ACB in comparison to IASLI to control chronic KOA pain while observing its effect on function and quality of life (QoL) outcomes through a prospective, single-blinded randomized trial. Recent studies involving use of the ACB in chronic KOA pain control have been retrospective studies and, to the best of our knowledge, this is the first prospective study to evaluate the efficacy of the ACB in chronic KOA pain control.

MATERIALS AND METHODS

This was a prospective single-blinded, randomized trial with two parallel arms conducted in an outpatient rehabilitation setting of a tertiary medical center. Eligible subjects were recruited between July 2019 and May 2020 and the three month follow up was completed in August 2020. The Institutional Review Board approved the study protocol (MREC ID NO: 201945-7302; Malaysian National Medical Research Register: NMRR-19-2952-50384; Clinical Trials.gov – Identifier: NCT04264481) and the study conformed to the principles outlined in the Declaration of Helsinki.

Potential subjects were individuals with chronic KOA fulfilling the American College of Rheumatology 1986 clinical and radiological criteria. The inclusion criteria were antero-medial knee pain of at least 6 months duration with matching knee radiological findings of KOA, a Kellgren–Lawrence (KL) grade of 2–4, a visual analogue scale (VAS) pain score of at least 4/10 during weight bearing, and an age above 18. Subjects were excluded if there was presence of other knee pathologies such as fracture or rheumatic diseases, referred pain from the back suggestive

of lumbar radiculopathy, previous knee surgery, isolated lateral knee pain, history of intra-articular knee injections or peri-joint nerve blocks within 3 months of the study, neuropathic knee pain, or inability to give consent.

Subjects were randomized using a computer-generated randomization sequence by a non-participating staff member. The allocations were concealed until the day of injection, with only the interventionist being unblinded to the intervention allocation for safety reason. Standard precautions prior to injections were withholding anti-platelet medications for 5 to 7 days prior to injection and deferring the procedure due to fever or injection site skin pathology.

1. IASLI

IASLI was performed by a skilled interventionist under sonographic guidance (Venue 50; GE Healthcare, Chicago, IL) with a 12 Hz linear probe using aseptic technique with cutaneous analgesia of 1% lidocaine given prior to injection. A supero-lateral approach to the joint space was employed with real-time sonographic needle tip placement to ensure intraarticular delivery of the injectate. The injectate consisted of 40 mg of triamcenolone acetate + 2 mL of lidocaine 1% which was introduced via a 23G needle into the joint space.

2. ACB

The adductor canal and its neurovascular contents were identified with a high-frequency linear ultrasound transducer (Venue 50; GE Healthcare) by a skilled interventionist at the mid-canal level determined by the sartorius muscle forming the roof of the canal approximately 7 to 8 cm proximal to the superior pole of the patella on the medial aspect of the thigh (**Fig. 1**). Appearing as a hyperechoic circular structure, the SN which is the largest cutaneous branch of the femoral nerve provides cutaneous innervation over the anteromedial aspect of knee, lower leg, and foot, and is a pure sensory nerve [23]. The SN is usually visualized anterolateral to the superficial femoral artery at the mid-canal level, deep to the sartorius muscle and approached in the lateral-to-medial direction with the aid of Doppler scanning to confirm the vascular structures [24].

Following aseptic skin preparation and cutaneous anaesthesia of 1% lidocaine, a 22-gauge spinal needle (Spinocan; B. Braun, Melsungen, Germany) was introduced in plane lateral to the transducer with real-time visualisation of the needle shaft and tip throughout the procedure, ensuring safety by avoiding trauma to the neurovascular bundle (**Fig. 2**). The needle was passed through the posterior fascia of sartorius muscle, where it entered the fascia overlying the superficial femoral artery and SN [25] under

sonographic guidance towards the adductor canal which is an aponeurotic tunnel located in the middle third of the thigh bounded medially by the adductor longus, laterally by the vastus medialis, and superiorly by the sartorius and the sub-sartorial fascia [18,26].

The injectate, consisting of a 5 mL bupivacaine 0.5%, 5 mL lidocaine 1%, and 10 mL of 0.9% saline, was infused around the SN (**Fig. 2**). Post-procedure, the subject assumed an upright position to allow for the injectate to track away from the femoral nerve.

The demographic information, knee involvement, KL grade, and sonographic knee findings were noted at baseline. The primary outcome measure was the numerical rating scale (NRS) for KOA pain, and secondary outcomes were the Knee Injury and Osteoarthritis Outcome Scores (KOOS) subset scores for function and QoL, as well as analgesia usage, all of which were recorded at baseline, at 1 month, and at 3 months.

3. NRS for pain

The NRS is a segmented numeric version of the VAS widely used as a unidimensional measure of pain intensity in adults [27,28]. Pain was rated from a score of 0 (no pain) to 10 (extreme pain) with increasing scores indicating the severity of pain. Subjects were requested to rate their average pain score within the last 2 weeks from the review dates. The NRS pain score was recorded prior to injection, within 1 hour after injection, and at 1 month and 3 months post injection.

4. KOOS questionnaire

KOOS was developed in 1998 as an extension of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Osteoarthritis Index with the purpose of evaluating short and long-term symptoms and function in young and physically active subjects with knee injury and OA. It was intended to be used in cases of knee injury that can result in post-traumatic OA or in primary OA and has been used in male and female ranging from 14–79 years in age with varying disorders resulting in knee complaints such as anterior cruciate ligament tear, meniscus tear, and mild, moderate, and severe OA [29]. Five subscales of KOOS are scored separately: pain (nine items), symptoms (seven items), activities of daily living function (17 items), sport and recreation function (five items), and QoL (four items). A Likert scale is used, and all items have five possible answer options, scored from 0 (no problems) to 4 (extreme problems) and each of the five scores is calculated as the sum of the items included. Scores are transformed to
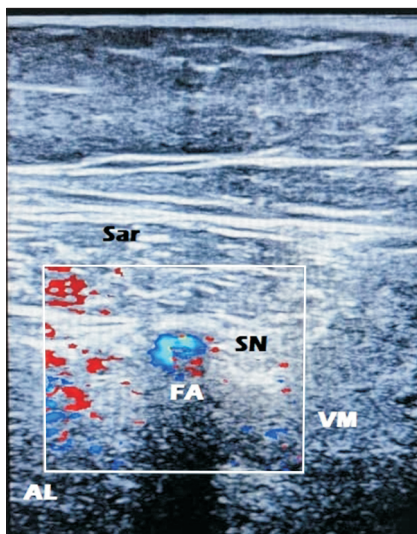

Fig. 1. Ultrasound image of the adductor canal at the level of mid-thigh. Sar: sartorius, SN: saphenous nerve, VM: vastus medialis, AL: adductor longus, FA: femoral artery.

Fig. 2. Insertion of needle and advancement under sonographic guidance. White arrowheads indicating the acoustic shadow of spinal needle. SN: saphenous nerve, VM: vastus medialis, FA: femoral artery. *Injectate.

a 0–100 scale, with zero representing extreme knee problems and 100 representing no knee problems, as common in orthopaedic assessment scales and generic measures [29]. A Malay-validated version of the KOOS Questionnaire was used for patients who could not complete the English language questionnaire [30]. KOOS subset scores were tabulated for pain, function and QoL subscales at baseline, 1 month, and 3 months post-intervention, using an online calculator available on https://www.orthotoolkit.com/koos/.

All patients underwent a bedside knee ultrasound to identify structural abnormalities such as supra-patellar effusion, Hoffa fat pad hyperactivity, medial radial displacement of the meniscus, skyline abnormalities of the joint space, and presence of a Baker's cyst. Knee radiographs were done to ascertain KL grade. All pre-existing medications and therapy were continued. **Fig. 3** summarises the subject flow through the study.

5. Data analysis

Statistical analysis was done using SPSS software ver. 23 (IBM Co., Armonk, NY). Descriptive statistics were used to analyse demographic data, the side of the KOA, the number of knees injected per patient, and sonographic knee findings utilising the chi-square test of association to compare groups at baseline, which included the mean, median, and standard deviations.

NRS pain scores were not normally distributed (Shapiro–Wilk) and were analysed using non-parametric tests. The Mann–Whitney U-test was used for intergroup analysis and the Friedman test for intragroup analysis. Age, KOOS function, and QoL scores were normally distributed (Shapiro–Wilk), thus were analysed using repeated measures analysis of variance.

Analgesia use was analysed using a non-parametric test for independent samples. Cohen's d effect size was used to calculate the therapeutic effect for both groups.

6. Sampling and sample size

This study was conducted via a convenience sampling method. Sample size was calculated using G*Power version 3.1.9.2 (Universitat Kiel, Kiel, Germany) using the effect size from Lee et al. [15], which is 0.3; with the study powered at 0.8 and significance level at 0.05, the sample size for this study is 64 with 32 knees in each arm. To allow for a 25% attrition rate, the sample size was set at 86; 43 in
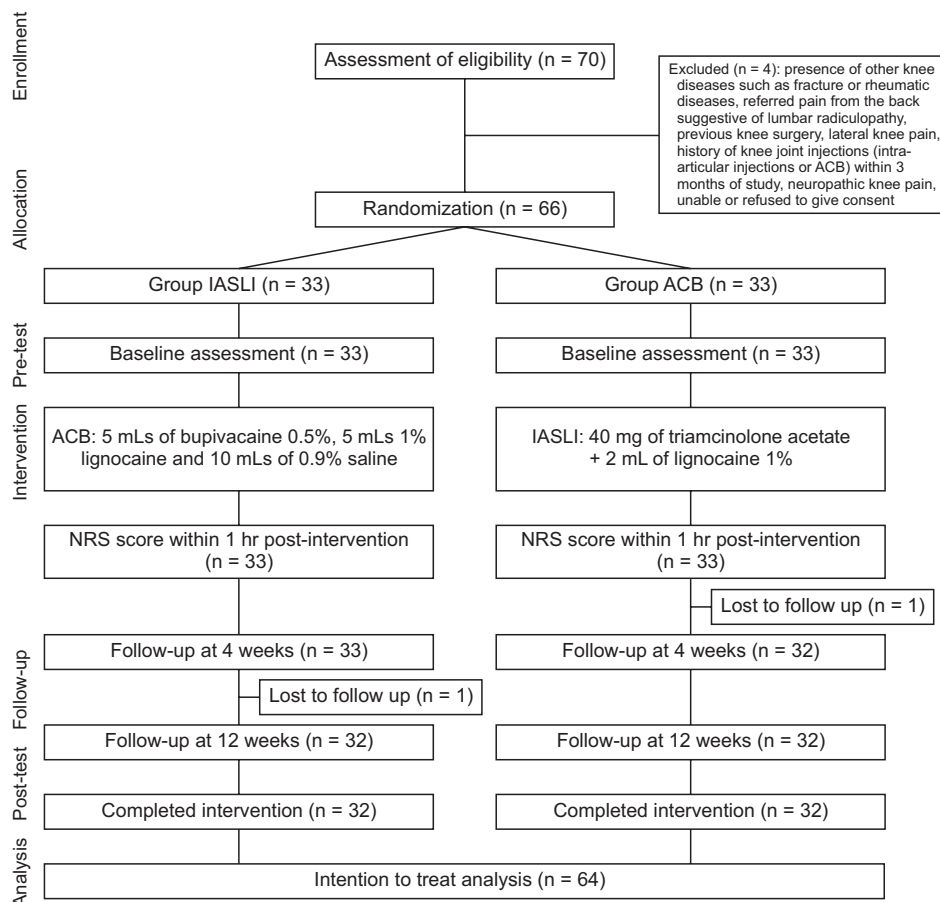

Fig. 3. Subject flow through the study. KOA: knee osteoarthritis, VAS: visual analogue scale, ACB: adductor canal block, IASLI: intra-articular steroid and lidocaine injection, NRS: numerical rating scale.

Table 1. Baseline characteristics of patients

Characteristic	IASLI (n = 32)	ACB (n = 32)	P value[a]
Sex (male:female)	7:25	9:23	0.564
Age (yr)	64.8 ± 11.6	66.4 ± 12.9	0.463
Ethnicity			
Malay	20 (62.5)	15 (46.9)	0.520
Chinese	9 (28.1)	12 (37.5)	
Indian	3 (9.4)	5 (15.6)	
KL grade			
KL 2	1 (3.1)	1 (3.1)	0.071
KL 3	5 (15.6)	13 (40.6)	
KL 4	26 (81.3)	18 (56.3)	
Side of KOA (right:left)	18:14	15:17	0.453

Values are presented as number only, mean ± standard deviation, or number (%).
IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, KL: Kellgren–Lawrence, KOA: knee osteoarthritis.
[a]χ^2 test for between-group comparison ($P < 0.05$).

Fig. 4. Analgesia use in IASLI *versus* ACB group at assessment time points (%). IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, Pre: baseline, 1M: 1-month post intervention, 3M: 3-months post intervention.

Table 2. Analgesia use at baseline, 1st month and 3rd month post intervention

Time	IASLI (n = 32)	ACB (n = 32)	P diff	P value for between group comparison
Baseline				
Analgesia	21 (65.6)	19 (59.4)		
No analgesia	11 (34.4)	13 (40.6)	0.606	0.608
1M				
Analgesia	10 (31.2)	12 (37.5)		
No analgesia	22 (68.8)	20 (62.5)	0.599	0.602
3M				
Analgesia	18 (56.2)	19 (59.4)		
No analgesia	14 (43.8)	13 (40.6)	0.800	0.802

Values are presented as number (%).
IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, 1M: 1-month post-intervention, 3M: 3-months post-intervention, P diff: P value of intragroup comparison.

Table 3. Sonographic findings in the enrolled knees

Group	IASLI (n = 32)	ACB (n = 32)	P value[a]
Suprapatellar effusion			
Present	21 (65.6)	26 (81.2)	0.157
Absent	11 (34.3)	6 (18.8)	
MRD			
Yes	14 (43.8)	17 (53.1)	0.453
No	18 (56.2)	15 (46.8)	
HOFFA			
Yes	0	2 (6.3)	0.492
No	32 (100)	30 (93.8)	
Baker's cyst			
Present	8 (25.0)	3 (9.4)	0.098
Absent	24 (75.0)	29 (90.6)	

Values are presented as number (%).
IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, MRD: medial radial displacement of medial meniscus, HOFFA: reactivity of Hoffa's fat pad.
[a]χ^2 test for between-group comparison ($P < 0.05$).

each arm.

RESULTS

Sixty-six knees were recruited out of 70 eligible knees. Sixty-four knees were available for analysis; 32 in each group with 2 knees lost to follow-up at the first and third months, respectively (**Fig. 3**). There were no significant adverse events observed following intervention in either group.

Baseline demographics were comparable between the study arms as described in **Table 1**. Analgesia usage is summarised in **Table 2** and **Fig. 4**; at 3 months post-intervention, there was more analgesia usage in the ACB group (59.4%) compared to the IASLI group (56.2%), which was not s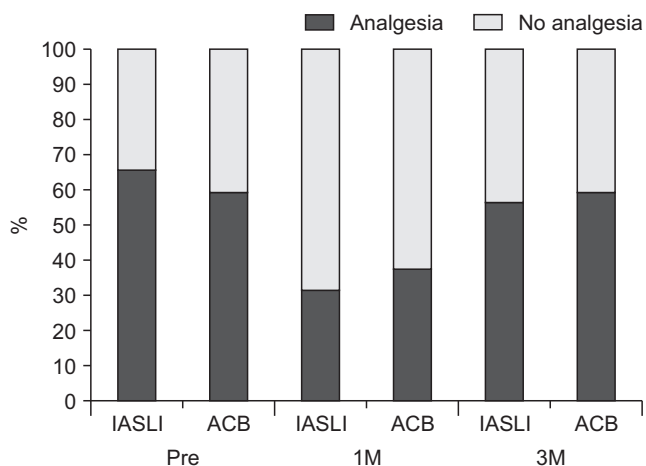tatistically significant ($P = 0.802$). Sonographic find-ings are summarised in **Table 3**. There was more suprapatellar effusion (81.2%, $P = 0.157$), medial radial displacement of the medial meniscus (53.1%, $P = 0.453$), and active Hoffa Fat pad (6.3%, $P = 0.492$) in the ACB group; there was a greater presence of Bakers cyst in the IASLI group (25.0%, $P = 0.098$). All differences were not statistically significant.

Baseline NRS, KOOS functional, and QoL scores were not statistically significant between the groups. The mean difference for pain scores was most significant at 1 hour post-intervention at –4.28 ($P < 0.001$, Cohen's d = 2.17) in the IASLI group and –4.97 in the ACB group ($P < 0.001$, Cohen's d = 2.95), however the intergroup difference was not significant ($P = 0.350$) as in **Table 4**. At 1 month post-intervention the NRS scores showed a reducing trend in both

Table 4. The evolution of outcome measurements

Measurement	IASLI (n = 32)				ACB (n = 32)				P between group comparison
	Mean score	Mean difference	P group by time interaction	Cohen's d	Mean score	Mean difference	P group by time interaction	Cohen's d	
NRS score									
Pre	6.63 ± 1.41				6.75 ± 1.41			0.805	0.805
Within 1 hr	2.34 ± 2.40	–4.28	< 0.001	2.17	1.78 ± 1.91	–4.97	< 0.001	2.95	0.350
1 Month	4.13 ± 2.20	–2.5	< 0.001	1.34	4.69 ± 2.69	–2.06	0.006	0.95	0.416
3 Month	5.53 ± 2.38	–1.09	0.395	0.55	4.38 ± 2.76	–2.38	0.004	1.085	0.077
KOOS function score									
Pre	48.86 ± 23.81				51.61 ± 19.15				0.612
1 month	58.50 ± 21.94	9.64	0.011	0.42	50.96 ± 21.62	–0.66	> 0.999	0.03	0.171
3 month	53.00 ± 18.35	4.13	0.405	0.19	57.33 ± 18.16	5.72	0.121	0.3	0.346
KOOS QoL score									
Pre	31.78 ± 19.48				32.28 ± 15.43				0.910
1 month	40.20 ± 18.42	8.42	0.025	0.44	32.05 ± 3.37	–0.227	> 0.999	0.02	0.071
3 month	31.94 ± 19.49	0.16	0.058	0.008	33.68 ± 17.8	1.398	> 0.999	0.08	0.710

Values are presented as mean ± standard deviation or number only.
Cohen's d effect size: < 0.2 = small effect, 0.2–0.8 = moderate effect, > 0.8 = large effect.
IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, NRS: numerical rating scale, Pre: baseline, KOOS: Knee Osteoarthritis and Injury Outcome Score, QoL: quality of life.

groups, with the IASLI group at –2.5 ($P < 0.001$, Cohen's d = 1.34) and the ACB group at –2.06 ($P = 0.006$, Cohen's d = 0.95), with intergroup differences not being statistically significant ($P = 0.416$). The mean difference in NRS scores at 3 months post-intervention was less pronounced in the IASLI group (–1.09) in comparison to the ACB group (–2.38) ($P = 0.077$); with a large effect size observed in the ACB group (Cohen's d = 1.085). The mean difference of NRS scores at 3 months in the ACB group was –2.38, which was significant ($P = 0.004$). At all time points measured, the intergroup NRS scores were not significantly different.

KOOS function scores demonstrated significant improvement in the IASLI group at 1 month post-intervention (mean score = 58.50 ± 21.94, mean difference = 9.64) ($P = 0.011$) with a moderate effect size (Cohen's d = 0.42) as compared to the ACB group (mean score = 50.96 ± 21.62, mean difference = –0.66, Cohen's d = 0.03), however intergroup differences were not statistically significant ($P = 0.171$). At 3 months post intervention, the ACB group demonstrated better scores (mean score = 57.33 ± 18.16, mean difference = 5.72) with a moderate effect size (Cohen's d = 0.3) compared to the IASLI group (mean score = 53.00 ± 18.35, mean difference = 4.13), with a small effect size (Cohen's d = 0.19), which is not statistically significant between groups ($P = 0.346$). KOOS QoL scores mirrored the results of functional scores; at 1 month the IASLI group showed better scores (mean score = 40.20 ± 18.42, mean difference = 8.42) and moderate effect size (Cohen's d = 0.44) compared to the ACB group (mean score = 32.05 ±
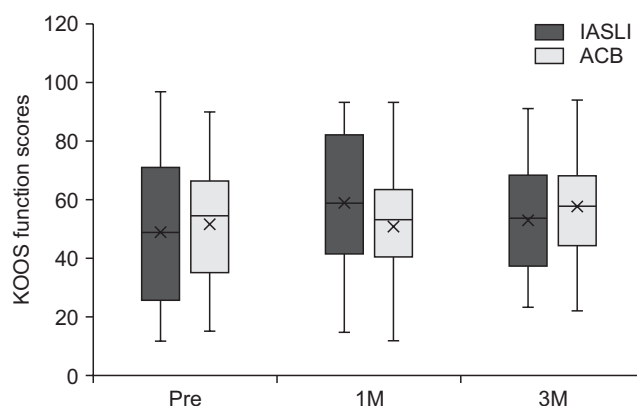

Fig. 5. KOOS functional scores for IASLI *versus* ACB at assessment time points. Lower line: minimum value, Upper line: maximum value, (Box) Lower line: Q1 lower quartile, Middle line: median, X: mean, Upper line: Q3 upper quartile, KOOS: Knee Injury and Osteoarthritis Outcome Scores, IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, Pre: baseline, 1M: 1-month post intervention, 3M: 3-months post intervention.

3.37, mean difference = –0.227, Cohen's d = 0.02) which was not statistically significant ($P = 0.071$). At 3 months, the ACB group scored better (mean score = 33.68 ± 17.8, mean difference = 1.398, Cohen's d = 0.08) compared to the IASLI group (mean score = 31.94 ± 19.49, mean difference = 0.16, Cohen's d = 0.008), but it was not statistically significant ($P = 0.710$) with both arms demonstrating a small effect size.

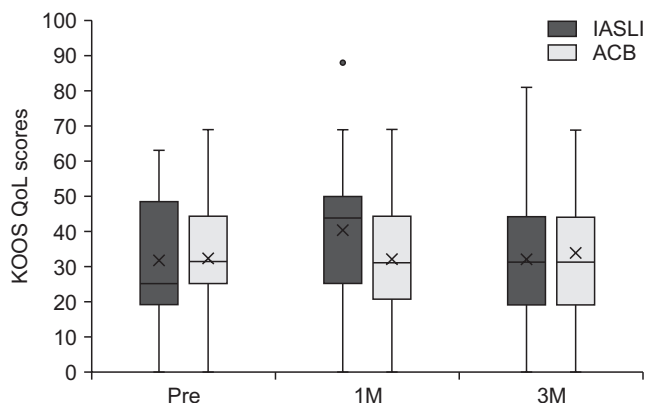The study outcome is summarised in **Table 4**, and **Figs. 5–8**.

Fig. 6. KOOS QoL scores for IASLI *versus* ACB at assessment time points. Lower line: minimum value, Upper line: maximum value, (Box) Lower line: Q1 lower quartile, Middle line: median, X: mean, Upper line: Q3 upper quartile, KOOS: Knee Injury and Osteoarthritis Outcome Scores, QoL: quality of life, IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, Pre: baseline, 1M: 1-month post intervention, 3M: 3-months post intervention.
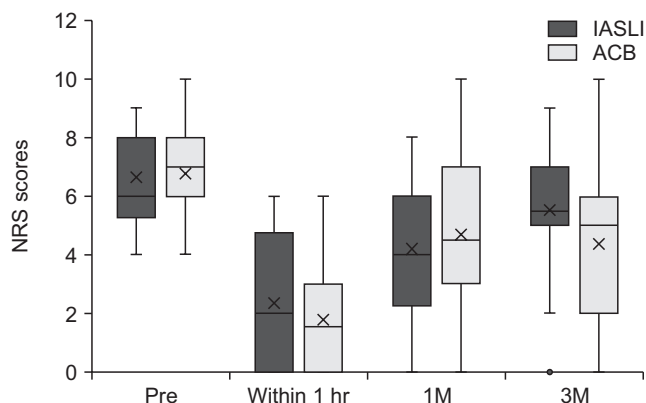
Fig. 7. NRS scores for pain of IASLI *versus* ACB at assessment time points. Lower line: minimum value, Upper line: maximum value, (Box) Lower line: Q1 lower quartile, Middle line: median, X: mean, Upper line: Q3 upper quartile, NRS: numerical rating scale, IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, Pre: baseline, 1M: 1-month post intervention, 3M: 3-months post intervention.
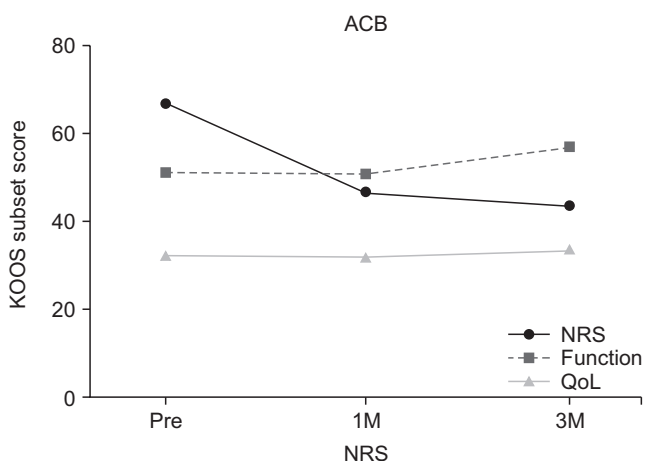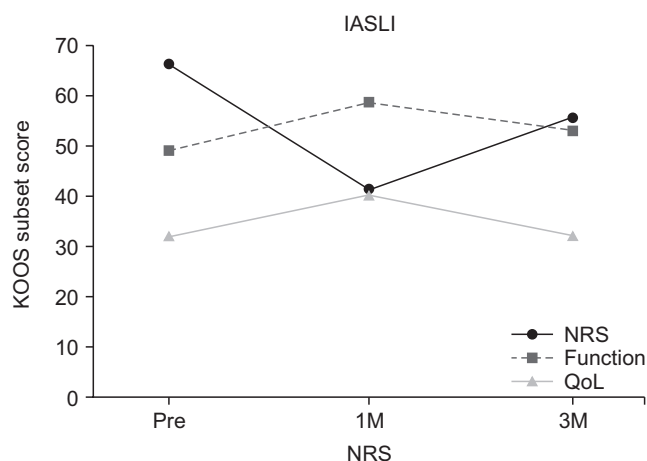

Fig. 8. Correlation between NRS pain score (%) and KOOS functional and QoL scores for IASLI and ACB subjects at assessment time points. IASLI: intra-articular steroid and lidocaine injection, ACB: adductor canal block, NRS: numerical rating scale, KOOS: Knee Injury and Osteoarthritis Outcome Scores, QoL: quality of life, Pre: baseline, 1M: 1-month post intervention, 3M: 3-months post intervention.

DISCUSSION

IASLI injection is a commonly performed KOA pain control procedure. A systematic review has shown that intra-articular corticosteroids are probably effective in improving symptoms of KOA for 16 to 24 weeks with doses equivalent to 50 mg of prednisone [31]. Chronic KOA pain has also shown a response to intra-articular 0.5% lidocaine injection for a 3-month period [32]. IASLI introduces both corticosteroids and local anaesthetics into the knee joint. Corticosteroids interrupt the inflammatory and immune cascade resulting in a reduction of vascular permeability, inhibiting accumulation and action of inflammatory cells, and preventing the production of inflammatory mediators responsible for the cardinal signs of inflammation and pain [33]. Corticosteroids may alter synovial fluid viscosity and hyaluronic acid concentration. Intra-articular lidocaine confers a neuronal membrane-stabilizing effect and long-lasting anti-inflammatory action by inhibiting both C fibres and sympathetic postganglionic neurons; anti-inflammatory activity was noted at sub-clinical concentrations. However, the myotoxic and neurotoxic effects of lidocaine may occur at concentrations used for acute pain management [32]. Despite proven analgesic effects, intra-articular corticosteroids alone have a limited duration of benefits and unproven efficacy in functional improvement. Four main adverse joint findings have been structurally observed in patients after intra-articular corticosteroid injections: accelerated OA progression, subchondral insufficiency fracture, complications of osteo-

necrosis, and rapid joint destruction including bone loss. Thus, intra-articular corticosteroids should be avoided when possible [34].

Park et al. [35] suggested that antero-medial knee innervation is from the nerve to the vastus medialis and the infrapatellar branch of the saphenous nerve that divides into multiple smaller branches distally, making sonographic identification challenging. They concluded that more proximal targets reduce complications as well as increased probability of successful analgesia. Such an injection can be achieved via the ACB to the SN. Nociceptive pain in KOA can be attributed to richly innervated structures such as the subchondral bone, periosteum, periarticular ligaments, periarticular muscle spasm, synovium, and joint capsule [36]. The ACB is postulated to interrupt pain signals originating from the lesions mentioned above. Koh et al. [13] determined that the ACB is one of the most useful analgesic modalities in contemporary perioperative management protocols that focus on rapid recovery after knee surgery.

The ACB is easy to perform with high success rates with the use of ultrasound, providing excellent pain relief around the knee joint when compared with a placebo [17,37-39]. IASLI can be technically difficult, especially in presence of osteophytes that obscure the needle path into the intra-articular space. Multiple studies have also suggested that the ACB offers satisfactory analgesia while preserving mobility in patients after arthroscopic surgery or total knee arthroplasty [17,18,38,40-43]. Lee et al. [15], in a 3-month retrospective case-controlled comparative study, noted improvement of VAS and WOMAC scores in the 1st month, and reduction of opioid consumption per day in the first two months in the ACB group as compared to the non-ACB patients with refractory anteromedial knee pain from KOA. Other studies have also concluded that SN blocks provide pain relief within 2 days that persists to 1 month in 56% of subjects and in 40% of subjects at 3 months after the

In our study, pain relief was most significant within 1 hour post intervention in both groups in comparison to baseline pain levels due to the immediate onset of the short acting anaesthetic, *i.e.*, lidocaine that was present in both injectates. There was no inter-group difference at 1 hour. The IASLI group showed significant pain score improvements at 1 month post-intervention compared to baseline, but not in other outcome domains: KOOS functional scores ($P = 0.011$) and QoL scores ($P = 0.025$). The pain improvement was not statistically significant between groups at 1 month post-intervention. At 3 months, IASLI effect appears to wear off, unlike ACB subjects, who had significant pain reduction as compared to baseline with a large effect size (Cohen's d = 1.085) in comparison

to IASLI group, which demonstrated only moderate effect size at the third month (Cohen's d = 0.55). Although the inter-group pain score improvement was insignificant at 3 month ($P = 0.077$), pain score trends were mirrored in functional and QoL improvement (**Fig. 8**).

A Cochrane Systemic Review noted a small-to-moderate benefit observed at 1–2 and 4–6 weeks after intra-articular corticosteroid injection; these effects decreased over time and there is no evidence of any benefit at 6 months post-injection [44]. Pain relief appears to be better sustained in the ACB group compared to the IASLI group, with a steroid sparing benefit, likely due to the persistent effect of bupivacaine. In a Japanese study, a mixture of 4% tetracaine and 0.5% bupivacaine prolonged the analgesic effects of a trigeminal nerve block for trigeminal neuralgia for more than 3 months [45]. The rationale for the use of a nerve blockade like the ACB is that the analgesic effect outlasts the conduction blockade due to elimination of the mechanism that sustains central sensitization in chronic pain generators, such as chronic KOA [46]. Systemic uptake of local anesthetic and intraneuronal spread of local anesthetics may also explain how nerve blocks such as ACB provide sustained analgesia through mechanisms that are postulated to affect pain generation at the spinal level [47].

The efficacy of the ACB in comparison to IASLI was not statistically significant at 3 months, likely due to the presence of more knee pain generators in the ACB group: suprapatellar effusion, medial radial displacement of the medial meniscus, reactive Hoffa's fat pad, and Baker's cyst [48]. The majority of knees in both groups exhibited severe KOA (KL grade stage 4), and thus some degree of central sensitisation of the central nervous system was thought to be well established, resulting in a non-sustained analgesic effect, especially that of IASLI. Baseline KOOS QoL scores for both groups were low (a mean of 31.78 in the IASLI group and 32.28 in the ACB group), hence any improvement in scores was not statistically significant, as QoL was already significantly affected from the beginning. Other factors limiting QoL and function, such as range of movement limitation due to bony deformity and joint stiffness, were not accounted for. This study was limited by the movement control order imposed by the local authorities in the wake of COVID-19, disrupting the recruitment process, and causing hesitancy for current subjects to attend therapy and follow-up assessments. Therapy was prescribed but adherence was not enforced or standardized. Patients were permitted to continue current analgesia use with no dosage adjustment or standardisation. Recall bias may potentially affect the KOOS questionnaire as patients are required to recall impairments over the past week. Many factors can impact pain, such as psychological and environmental factors, causing heightened pain scores at

follow-up that did not reflect actual NRS pain scores over the 2 weeks prior to follow-up.

Overall, this study had a low drop-out rate (3.0%), an ample follow-up period (3 months) to monitor the therapeutic effect of a single injection, and comparable baseline characteristics (age, sex, body mass index, and KL grade) across both groups compared. We would suggest that future studies control for sonographic knee findings and other personal and environmental factors which can affect QoL.

In conclusion, the ACB has a larger effect size compared to IASLI in anteromedial knee pain control in chronic KOA up to 3 months post intervention. With improved pain relief, the ACB recipients demonstrated a better functional status at 3 months with a moderate effect size, while there was minimal improvement in QoL. The ACB potentially offers a substantial analgesic window for KOA patients to actively participate in therapy, thus potentially improving the symptoms and functional outcomes of KOA.

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