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Original Research Articles

Correlation of Lumbar Medial Branch Neurotomy Results with Diagnostic Medial Branch Block Cutoff Values to Optimize Therapeutic Outcome

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Key Point:
Double diagnostic medial branch block (MBB) blocks better predict favorable medial branch neurotomy (MBN) outcomes compared with single MBB. Patient reported pain relief post-MBB using a 70% cutoff value for a double block protocol and an 80% for a single block protocol pain relief post-MBB best predicted favorable overall outcome following MBN.

Abstract

Objective. We sought an optimal medial branch block (MBB) cutoff value for both single and double MBB protocols that would best correlate with a positive outcome of medial branch neurotomy (MBN).

Outcome Measures. We analyzed the percentage of subjective pain relief following MBB, confirmed by numerical rating scale (NRS) in aggravating positions before and 45 minutes after MBB. The percentage of overall pain relief following MBB was plotted against the following outcome variables: degree of subjective pain relief, duration of relief, patient satisfaction and activity level, no other doctor's visits, and reduction in medications use.

Results. Using the percent of pain relief post-MBB plotted in 10% increments in the double-MBB group, patients reporting 70% or greater pain relief following MBB showed statistically favorable outcome for the following four criteria: percentage of pain relief, duration of relief, patient satisfaction, and pain medications reduction. In the single MBB group, patients reporting 80% or greater pain relief following MBB had favorable outcomes for improvement in activity level and patient satisfaction.

Conclusions. The double MBB protocol better correlated with favorable MBN outcomes compared with a single MBB protocol. Using a double MBB protocol, a 70% cutoff value for reported subjective pain relief post-MBB best predicted overall outcome following MBN. Without a confirmatory MBB, an 80% cutoff value was the optimal value.

Key Words. Zygapophyseal Joint; Low Back Pain; Chronic Pain; Facet Joint; Radiofrequency; Medial Branch; Medial Branch Neurotomy; Medial Branch Block

Introduction

If one uses controlled diagnostic medial branch blocks (MBB) as the criterion standard to diagnose lumbar Z-joint pain, the prevalence of lumbar Z-joint related pain ranges from ~15% [1] in a younger population complaining of chronic low back pain to ~40% in an older population [2]. Acceptance of the MBB criterion standard has contributed to increased diagnosis of Z-joint pain and has contributed to Z-joint interventions becoming the second most commonly performed pain management procedures in the United States, ranking just behind epidural steroid injection [3]. Despite the general acceptance of Z-joints as a common source of pain, controversy regarding whether

or not diagnostic MBB injections should be authorized is caused by the high occurrence of false-positive rate reported between 25% [4] and 41% [5,6] following a single MBB, later negated by a negative confirmatory injection.

Even though the diagnosis of pain traveling via the lumbar medial branches may be better defended using a double-block protocol with 80% subjective reported relief [7–9], debate continues regarding the need for a confirmatory block and the exact cutoff subjective pain relief that will maximize the positive predictive value of MBN and will minimize the exclusion of patients that may benefit from MBN. Cohen et al. [10] retrospectively compared the success of lumbar Z-joint radiofrequency denervation of patients reporting 50% or greater subjective relief of pain following diagnostic MBB(s) to those reporting 80% or greater subjective pain relief. Their success rate, determined by 50% or greater pain relief following medial branch neurotomy (MBN), was 52% in the group with greater than 50% relief compared with an increase of only 6–56% in the group with greater than 80% relief. The authors concluded that an 80% cutoff value did not improve success rates and may lead to misdiagnosis and withholding a potentially valuable treatment from good candidates.

Our study sought to confirm or refute the need for a confirmatory diagnostic MBB and sought the optimum cutoff value for reported subjective relief following MBB that best predicts favorable MBN results and minimizes elimination of patients that would potentially benefit from MBN. We also sought data that would help us weight the risk–benefit ratio of offering MBN following a single MBB compared with a confirmatory double MBB. To both ends, we evaluated our MBN results based on either one or two block protocol and stratified results from 50% to 100% subjective MBB reported pain relief in 10% increments. MBN outcome is correlated with the degree of subjective pain relief, duration of relief, patient satisfaction and activity level, no other doctor's visits, and reduction in medications use.

Materials and Methods

We retrospectively analyzed data routinely collected per our institutional standardized protocols combined with prospective audit data collected by telephone interviews of study patients. Data were collected from charts of 211 consecutive patients that had undergone diagnostic MBB from August 2009 to September 2010. A research specialist stratified the patients without looking at outcome with the instructions to include patients with chronic and debilitating low back pain with or without proximal non-radicular extremity pain of greater than 6-month duration, a clinical diagnosis of a lumbar facet syndrome, and pain unresponsive to conservative treatment including medical management, physical therapy, and previous interventions, who underwent one or more diagnostic MBB performed on a separate session from MBN. The diagnosis of lumbar facet syndrome was typically made by the senior author when the patient had two or more of the symptoms consistent with posterior element pain including local tenderness over one or more facet joints, back pain aggravation by extension and rotation, morning stiffness or pain worse in the morning and improving with movement, and no other obvious cause for chronic back pain. Exclusion criteria included patients undergoing treatment for other sources of pain (10 patients), such as concomitant radiculopathy due to a disc herniation or stenosis, or buttock pain due to the sacroiliac (SI) joint pathology.

MBB/Dorsal Ramus Block

Diagnostic MBBs were performed in a surgical suite of an ambulatory surgical center. Prior to the procedure, all patients were tested by an independent observer in a variety of loading positions and aggravating movements. Visual analogue scale scores were recorded during patient movements including flexion, extension, side bending and with activities including sitting, standing, and walking. Injection technique involved fluoroscopic guidance using anterior–posterior, and oblique fluoroscopic views, when a 25 gauge 3.5-inch spinal needle was advanced to the junction of the transverse process and superior articular process (SAP) at each lumber level above L5, and to the junction of the SAP and sacrum to anesthetize the L5 dorsal ramus. At each level, 0.2–0.3 mL of either 0.5% or 0.75% bupivicaine was injected at a minimum of three separate locations along the course of the targeted medial branch or dorsal ramus of L5. The patients were again tested by an independent observer 45–60 minutes following the block and in more recent cases were also retested 1–2 hours after the procedure, including self-testing outside of the surgical suite. The patients would record their responses over the rest of the day and for several days following the block, using a pain diary. Typically, the patients would be seen in follow-up in 2–3 weeks to discuss results of the MBB.

MBN

Patients were offered MBN if they reported 50% or greater subjective relief of pain for minimum of 2 hours of duration. The patients with less than 70% relief, however, were a minority. Confirmatory injections were not done for patients if they had workers' compensation (WC) insurance, as they are disallowed by California Workers Compensation, and in some cases for patients who did not want a second confirmatory MBB procedure.

MBN were also performed in the surgical suite of an ambulatory surgical center, under a fluoroscopic guidance. Lesions were performed at each level using 18-gauge Teflon-coated (NeuroTherm, Wilmington, MA, USA) radiofrequency (RF) needles with a 1 cm exposed tip placed parallel to the medial branch (or dorsal ramus) above the intertransverse ligament and slightly above the junction of the transverse process (or sacrum) and the superior articular process. RF current was applied for 90 seconds at 85 degrees Celsius. In a few early MBN procedures, we performed RF using a single lesion at each

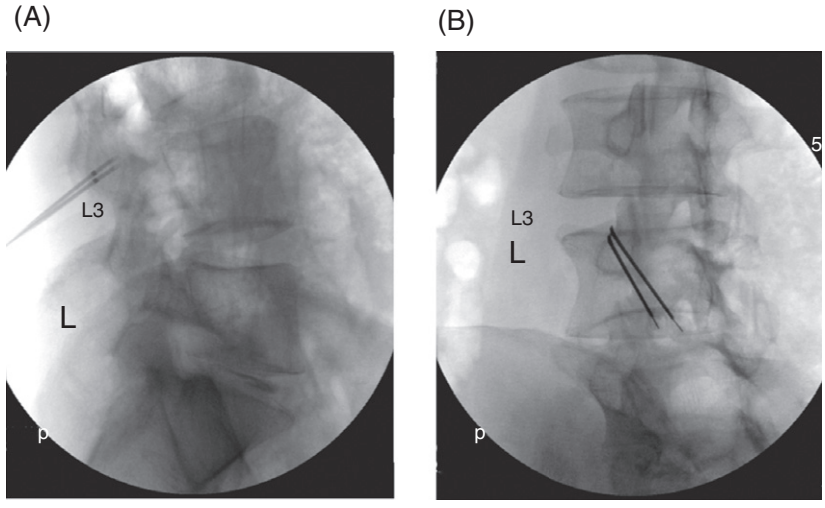


Figure 1 Example of a typical medial branch neurotomy using a bipolar technique with two 18-gauge needle with a 1-cm exposed tip. (A) Lateral view; (B) oblique view.

level, but in most procedures, two or more lesions were made at each level using a unipolar, bipolar (Figure 1), or both techniques.

Outcome Measures and Follow-Up

Outcome results of a therapeutic MBN procedure were assessed at a scheduled 6-week follow-up visit, and later on, patients were contacted by phone. The phone interview was done by a person unknown to the patient. Follow-up outcome measures included percent of subjective total relief, duration of pain relief, medication reduction, percent of daily activity improvement, no other doctor's visits for this pain (yes/no), and patient satisfaction. Our positive MBN outcome criteria included:

1. ≥50% of subjective pain relief;
2. duration of pain relief ≥6 months;
3. positive patients' satisfaction;
4. ≥50% of improvement in activity level;
5. no other doctor's visits; and
6. reduction in pain medications use.

A positive patients' satisfaction was predefined as an affirmative response (1 or 2) to the following four options: 1) the treatment met my expectations; 2) I did not improve as much as I had hoped, but I would undergo the same treatment for the same outcome; 3) the treatment helped, but I would not undergo the same procedure for the same outcome; and 4) I am the same or worse than before the treatment.

Statistical Analysis

All statistical analyses were performed with the Statistical Package for the Social Sciences/PC+ software (SPSS Inc., Chicago, IL, USA). To compare baseline demographic and follow-up data between single-block paradigm group and double-block paradigm group, the independent t-test for continuous data, and Pearson chi-square and Fisher's exact tests for categorical data were evaluated. To find out optimal "cutoff" value, Pearson chi-square and Fisher's exact tests were evaluated comparing different subgroups within each single- and double-block group (i.e., comparing patients with ≥50% of pain relief after MBN among different MBB subgroups including those who had less than 70% pain relief after diagnostic MBB vs patients who reported more than 70% of pain relief). Statistical testing was performed at a pre-set alpha of 0.05.

Results

Demographic

Two hundred eleven consecutive patients underwent diagnostic MBBs. Of those patients, 111 (53%) reported 50% or greater pain relief following first MBB. Forty of those patients underwent second confirmatory block, with 23 patients reporting a positive response of more than 50% of temporary pain relief. Forty-three patients among a "positive single-block group" (71 patients) underwent therapeutic MBN procedure. Fourteen patients among a "positive double-block group" (23 patients) underwent MBN. Thirty-three patients in a single-block group and 10 patients in a double-block group had positive response, but they did not proceed with a MBN treatment for various reasons, including declining or not being offered the treatment procedure or refusing to follow up or failing to be reached (Figure 2).

Demographic and clinical characteristics of the patients are presented in Table 1. Our protocol included baseline patient information such as age, gender, duration of symptoms, use of narcotics, number of levels treated, laterality, previous surgery, 0–100 numerical rating scale (NRS) pain scores for low back and leg pain, tolerance of sitting, standing, walking, lying down, the distress and risk assessment method (DRAM) score, and worker's compensation. The average age of the two groups was 58.2 ± 12.5 years (range 27–86), and males accounted for half of the people in each group. The average duration

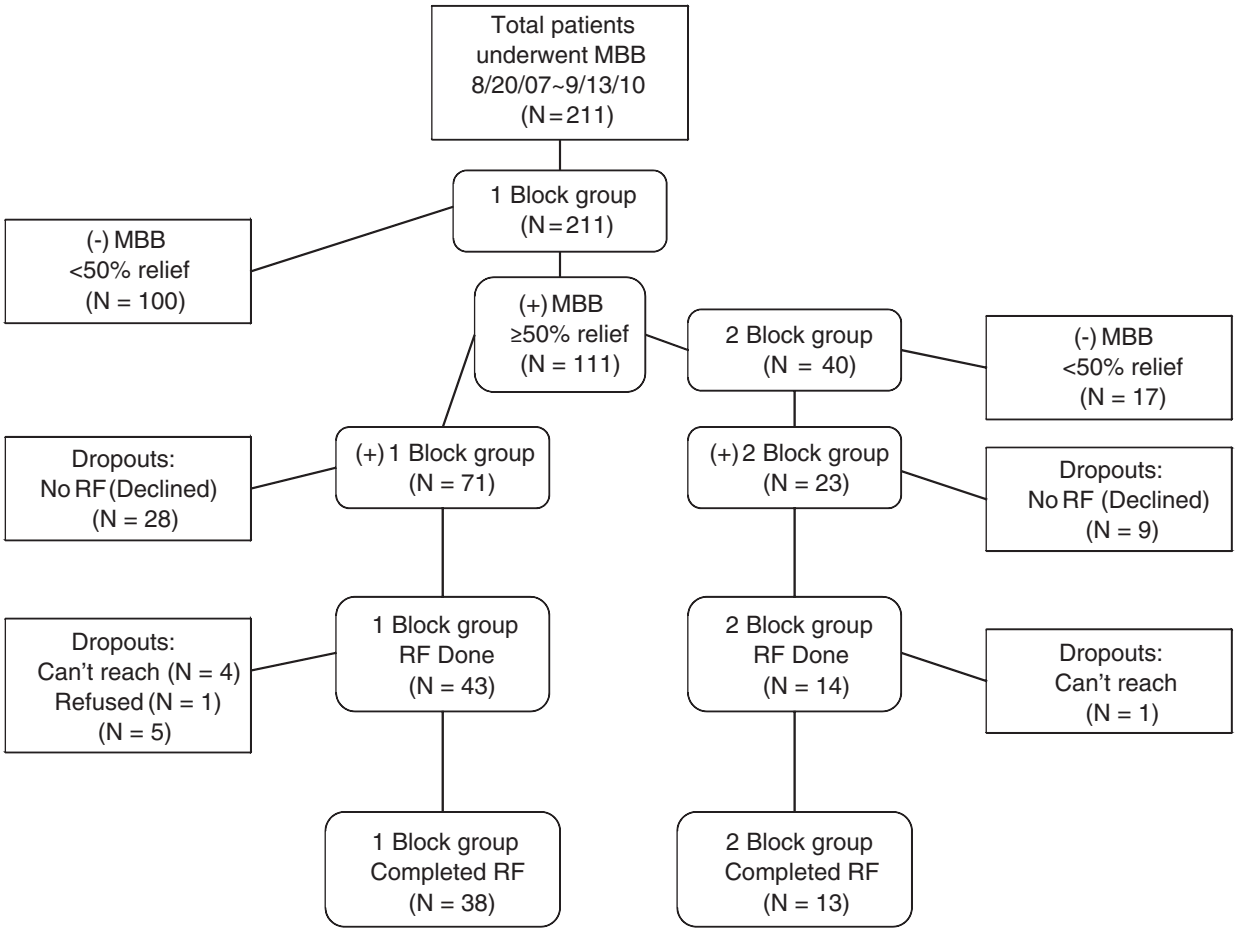


Figure 2 Flow chart showing progression of subjects in each study group.

of symptoms was 10.2 ± 11.1 years (range 0.2–46) with an average of 47% of patients requiring daily narcotics use. The mean pain NRS was 75% for the low back and 22% for the leg with no statistical difference between the single- and the double-block group. The mean tolerance for sitting, standing, walking, and lying down ranged from 26 to 55 minutes in both groups. An average of 65% of the patients among two groups had normal psychological score (1/4 DRAM score), 35% of patients were in an "at-risk" category (2/4 DRAM). An average of 45% of patients among both groups was covered by workman's compensation insurance. There was no significant statistical difference between the two groups in neither demographic nor clinical characteristics.

Results of Single- and Double-Block Groups

The results of MBN of each group are presented in Table 2. Twenty-four of 38 patients (63.2%) in the single-block group reported ≥50% subjective pain relief with a mean relief of 76.7%. In the double-block group, 11/13 patients (84.6%) reported ≥50% subjective pain relief with a mean relief of 71.1% ($P = 0.185$). Eighteen of 38 patients (47.4%) in the single-block group reported ≥6 month pain relief with a mean duration of relief of 9.9 months. In the double-block group, 10 of 13 patients (76.9%) reported ≥6 months pain relief with the mean duration of relief of 9.8 months ($P = 0.106$). Twenty-one of 38 patients (55.3%) in the single-block group reported ≥3 month pain relief with a mean duration of relief of 9.1 months. In the double-block group, 11 of 13 patients (84.6%) reported ≥3 months pain relief with the mean duration of relief of 9.3 months ($P = 0.096$). The percentage of patients who were able to reduce or discontinue pain medications was 61.3% in the single-block group and 75% in the double-block group ($P = 0.492$). The percentage of patients who improved daily activity by over 50% of their pre-procedure level was 56.8% in the single-block group and 50% in the double-block group ($P = 0.683$). About 70% of patients in each group no longer visited a doctor because of their pain ($P = 1.000$). Positive patients' satisfaction on each group was 63.6% in the single-block group and 77% in the double-block group ($P = 0.407$).

Table 1 Demographic and clinical characteristics of study patients who were included in the follow-up analysis

	Single Block	Double Block	*P* value
Age (years)	58.4 ± 13.1	57.5 ± 10.9	0.829
Gender			
Male (%)	44.7%	46.2%	0.929
Female (%)	55.3%	52.8%	
Duration of symptoms (years)	8.1 ± 10.1	16.0 ± 12.3	0.052
Narcotic use			
None	30.0%	11.1%	0.790
Occasional non-narcotic	5.0%	11.1%	
Daily non-narcotic	5.0%	11.1%	
Occasional narcotic	10.0%	22.2%	
Daily narcotic	50.0%	44.4%	
Number of levels treated			
Total	5.3 ± 2.0	4.4 ± 2.4	0.188
Unilateral	3.6 ± 0.5	3.5 ± 1.2	0.676
Laterality			
Unilateral	50.0%	69.2%	0.336
Bilateral	50.0%	30.8%	
Previous surgery (%)	9.7%	27.3%	0.314
Baseline NRS pain of low back	77.1 ± 19.9	73.1 ± 18.4	0.530
Baseline NRS pain of leg pain	21.2 ± 19.5	22.7 ± 16.8	0.819
Baseline sitting tolerance (minute)	38.9 ± 35.2	31.8 ± 16.0	0.617
Baseline standing tolerance (minute)	26.9 ± 19.4	26.0 ± 20.7	0.919
Baseline walking tolerance (minute)	31.6 ± 16.2	42.0 ± 24.9	0.282
Baseline lie down tolerance (minute)	55.4 ± 56.9	43.3 ± 17.6	0.391
Psychological score (DRAM)			
Normal	58.8%	71.4%	0.669
At risk	41.2%	28.6%	
Distressed depressive	0%	0%	
Distressed somatic	0%	0%	
WC			
Yes (%)	43.2%	46.2%	0.856
No (%)	56.8%	53.8%	
Motor vehicle accident			
Yes (%)	10.5%	15.4%	0.639
No (%)	89.5%	84.6%	
Litigation			
Yes (%)	18.4%	7.7%	0.359
No (%)	81.6%	92.3	

NRS = numerical rating scale; DRAM = distress and risk assessment method.

Correlation of Incremental Percent of Pain Relief Following MBB and MBN Outcomes

Incremental correlation of the degree of pain relief following a single or a double MBB was plotted in 10% increments against the outcome results following therapeutic MBN (Tables 3–10).

In the single-block group, at the ≥80% MBB cutoff value, we found a statistically significant difference in two of six criteria, including "patient satisfaction" ($P = 0.014$) and improvement in the patients' activity level above 50% as compared with their pre-procedure level ($P = 0.008$).

At the ≥80% cutoff value, 57.9% (11/19) of patients reported 50% or greater pain relief for ≥6 months of duration, with an average of 10.7 months (Tables 3 and 4).

At the ≥90% cutoff value in a single MBB group, we found a statistically significant difference for one out of six criteria of improvement in the patients' activity level ($P = 0.048$). At the same ≥90% cutoff value, 64.3% (9/14) of patients reported 50% or greater pain relief for ≥6 months of duration, with an average of 11.1 months (Tables 3 and 4).

In the double-block group, at the ≥70% MBB cutoff value, we found a statistically significant difference in four of six

Table 2 The results of two treatment groups

	Single Block (N = 38)	Double Block (N = 13)	*P* value
Number of patient with relief ≥50% following MBN	63.2% (24/38)	84.6% (11/13)	0.185
(Mean relief at ≥50%)	(76.7%)	(71.1%)	
Number of patient with duration of relief ≥6 months following MBN	47.4% (18/38)	76.9% (10/13)	0.106
(Mean duration at ≥6 months)	(9.9 months)	(9.8 months)	
Number of patient with duration of relief ≥3 months following MBN	55.3% (21/38)	84.6% (11/13)	0.096
(Mean duration at ≥3 months)	(9.1 months)	(9.3 months)	
Medication reduction (number of patient) following MBN	61.3% (19/31*+†)	75.0% (9/12‡)	0.492
Number of patient with daily activity improvement ≥50% following MBN	56.8% (21/37§)	50.0% (6/12¶)	0.683
No other doctor's visit for this pain following MBN	69.7% (23/33*)	75.0% (9/12¶)	1.000
Satisfaction (number of patient) following MBN			0.407
1. The treatment met my expectations	51.5% (17/33*)	46.2% (6/13)	
2. I did not improve as much as I had hoped, but I would undergo the same treatment for the same outcome	12.1% (4/33*)	30.8% (4/13)	
3. The treatment helped, but I would not undergo the same procedure for the same outcome	21.2% (7/33*)	7.7% (1/13)	
4. I am the same or worse than before the treatment	15.2% (5/33*)	15.4% (2/13)	

* Five patients had other sources of pain diagnosed post MBN and could not accurately answer the question.
† Two patients did not take pain medication before or after MBN, and therefore the yes no medication question was not answered.
‡ One patient took no medication before or after MBN.
§ One patient did not answer question.
¶ One patient had continued pain on the side opposite the MBN.
MBN, medial branch neurotomy.

criteria, including the percentage of pain relief ($P = 0.013$), duration of relief ($P = 0.013$), patient satisfaction ($P = 0.038$), and pain medications reduction ($P = 0.045$).

At the ≥70% cutoff value in a double-block group, 90.9% (10/11) of patients reported 50% or greater pain relief for ≥6 months of duration, with an average of 9.8 months (Tables 3 and 4).

For the summary of the outcome criteria results for the single and the double-block group, see Tables 9 and 10.

Discussion

Prior studies comparing lumbar MBN outcome based on MBB results either compared two different cutoff values (i.e., 50% vs 80%, 50% vs 100%, and etc) [10–14] or used vague criteria like "clear relief from the diagnostic block" [15], "significant relief" [16], or "complete or profound relief" [17]. Most outcome studies, however, typically used one specific cutoff value for MBB relief to qualify for MBN and did not report MBN results based on a stratification of MBB results. Furthermore, comparison between studies is not always possible because outcome instruments and the requirements to satisfy successful outcome were more or less stringent.

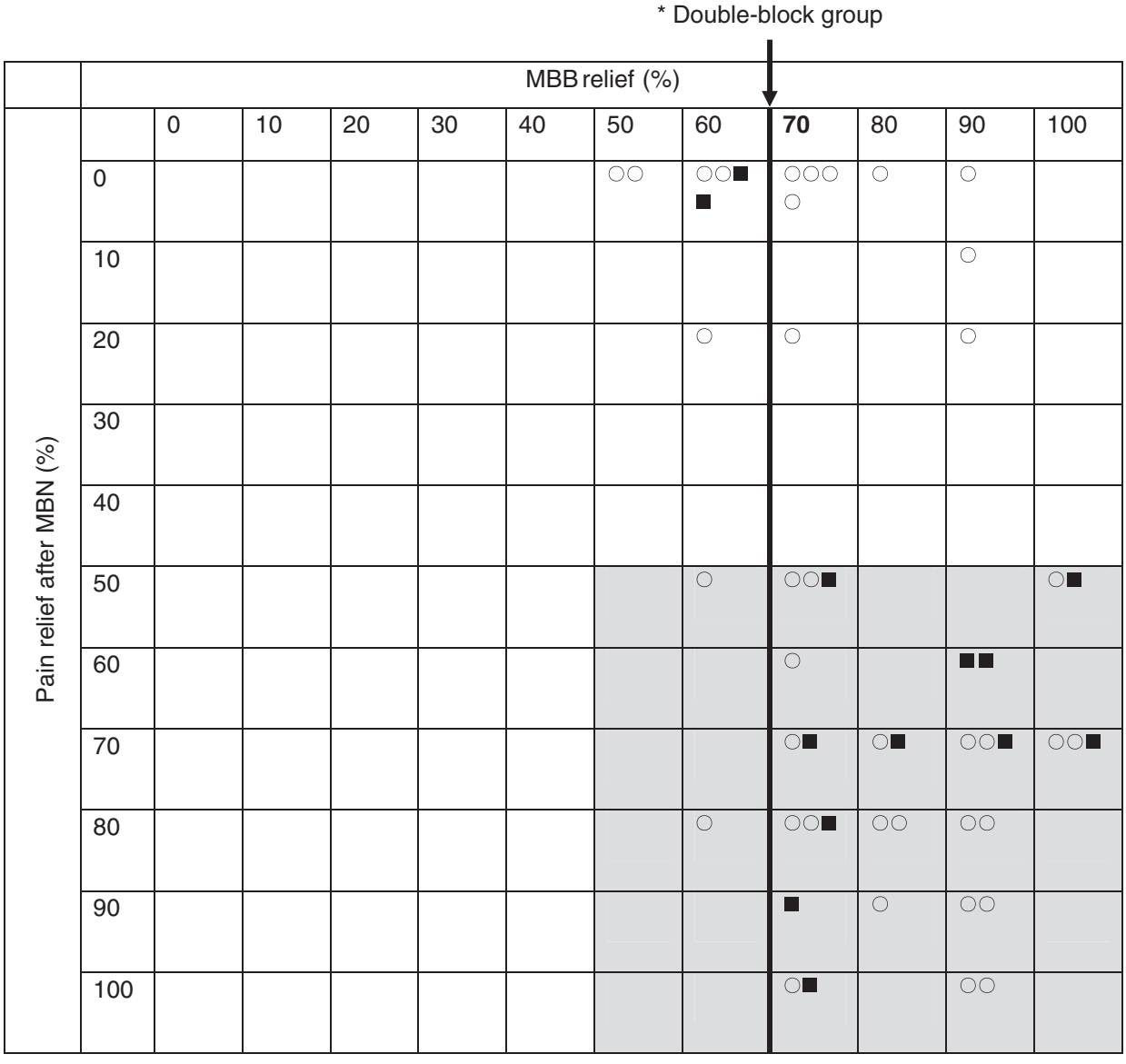
Macvicar and Bogduk [14] required 100% reported index pain relief following controlled MBB to qualify for a MBN and, in addition, required 100% pain relief, restoration of four activities of daily living, no need for further health care, and return to work for a minimum of 6 months to qualify as a successful MBN. Using these strict inclusion and success criteria, 55% of patients achieved a successful outcome for an average of 15 months after the first MBN and 13 months after repeat MBN.

Cohen et al. [10] used a more lenient cutoff value of 50% or greater relief following a single MBB. He opined that a confirmatory MBB was not needed based on a "low" false-positive block rate of 25–40% and the low complication rate of MBN.

However, most prior outcome studies used a double MBB protocol with a 70% or 80% cutoff value. For example, Gofeld et al. in 2007 [18] used an MBB cutoff value of 70% and confirmation of relief on a second MBB session. Using the 70% double-block requirement, he reported good 119 (68.4%) (>50%) to excellent (>80%) pain relief lasting from 6 to 24 months post-MBN. Using an 80% cutoff value, Dreyfuss in 2000 [19] reported that 60% of the patients experienced 90% or greater relief of pain at 12 months. Nath's (2008) randomized control trial [20] also used an 80% double MBB cutoff value and post-MBN he reported statistically significant improvement in back and leg pain as well as back and hip movement compared with the placebo group.

Both Datta et al. and Falco et al. [7,8] used an 80% or greater MBB cutoff value and controlled MBB to exclude studies for systemic reviews of MBN outcomes. Both reviews concluded that uncontrolled MBB were unreliable

Table 3 Correlation of incremental percent of pain relief following MBB and percent of pain relief in patients who had MBN treatment



○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: cut-off value showing statistical significance.

with a false-positive rate ranging from 27% to 63%. Using the double MBB protocol with an 80% subjective pain relief, the authors found multiple studies reporting favorable outcomes following MBN and one following repeat MBN [21–28].

Recently, the 80% cutoff value was indirectly supported as the ideal cutoff by Manchikanti et al. [11] and Pampati et al. [13]. Both studies analyzed data from long-term follow-up evaluation of repeat MBB to confirm the previous MBB. They report that confirmation of prior MBB was best using a double-block protocol with an 80% cutoff value compared with a single block with 80% relief, single block with 50% relief, or double blocks with 50% relief.

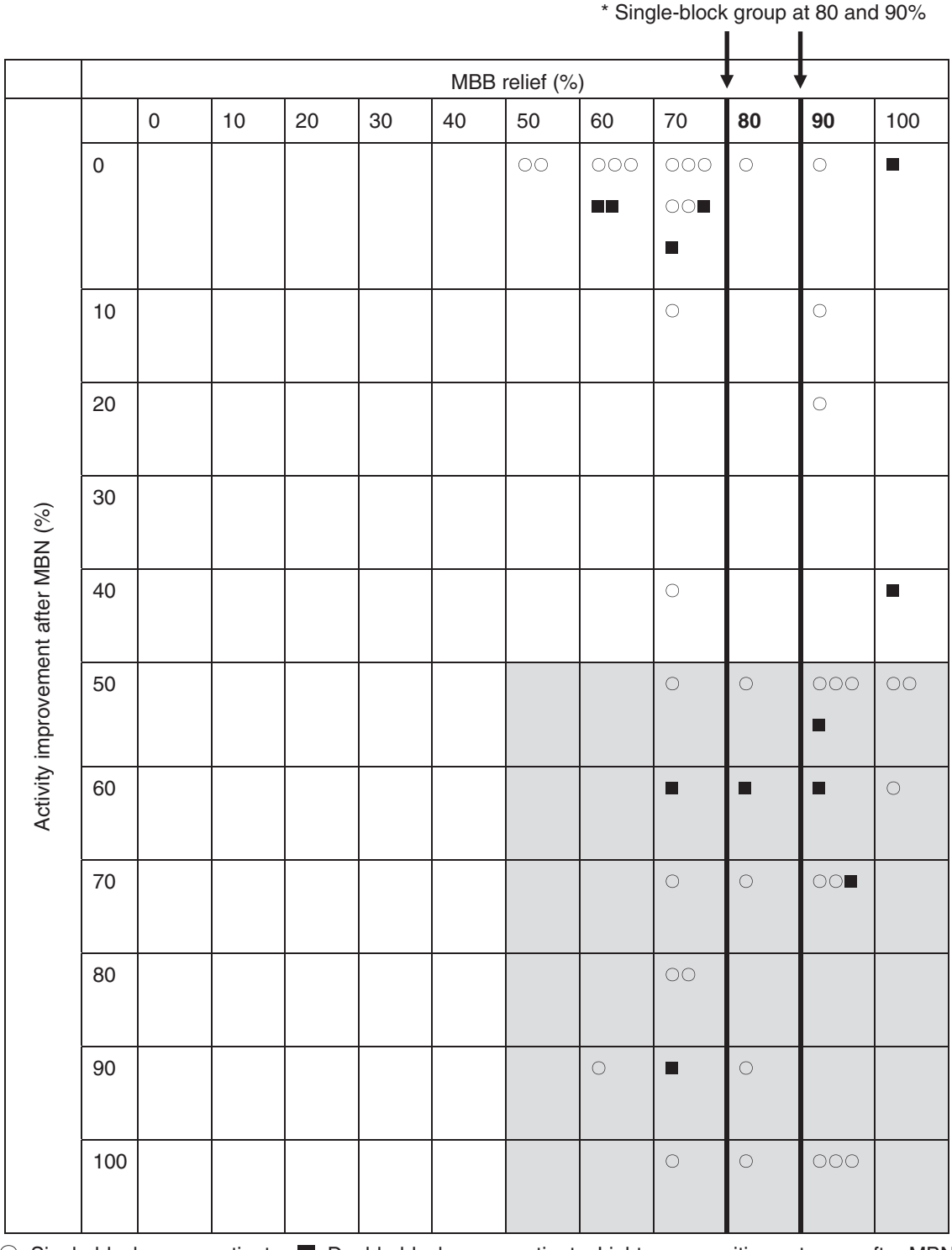
Rather than assessing MBN outcome based on a single MBB cutoff value and an arbitrary combination of outcome measurement criteria, we individually compared

Table 4 Correlation of incremental percent of pain relief following MBB and a duration of pain improvement in patients who had MBN treatment

Duration of pain relief after MBN (months)	MBB relief (%)											
		0	10	20	30	40	50	60	**70** * Double-block group	80	90	100
	0						○○	○○○ ■■	○○○ ○	○	○○	
	1								○○	○	○○	
	3								○	○		○■
	6							○	○○○ ○■■ ■	○	○○○ ■■■	
	9							○	■■	○■	○○○	
	12										○	○
	15								○			
	20											
	25											○■

○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: cut-off value showing statistical significance.

Table 5 Correlation of incremental % of pain relief following MBB and activity improvement in patients who had MBN treatment



○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: cut-off value showing statistical significance.

Table 6 Correlation of incremental % of pain relief following MBB and patient satisfaction in patients who had MBN treatment

Satisfactions after MBN	MBB relief (%)	0	10	20	30	40	50	60	* Double-block group **70**	* Single-block group **80**	90	100
	(4) same or worse							○○ ■■	○○	○		
	(3)wouldn't undergo							○	○○ ○○ ■		○○	
	(2)would undergo the same tx							○		○■	○■	○■ ■
	(1) Met expectation							○	○○ ○○ ■■ ■■	○○ ○	○○ ○○ ○○ ○■ ■	○○

○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: cut-off value showing statistical significance.

six standard outcome measurements following MBN to the percent relief recorded post one or two diagnostic MBB in 10% increments beginning at a 50% cutoff value.

Consistent with the above studies [18–29], 74% of our patients undergoing MBN reported 50% or greater overall pain relief (63% in single-block group and 85% in double-block group). Sixty-two percent of patients reported pain relief for more than 6 months of duration (47% single-block group and 77% double-block group) with an average of 10 months. Seventy percent of patients reported pain relief for more than 3 months of duration (55% single-block group and 85% double-block group) with an average of 9 months. The failure of 43% of our patients undergoing a confirmatory MBB to report 50% or greater pain relief is consistent with our 38% false-positive MBB results reported by Schwarzer et al. [4] and the 49% false-positive rate reported by Manchikanti et al. [11].

Table 7 Correlation of incremental % of pain relief following MBB and medication reduction in patients who had MBN treatment

* Double-block group

Medication reduction after MBN	MBB relief (%)											
		0	10	20	30	40	50	60	**70**	80	90	100
	NO							○○○ ■■	○○○ ○	○	○○○	○■
	YES							○○	○○○ ○○■ ■■■	○○○ ○■	○○○ ○○○ ■■■	○○■

○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: cut-off value showing statistical significance.

Table 8 Correlation of incremental % of pain relief following MBB and "No other doctor's visit" in patients who had MBN treatment*

NO other dr's visits for this pain after MBN	MBB relief (%)											
		0	10	20	30	40	50	60	70	80	90	100
	YES						○○	○■	○○○ ○■		○○○	■
	NO							○○○ ■	○○○ ○○○ ○■■ ■■	○○○ ○■	○○○ ○○○ ○■■ ■	○○

○: Single-block group patients; ■: Double-block group patients; Light gray: positive outcome after MBN among the patients reported 50% or greater pain relief from MBB.
*: no statistical significance was found for this criterion.

Table 9 Single-block group: optimal cutoff values

Individual criteria	Statistically Significant (SS) Cut off per Criteria (%)					
	50	60	70	**80**	**90**	100
. Pain relief						
. Duration of relief						
. Medication reduction						
. Satisfaction				SS		
. Activity improvement				SS	SS	
. No other dr's visit						

Light gray with SS: Statistically significant difference per MBB value.

Our purpose, however, was to evaluate the need for a confirmatory MBB and to find an ideal MBB cutoff value. In this regard, our double MBB block protocol correlated with MBN outcome better than our single MBB protocol.

Stratifying percent of pain relief post-MBB in 10% increments in the double-MBB group showed that a 70% cutoff value statistically predicted favorable results in the four of six criteria including percentage of pain relief, duration of relief, patient satisfaction, and pain medications reduction. In confirmed MBB patients with 70% or greater pain relief post-MBB, 91% (10/11) of patients reported greater than 50% relief lasting 6–25 months with an average of 10 months (Tables 3 and 4). We could not, however, find a progressive statistically validated improvement in outcome variables as one progressed from a 50% to 100% cutoff value.

In the single MBB group, 80% cutoff predicted favorable outcome in two criteria: patient satisfaction and improvement in activity level. Using the 80% cutoff value, 58% (11/19) of patients reported 50% or greater pain relief for 6 months or longer with an average of 10.7 months (Tables 3 and 4).

Because our study is an audit of a private interventional practice, our results are confounded by a number of patients in both the single (39%, 28/71) and the double (39%, 9/23) MBB group not undergoing an MBN for a variety of reasons despite meeting requirements for a MBN [30]. We did not study this group of patients; however, the insurance, patient, or physician decision not to proceed to MBN may have selected patients who would not do well for reasons other than MBB results. Another limitation was created by stratifying groups in 10% increments that lowered to ~20 the average number of patients in each group.

In conclusion, we confirmed by MBN results the International Spine Interventional Society (standards [31] that are based on the assumption that double diagnostic blocks best predict MBN outcome compared with a single block due to the high false-positive rate of a single MBB.

If a confirmatory injection is omitted, our data best support an 80% cutoff value that is statistically significant for 2/6 outcome variables with a 58% chance of significant pain relief for 6 months or longer (average of 11 months). Using a double-block protocol our data found, a 70% cutoff value may be the best compromise between successful outcome and unfair denial of care. Our 70% cutoff value predicted a greater than 90% chance of significant pain relief for greater than 6 months (average of 10 months).

Table 10 Double-block group: optimal cutoff values

Individual criteria	Statistically Significant (SS) Cut off per Criteria (%)					
	50	60	**70**	80	90	100
. Pain relief			SS			
. Duration of relief			SS			
. Medication reduction			SS			
. Satisfaction			SS			
. Activity improvement						
. No other dr's visit						

Light gray with SS: Statistically significant difference per MBB value.

Finally, and perhaps the most clinically relevant finding, no patient in the double MBB group reporting less than 70% pain relief following MBB reported satisfactory pain relief following MBN.

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