e-ISSN (online): 2745-9497

Journal of Anesthesiology and Clinical Research (JACR)

Journal website: https://hmpublisher.com/index.php/jacr

Morphine Consumption and/or Numerical Scale in Pain Studies: Silverman Integrating Approach (SIA SCORE)

Okba Laouamri[1*]

[1]Aggregate Professor of Anesthesia Resuscitation, Ferhat Abbas University of Setif, Setif, Algeria

ARTICLE INFO

Keywords:
Analgesia technique
Knee ligamentoplasty
Morphine consumption
Pain

***Corresponding author:**
Okba Laouamri

E-mail address:
laokbus@gmail.com

The author has reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/jacr.v5i1.452

A B S T R A C T

Introduction: Ligamentoplasty pain management is dynamic performance, demanding constant vigilance and adaptation. The aim of this prospective study was to compare the analgesic efficacy of three techniques for knee ligamentoplasty using an integration score, the SIA score. **Methods:** The study included 165 patients undergoing primary reconstruction of the anterior cruciate ligament of the knee. The first group, systemic analgesia (SA), received balanced systemic analgesia postoperatively for a minimum of five days, based on Paracetamol, Diclofenac, and a morphine PCA. In addition to the systemic analgesia already described, the second group, femoral analgesia (FA), will benefit from a femoral peri-nervous catheter in the crural position. The third intra-articular analgesia (IAA) group received, in addition to the same systemic analgesia, an infusion through an epidural catheter of 20 ml of 0.125% bupivacaine, followed by maintenance with 8 ml/h of the same local anesthetic via an electric syringe pump for 36 h. Cumulative morphine consumption was assessed, as well as pain at rest, using a numerical scale (EN) from 1 to 10 and an integration of these two parameters. **Results:** Morphine consumption was lower in the AF group. The lowest mean rank was in the AF group, followed by the AIA group, and the difference was statistically significant with an H = 6.89 and a p= 0.032. The difference was significant between the AS group and the AF group (p = 0.09); the other inter-group differences were not significant. 23.2% of patients had an AIS score between [-100, -200], and were in little pain and consumed little morphine (effective treatment); 14.2% of patients had an AIS score between [100, 200] and were in great pain and consumed a lot of morphine (morphine-resistant or very sensitive to pain). **Conclusion:** Analgesia in the femoral peri-nerve group was more effective, with a reduction in mean EN compared with the other two groups.

1. Introduction

The pain in knee ligamentoplasty is a complex concerto, each note played by a different instrument. Tissue injury, inflammation, and nerve irritation form the percussion section, while capsular stretch and joint mobilization add their melodic twang. The challenge, as pain conductors, lies in identifying the dominant themes and crafting an analgesic symphony that silences the cacophony and allows the healing crescendo to flourish. Multimodal analgesia is the master instrument, a fusion of techniques that harmonize with each other to create a symphony of pain relief. Regional nerve blocks, targeting the nerves supplying the surgical field, become the lead violins, providing targeted and potent analgesia. Non-opioid medications, like NSAIDs and gabapentin, join as the cellos, offering broad-spectrum pain relief while minimizing the risks of opioid dependence. Physical modalities, like ice and cryotherapy, add their percussive rhythm, aiding in inflammation control.[1]

The melody of innovation is constantly evolving. Ultrasound-guided blocks, with their pinpoint accuracy, are replacing the traditional landmarks, while new analgesic agents, like liposomal

bupivacaine, offer extended durations of pain relief. Research is exploring the potential of personalized medicine, tailoring the analgesic symphony to individual genetic and pain profiles. However, the score is not without its discords. Regional block failures, medication side effects, and incomplete pain control remain challenges we must address. Continuous monitoring and patient communication are crucial, allowing us to fine-tune the analgesic symphony and adjust the volume and tempo as needed. Knee ligamentoplasty pain management is dynamic performance, demanding constant vigilance and adaptation. By embracing multimodal analgesia, staying tuned to the latest advancements, and prioritizing patient communication, we can orchestrate a harmonious recovery, ensuring that the postoperative symphony plays a tune of comfort and progress, not of pain and despair.[1,2] In a comparative study of three analgesic techniques for treating the anterior cruciate ligament of the knee, morphine consumption and the numerical scale were the criteria for judging analgesic effectiveness. The use of self-controlled morphine can identify two subgroups of patients that can hinder the precision of the comparative study: a subgroup of patients resistant to morphine and a subgroup of patients who consume morphine for purposes other than pain.

2. Methods

This was a prospective, comparative, randomized, single-center study conducted over three years in the orthopedics and traumatology unit of the Sétif Hospital in Algeria. A total of 165 cases were included, divided into three study groups by drawing lots. Inclusion criteria were consenting patients and admitted for anterior cruciate ligament rupture. All patients were under spinal anesthesia. 1st group (AS): patients receiving systemically balanced analgesia (paracetamol + diclofenac + PCA morphine). The 2nd group (AF): patients receiving, in addition to paracetamol, Diclofenac, and PCA morphine, continuous femoral peri-nerve analgesia. The 3rd group (AIA): patients receiving, in addition to paracetamol, diclofenac, and morphine PCA, continuous intra-articular analgesia.

In the immediate postoperative period and until catheter removal, by the following judgment criteria: quantitative: cumulative morphine consumption, qualitative: estimation of pain at rest and on mobilization using a numerical scale (EN) from 1 to 10. Data will be collected on a data sheet at h2, h4, h6, h8, h12, h16, h20, h24, h28, and h36. (T0: injection of local anesthetic for both the AF and AIA groups and the patient's installation at the post-operative level for the AS group). Statistical approach to data integration of pain scores and morphine consumption: Silverman integrating approach (SIA). This approach consists of ranking the pain scores and morphine consumption, then calculating the sum and difference of the percentages of the ranks of each parameter so that they are statistically interpretable.

3. Results

The average age was identical for all three groups, at around 30 years (ANOVA: F = 0.335, p = 0.716) (Table 1). The study noted that the difference was not significant between the two genders in the three groups (Chi2 = 0.512, p = 0.774). The AF and AIA groups each had 3 cases of ASA 2, compared with only 01 in the AS group, but the difference was not statistically significant, with a Chi-square = 1.193, p = 0.551.

Table 1. Demographic data by study group.

Groups	Total (N = 165)	Systemic balanced analgesia (n=55)	Femoral peri-nerve (n=55)	Continuous intra-articular (n=55)	P
Age	30,00 ± 7,30	29.36 ± 6.745	30.16 ± 7.932	30.47 ± 7.280	0.716
Gender					0,774
Male	(161) 97,6%	33,5% (54)	32,9% (53)	33,5% (54)	
Female	(04) 2,4%	25% (01)	50% (02)	25% (01)	
ASA					0,551
ASA 1	(158) 95,8%	(54)	(52)	(52)	
ASA 2	(07) 4,2%	(01)	(03)	(03)	

Postoperative pain assessment at rest, using a numerical scale from 0 to 10, was collected repeatedly from the second hour to the fifth day. From H2 to D5 post-operatively, the means with standard deviations for EN are summarized in Table 2.

Table 2. Means with standard deviations of EN at rest by the group.

	Total	**AS Group**	**AF Group**	**AIA Group**	**p**
H2	0,72(1,66)	0,67(1,41)	1,08(2,31)	0,44(0,99)	NS
H4	2,19(2,10)	2,45(2,21)	1,65(1,89)	2,42(2,12)	NS 0.084
H6	3,52(2,32)	3,50(2,39)	3,12(2,38)	3,91(2,16)	NS
H8	3,54(2,49)	3,52(2,47)	3,16(2,39)	3,91(2,59)	NS
H12	2,29(2,26)	2,58(2,36)	2,27(2,35)	2,04(2,26)	NS
H16	1,63(1,92)	1,98(2,11)	1,49(1,95)	1,42(1,68)	NS
H20	1,38(1,79)	1,60(1,79)	1,18(1,64)	1,35(1,93)	NS
H24	1,11(1,55)	1,49(1,64)	0,69(1,30)	1,11(1,59)	0,034
H28	0,90(1,36)	1,24(1,52)	0,59(1,08)	0,85(1,36)	NS 0.063
H36	0,80(1,56)	1,26(2,04)	0,46(1,22)	0,61(1,13)	0,03
J2	0,87(1,43)	1,06(1,53)	0,75(1,41)	0,78(1,36)	NS
J3	0,61(1,29)	0,62(0,86)	0,45(1,13)	0,72(1,72)	NS
J4	0,57(1,38)	0,60(1,25)	0,20(0,56)	0,84(1,85)	NS
J5	0,57(1,48)	0,69(1,36)	0,41(1,33)	0,58(1,72)	NS

Consumption was lower in the AF (femoral peri-nerve) group, and the difference was statistically significant with an F = 3.539(2) and a p = 0.031. The post-hoc test shows a difference in mean of 6.12 ± 2.41 between the AS and AF groups with a significant p = 0.012, a difference in mean of 1.67 ± 2.41 with a non-significant p = 0.49 between the AF and AIA groups and a difference in mean of 4.45 ± 2.31 with a p = 0.056 at the limit of significance between the AS and AIA groups (Table 3).

Table 3. Comparative averages of morphine consumption as a function of time.

	AS Group		**AF Group**		**AIA Group**		**P**
	Average	**Standard deviation**	**Average**	**Standard deviation**	**Average**	**Standard deviation**	
H2	0,57	1,52	0,61	1,18	0,2	0,55	0,134
H4	2,12	2,78	1,5	2,49	1,4	1,91	0,243
H6	2,74	2,51	2,37	2,82	2,30	2,87	0,681
H8	2,86	2,84	1,60	2,04	2,66	2,59	0,041
H12	3,77	5,12	2,20	2,88	2,84	3,60	0,165
H16	2,41	3,10	1,45	1,83	1,32	1,62	0,037
H20	1,60	2,69	1,63	3,53	0,96	1,83	0,372
H24	1,02	1,60	0,72	1,51	0,84	2,13	0,735
H28	0,69	1,19	0,74	1,42	1,22	3,08	0,409
H36	1,57	3,71	0,48	0,88	0,73	1,11	0,088

For the SIA score (sum), patients in the range [100, 200] have more pain despite the use of more morphine; this is morphine resistance or very high pain sensitivity. Patients in the [-200, -100] range have less pain for less morphine consumption. As for the difference, patients in the [-200, -100] range have little pain, consume a lot of morphine, and are referred to as drug-prone. Patients in the [100, 200] range are very painful, consume little morphine, and are morphine-intolerant (Figure 1).

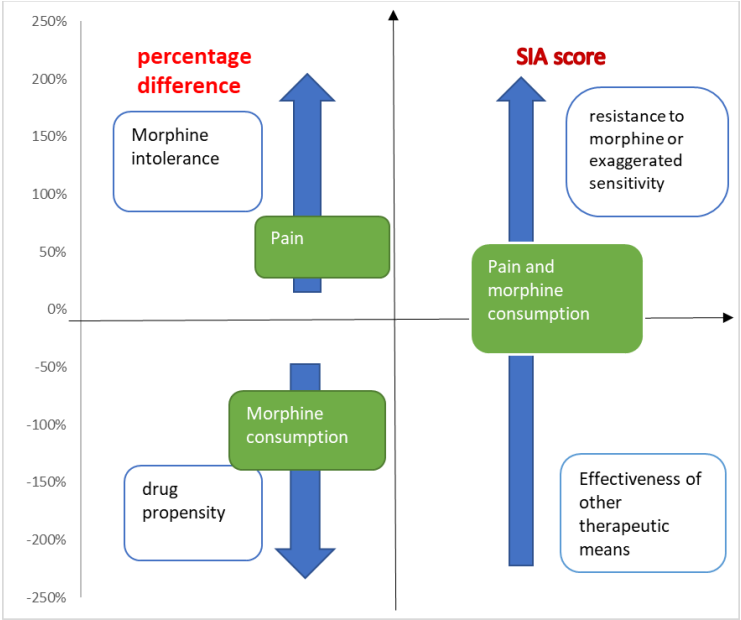

Figure 1. SIA score interpretation diagram.

23.2% of patients had an AIS score between [-100, -200], and were in little pain, and consumed little morphine (effective treatment), including 38.9% in the AIA group but without statistical significance; 14.2% of patients had an AIS between [100, 200] and were very painful and consumed a lot of morphine (morphine-resistant or very sensitive to pain), including 50% in the AS group. But the difference was not significant with a Chi-2 = 5.63 and a p = 0.228 (Figure 2).

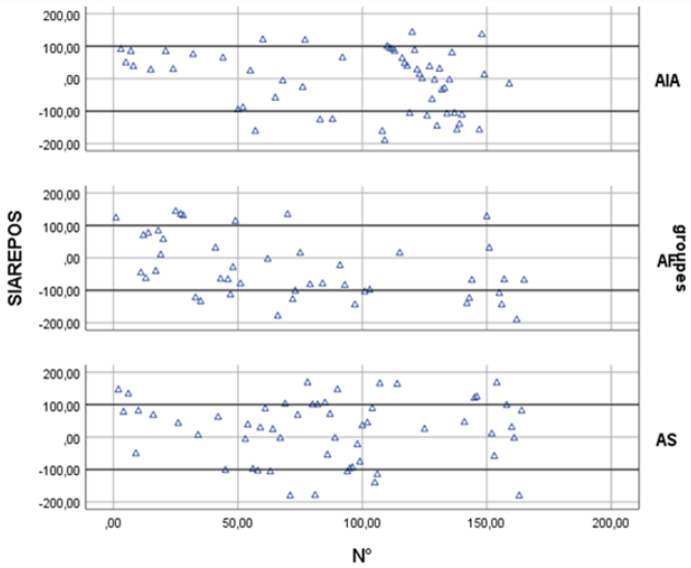

Figure 2: SIA score at rest.

For the difference (ranked pain score - ranked morphine), 4.5% of cases had values between [-100, -200] and were therefore not very painful but consumed a lot of morphine (propensity), 42.9% (03 cases/07) of which were in the AF group, but the difference was not significant; While 3.9% had values between [100, 200] and were therefore very painful but consumed little morphine (intolerant), 66.7% (4 cases/6) were in the AIA group and the difference was not significant with a chi-square = 4.67, p = 0.323 (Figure 3).

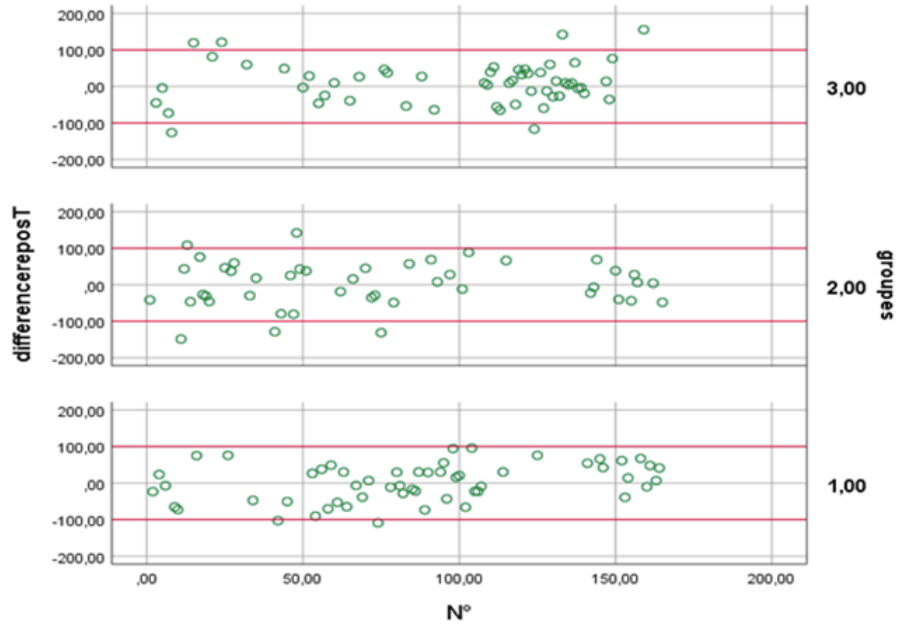

Figure 3: Differences in pain scores and morphine consumption.

Comparison of the global SIA score at rest on a Mann-Whitney test had found a mean rank of 77.32 in males and 112.67 in females, but the difference was not significant, with a U = 124.00 and a P = 0.177. The under-30s had a mean rank of 88.09 vs 62.03 for the over-30s at rest, and the difference was statistically significant, with a p < 0.0001. The WMWodds = 0.32 ± 1.10. The median global AIS score at rest was 8.43 (Table 4).

Table 4. Characteristics of the global AIS score at rest.

N	Average	Standard deviation	Min	Max	Percentiles		
					25e	50th (median)	75e
155	-5,35	96,86	-190,96	166,86	-97,58	8,43	78,90

On a Kruskal-Wallis test, the lowest mean rank was in the AF group, followed by the AIA group, and the difference was statistically significant with an H = 6.89 and a p = 0.032. The median test found a Chi-2 = 7.35 and a p = 0.025. On a post-hoc test, the difference was significant between the AS group and the AF group (p = 0.09). Other inter-group differences were not significant (Figure 4). The difference between the AS and AIA groups was not significant, p = 0.192. The difference was not significant between the AF group and the AIA group p = 0.195.

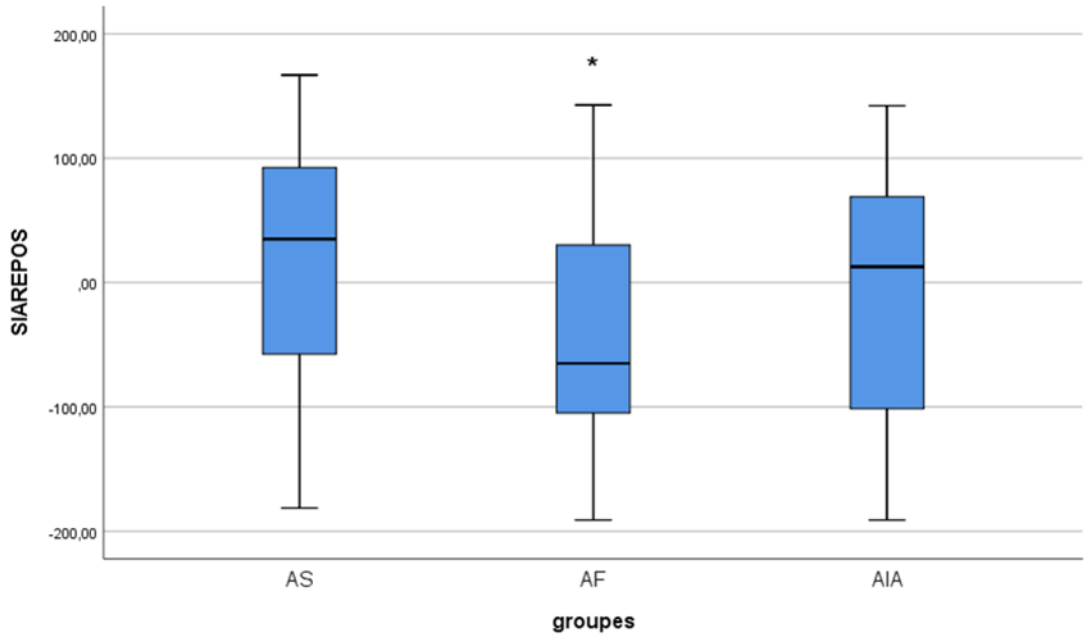

Figure 4: Difference in overall resting averages for rows by group.
(*): p < 0.05 between AS and AF groups.

4. Discussion

Overall, the very good effectiveness of the compared analgesic techniques was observed in 23.2% of cases and was better in the AIA than the AF group but without statistical significance. Depending on the kinetics of pain and morphine consumption at the time of peaks (H8 -H12), the effectiveness of FA was better. In this vision, the perfect effectiveness of the ALR cannot be affirmed. An improvement in practices, with fewer incidents in the AF group, a source of secondary failures, and the addition of infiltration of the surgical site and molecules potentiating the effect of local anesthetics in the AIA group could perhaps give a significant difference in favor of the ALR techniques introduced. 14.2% of patients were resistant to morphine or had increased sensitivity to pain. This resistance is more observed in the AS group, the group that had consumed the most morphine overall. We believe we are dealing with patients who present tolerance and secondary hyperalgesia following previous use of opioids (codeine type), or who present disafferentation pain which naturally resists opioids. There are even acute post-operative tolerances to opioids described in the literature.[3-5]

In Chelly's study[6], taken as an example to detail Silverman's approach to integrating pain scores and morphine consumption[1], the calculated fraction of patients resistant to morphine was 13.46%. The propensity concerned 4.5% of cases overall. With young age, the two parameters can explain the high consumption of morphine in our study among those under 30 years old. But despite this propensity rate, age remains a predictive factor of morphine consumption and increased pain with a 32% degree of evidence.[7] Another factor may explain the high morphine consumption despite the mild pain; this is the use of PCA for anxiolysis and mood described in Taenzer's studies[8] and Robert[9] where they found a strong correlation between morphine consumption and the degree of anxiety and mood compared to a weak correlation between morphine consumption and the degree of pain. In Chelly's study, the calculated fraction of patients with a propensity for morphine was 9.61%. Intolerance concerned 3.9% of cases and may be correlated with the side effects of morphine, a source of reluctance to self-inject. For the Chelly study, the calculated intolerance was 5.76%. In an international cohort study on the side effects of opioids used for the treatment of acute pain in the emergency department[10], the authors reported a 25% rate of side effects, and 4.7% of the cohort required suspension of treatment defining intolerance.

Overall, the femoral peri-nerve was better in terms of analgesia and opioid-sparing, followed by intra-articular analgesia. The difference is significant between the AF and the AS, and it is not significant between the other comparisons. This difference is only significant at H12, where the statistical tests show the superiority of FA over the other two techniques; the difference between the AIA and the AS is not significant. These results agree with those of several studies already debated, and it is believed that our AIA, as practiced, is insufficient to cover the pain of ligamentoplasty.

5. Conclusion

Analgesia in the femoral peri-nerve group was more effective, with a reduction in mean EN compared with the other two groups.

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