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Cost Comparisons of Various Diagnostic Medial Branch Block Protocols and Medial Branch Neurotomy in a Private Practice Setting

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Abstract

Objective. We calculated the average total facility and professional cost of medial branch neurotomy (MBN) procedure and diagnostic medial branch blocks (MBBs), based on increments of MBB results (50–100% cutoff values), to determine the most cost-effective protocol that correlates with positive MBN outcome.

Design/Methods. We evaluated both actual cost and the theoretical cost of procedures in three groups: 0, single and double MBB. We calculated costs assuming MBB success rates at incrementally higher levels by incrementally raising the cutoff values for a successful diagnostic MBB by 10% increments (from 50% to 100%). We analyzed each cutoff value using the preposition that all patients meeting the cutoff value would proceed to MBN. Those not meeting the cutoff value would not have the cost of MBN added to the cost calculations. A cost per successful procedure was also analyzed.

Results. Cost savings were noted when ≥70% cutoff MBB values were utilized and additionally when patients declined MBN for reasons other than their MBB outcome, although these dropouts lowered the cost-effectiveness of MBB when analyzed as cost per successful procedure. Costs over 5 years per successful procedure using 0, 1 and 2 diagnostic MBB protocol (x) and MBB protocol (o) were, however, similar at all MBB cutoff values.

Conclusions. Diagnostic MBB using progressively stringent MBB cutoff values incrementally excluded patients without posterior element pain as evidenced by incremental increase in positive outcomes following MBN. The exclusion of patients from MBN due to failure to report 70% or greater pain relief following MBB resulted in cost savings in favor of performing diagnostic MBB.

Key Words. Zygoapophyseal Joint; Low Back Pain; Chronic Pain; Facet Joint; Radiofrequency; Medial Branch

Introduction

Medial branch blocks (MBBs) and medial branch neurotomies (MBNs) are a growing cost for government and third party payers [1,2]. A recent randomized study by Cohen et al. [3] found that the diagnosis of lumbar facet pain based on clinical criteria rather than one or two diagnostic MBB sessions was the most cost-effective protocol. Indeed, the protocol of performing MBN based on clinical criteria is commonly used in Europe [4] even though there is no evidence that posterior element pain can be reliably differentiated from middle or anterior column pain by history, physical, or imaging studies [5–10]. On the other hand, using published results of MBB's success rates, Bogduk and Holmes recently calculated a significant cost saving by requiring a two MBB protocol [2].

As described by Bogduk and Holmes [2], the total cost of professional and facility reimbursement of a 0, 1, or 2 diagnostic MBB protocol is dependent on both the MBB : MBN cost ratio and the number of patients excluded (or included) from MBN based on one's MBB cutoff point [2,11,12]. In the United States, the MBB : MBN cost ratio for both facility and professional fee is approximately 1:2 [13], and therefore, the break-even point is 50% of patients are excluded from being offered an MBN because the degree of reported relief following MBB does not meet a pre-determined cutoff value. In other words, at a 1:2 ratio, the extra cost of diagnostic MBB is cost-effective if more than 50% of the patients do not proceed to MBN. One may therefore calculate the direct facility and professional costs and the differential between the 1 and 2 block protocols by simply determining the MBB exclusion rate at various cutoff levels. One would expect the number of excluded patients will increase as the chosen cutoff value of reported pain relief following MBB is raised, and therefore, total costs should decrease as MBB cutoff values are increased. Costs per successful treatment are in addition dependent on the technical success rate, the qualification for success, and

the ability of MBB to predict results [3]. Although the MBB false positive rates should decrease as one increases the cutoff values of MBB success [14–18], more stringent cutoff values may also increase the false negative rate [11,12,19]. In a clinical practice, patients who "pass" MBB but refuse MBN will also affect cost analysis.

Cohen et al. [3] studied the cost-effectiveness of a 0, 1, or 2 MBB protocols using a randomized design performed at three different teaching institutes; however, no published study confirms their results in a typical private interventional practice. As Cohen used a 50% reported subjective relief of pain cutoff to define a successful MBB, the cost-effectiveness of using a more stringent cutoffs [12,20] should yield different conclusions. Most troublesome, Cohen et al.'s results showed poor clinical correlation between a positive MBB and a positive MBN outcome as evidenced by a 37% success rate of 0-block group compared with almost the same 39% success rate of one-block group and a 67% success rate in two-block group despite rather lenient qualifications for success.

A practice audit rather than a prospective or randomized design may best answer the question of cost-effectiveness as applied to a typical clinical interventional practice. Such an audit may be compared with Cohen's randomized study if one uses his criteria for success and has a cohort of patients that had an MBN following either a one- or two-block MBB protocol. If we assume that a false negative rate of well-performed MBB is very low, we can anticipate that the number of patients with a positive MBN outcome in a hypothetical zero-block group will be similar to the number of patients who reported successful MBN outcome in the one- and two-block groups combined (given that in our study the two-block group have derived from the initial positive MBB group).

While we intellectually endorse a two-block MBB protocol [18,21,22], many of our patients undergo only one MBB because their insurance does not allow a confirmatory injection, the patients do not want a second block, or both. Although we now require a minimum of 70% relief and preferably 80% or higher relief following either a one- or two-block MBB protocol, prior to analyzing our results, we performed MBN on patients with between 50% and 69% of pain relief.

Our retrospective analysis of prospectively gathered audit data calculates and compares average total facility and profession costs (x), professional costs (o), and average total costs per successful MBN to Cohen's cost figures using his criteria for a successful MBN outcome using progressively higher MBB cutoff values.

Materials and Methods

We retrospectively compiled prospectively gathered data routinely collected per our institutional standardized audit protocol. We reviewed the collected data of 180 patients from August of 2007 to February of 2010 that had undergone one or more diagnostic MBBs. 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 nonradicular limb 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. Posterior element pain was suspected when a patient's history and physical examination revealed 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 axial or referred extremity pain. We excluded patients if they were treated for two sources of pain, including concomitant radiculopathy due to a disc herniation or stenosis or buttock pain due to the sacroiliac joint. Patients were grouped in three separate categories, including 1) "0-block group"—an estimated number of patients who did not have a diagnostic MBB procedure; 2) "single-block group"—patients who underwent one diagnostic MBB procedure; and 3) "double-block group"—patients who had two diagnostic MBB procedures.

Reimbursement

We analyzed data based on following Medicare reimbursement (2009) rates [13]: 1) facility fee: the cost for a diagnostic MBB is $372.73 for the first level and $52.93 for each subsequent level (maximum billable level is three); the cost for a radiofrequency (RF) denervation is $617.11 for the first joint and $191.23 for each subsequent level; 2) physician fee: the cost for a diagnostic MBB is $130.08 for the first level, $71.89 for the second level, and $73.34 for the third level (maximum billable level is three); the cost for an RF denervation is $214.83 for the first joint and $56.56 for each subsequent level. We performed MBBs on an average of ~3 levels per patient, resulting in a diagnostic MBB cost of $753.90 (= $372.73 + $52.93 + 52.93 + $130.08 + $71.89 + $73.34) including facility fee and physician fee. The cost for MBN averaged $1,327.52 (= $617.11 + $191.23 + $191.23 + $214.83 + $56.56 + $56.56). Because most insurance companies reimburse a percent of Medicare costs and all have an approximate MBB : MBN cost ratio of 1:2, we used average cost of 71% of Medicare fee. For convenience and panoptic calculation, a cost of MBB : MBN at a 1:2 ratio is $1,000:$2,000. The theoretical 5-year cost analysis of successful MBN procedures was based on hypothetical successful repeat MBN every 8 months without a repeat diagnostic MBB procedure. As an illustration, we added actual and theoretical cost analyses of MBB : MBN at a 1:4 ratio to demonstrate cost per successful treatment and total cost of procedures at 50% MBB cutoff value in each group, as covered by some insurances.

MBB/Dorsal Ramus Block

Diagnostic MBBs were performed in the operating room using fluoroscopy in an outpatient surgical center. Prior to

the injection, an independent observer tested patients and recorded VAS (visual analog scale) during patient movements including flexion, extension, side bending, and during activities including sitting, standing, and walking. After sterile prep and drape, a 25–gauge, 3.5-inch needle was advanced to the junction of the transverse process and superior articular process (SAP) at each lumbar level above L5, to the junction of the SAP and sacrum to anesthetize the L5 dorsal ramus. At each level, .2~.3 mL of either .5% or .75% bupivacaine was injected at a minimum of two depths along the course of the medial branch or dorsal ramus of L5. The patients were again tested by an independent observer in 45–60 minutes following the block, and in more recent cases were also retested in 1–2 hours after self-testing outside the surgical suite. The patients also recorded on a pain diary their responses over the rest of the day and the days following the block. Typically, the patients would be seen in follow-up in 2–3 weeks to discuss the results of the MBB.

Radiofrequency Neurotomy

In the early cases, patients were offered MBN if they reported at least 50% subjective relief of pain for at least 2 hours duration. The patients with less than 70% relief, however, were a minority and except when disallowed by the insurance company (California Workers Compensation) were most often scheduled for a confirmatory MBB.

MBN were performed in the surgical suite of an outpatient surgical center. We placed one or two 18-gauge Teflon coated RF needles with a 1 cm exposed slightly curved distal tip was 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 SAP. RF current was applied for 90 seconds at 85 degrees. In a few early MBN procedures, we performed RF using only a single lesion at each level, but in most procedures, we used a minimum of two lesions per level using either a unipolar or bipolar technique (see Figure 1).

Outcome Measures and Follow-Up

Our ongoing audit protocol includes baseline information as age, gender, duration of symptoms, narcotic use, previous surgery, 0–100 numerical rating scale pain scores for low back and leg pain, tolerance of sitting, standing, lying down, the Distress and Risk Assessment Method (DRAM) score, and workers' compensation. Results of an MBN patient were assessed at a scheduled 6-week follow-up, and those not seen after the initial follow-up were contacted by phone. The phone interview was done by a person unknown to the patient. Follow-up outcome measures include percentage of subjective total relief, duration of pain relief, medication reduction, percentage of daily activity improvement, no other doctor's visits for this pain (yes/no), and global perceived effect. A positive global perceived effect 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.
4. I am the same or worse than before the treatment.

"Successful outcome" of MBN was defined as a ≥50% subjective total relief, coupled with a positive global perceived effect that persisted ≥3 months.

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 exact tests for categorical data were evaluated. For the cost-effectiveness analysis,

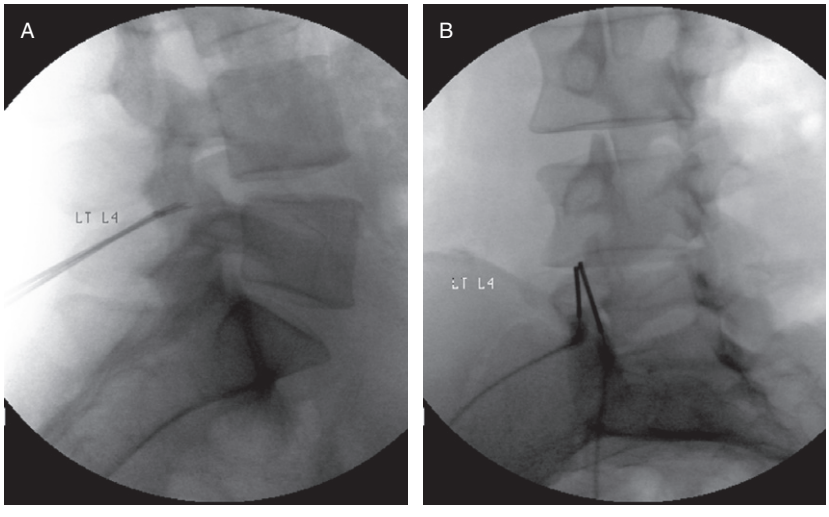

Figure 1 L4 medial branch neurotomy using a bipolar technique with two 18-gauge needle having a 1 cm exposed tip. A: Lateral view; B: Oblique view.

Kruskal–Wallis test was used if there was any statistically significant difference between three groups including estimated 0-block group. Statistical testing was performed at a preset alpha of 0.05.

Result

Subject Recruitment

We analyzed the average costs of 1 and 2 MBB protocols and estimated costs of a 0-MBB protocol using both average costs with and without an intention to treat patient group. The intention to treat group are those patients reporting equal or more pain relief than the MBB cutoff value but declining MBN. The theoretical analysis assumed that all patients meeting the chosen cutoff values of MBB results would undergo an MBN.

Actual Analysis Group: A total of 180 consecutive patients underwent MBB. Among 180 patients who underwent single diagnostic MBB, 100 patients reported 50% or greater subjective pain relief, and 36 patients underwent a confirmatory block. In the single session patients, 39 patients underwent MBN grouped as a single-block. Seventeen of those patients had successful outcome, with more than 50% of pain relief, lasting for at least 3 months coupled with a positive perceived effect. In the 36 patient who had two sessions of MBB, 20 patients had more than 50% pain improvement, and of those patients, 13 underwent MBN grouped as a double-block. Ten of those patients had successful outcome. There were 32 dropouts (25 in single-block group, 7 in double-block group) who declined to undergo neurotomy although the patients showed positive relief from block. Three patients who could not be reached at follow-up (two in single-block group, one double-block group) and one patient in single-block group who refused to follow-up were excluded from all analyses of success rates (see Figure 2, A1).

We estimated the MBN success rate of the 0-MBB group using the success rates of the single and double block which equaled 18.2% = (17 successful group 1 patients + 10 successful group 1 patients)/148 (the starting number of 180—the 32 dropouts). Theoretically, 33 patients of 180 patients would have a successful outcome (33 = 180 * 0.182) (see Figure 2, A2).

Theoretical Analysis Group: The theoretical analysis assumed that all patients meeting the 50% cutoff value of MBB results undergo an MBN. In the single-block group, 100 patients reported post-MBB subjective relief of equal or gather than 50%. The individual success rates were calculated by applying the success rates of the MBN actual group in the same MBB cutoff category. The calculation yielded an MBN success rate of 47.2%. In the double block group, all of those 100 patients would theoretically undergo a second confirmatory MBB, and that 56% would report 50% or greater pain relief derived from the actual number of second block patient reporting 50% or greater relief (36:16 = 56%). The success rates were calculated by the actual success rates in the 2 MBB block protocol and yielded a success rate of 83.3% (see Figure 2, A3 and Table 1).

We calculated costs assuming MBB success rates at incrementally higher levels by incrementally raising the cutoff values for a successful diagnostic MBB by 10% increments from 50% to 100%. We analyzed each cutoff value using the preposition that all patients meeting the cutoff value would proceed to MBN. Those not meeting the cutoff value would not have the cost of MBN added to the cost calculations (see Figure 2, B1~F2).

Demographic

Demographic and clinical characteristics of the patients are presented in Table 2. The average age of the two groups was 59.1 ± 12.0 years (range: 27–86) and males accounted for half of the people in each group. The average duration of symptoms was 10.8 ± 11.2 years (range: 0.2–46) and half of the people overall take narcotics daily. The mean pain numerical rating score was ~75% on the low back and ~25% on the leg in each group. The mean tolerance of sitting, standing, and lying down was ~30 minutes overall in each group. “Normal” psychological score (DRAM) accounted for more than half of the people overall and 33~44% of the participants was “at risk.” Forty-two patients (~50%) were covered by worker’s compensation. There was no demographic or clinical statistically significant difference between two groups.

Results of Single- and Double-Block Groups (Using Original 50% Cutoff Value)

The results of MBN of each group are presented in Table 3. Among 36 patients in the single-block group, 21 patients (58.3%) reported ≥50% subjective pain relief, and the mean relief in these 21 patients was 77.9%. In the double-block group, 11 out of 12 patients (91.7%) reported ≥50% subjective pain relief which was statistically significant higher than single-block group, and the mean relief in these 11 patients was 71.1%. Eleven of 12 patients (91.7%) in the double-block group reported ≥3 months pain relief which was a statistically higher percentage than the single-block group where 52.8% (19 out of 36 patients) had a successful outcome. The mean duration of relief in the 11 patients in the double-block group was 9.3 months and 10.2 months in the 19 patients in the single-block group. The percentage of patients who were able to reduce or discontinue medications was 58% in the single-block group and 82% in the double-block group ($P = 0.15$). The percentage of patients who improve daily activity ≥50% was 53~55% overall in each group ($P = 0.60$). The percentage of patients who does not need more doctor’s visit was 68% in the single-block group and 82% in the double-block group ($P = 0.32$). Positive global perceived effect on each group was ~70~80% overall ($P = 0.36$).

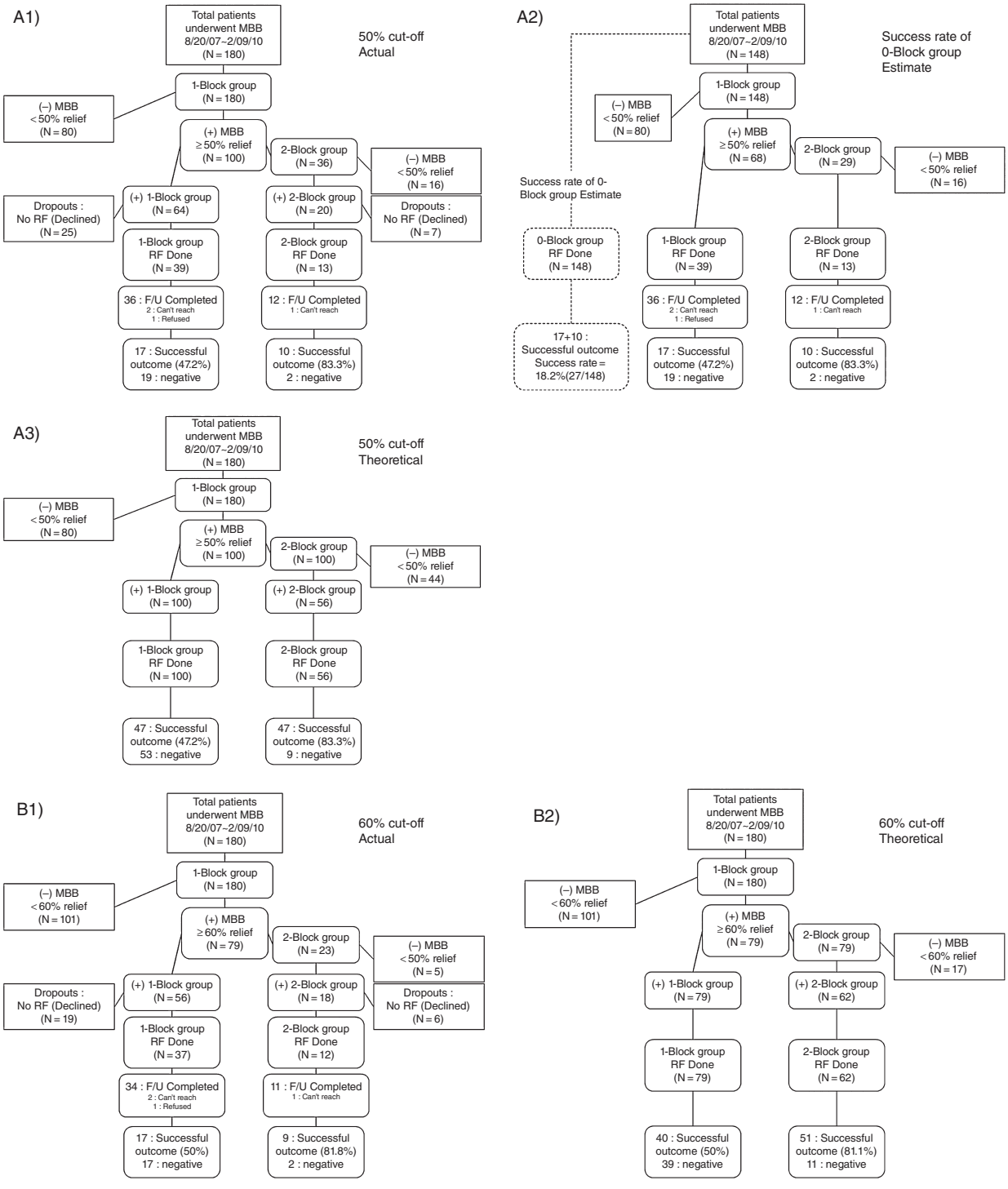

Figure 2 Flow chart of study subjects based on the actual and comparative theoretical analysis of outcomes, determined by incremental (by 10%, from 50% to 100%) increase in the medial branch block (MBB) cutoff value (A1,3: study subject based on 50% cutoff value of MBB; A2: The medial branch neurotomy (MBN) success rate of the 0-MBB group using the success rates of the single- and double-block groups; B1,2: study subject based on 60% cutoff value of MBB; C1,2: study subject based on 70% cutoff value of MBB; D1,2: study subject based on 80% cutoff value of MBB; E1,2: study subject based on 90% cutoff value of MBB; F1,2: study subject based on 100% cutoff value of MBB).

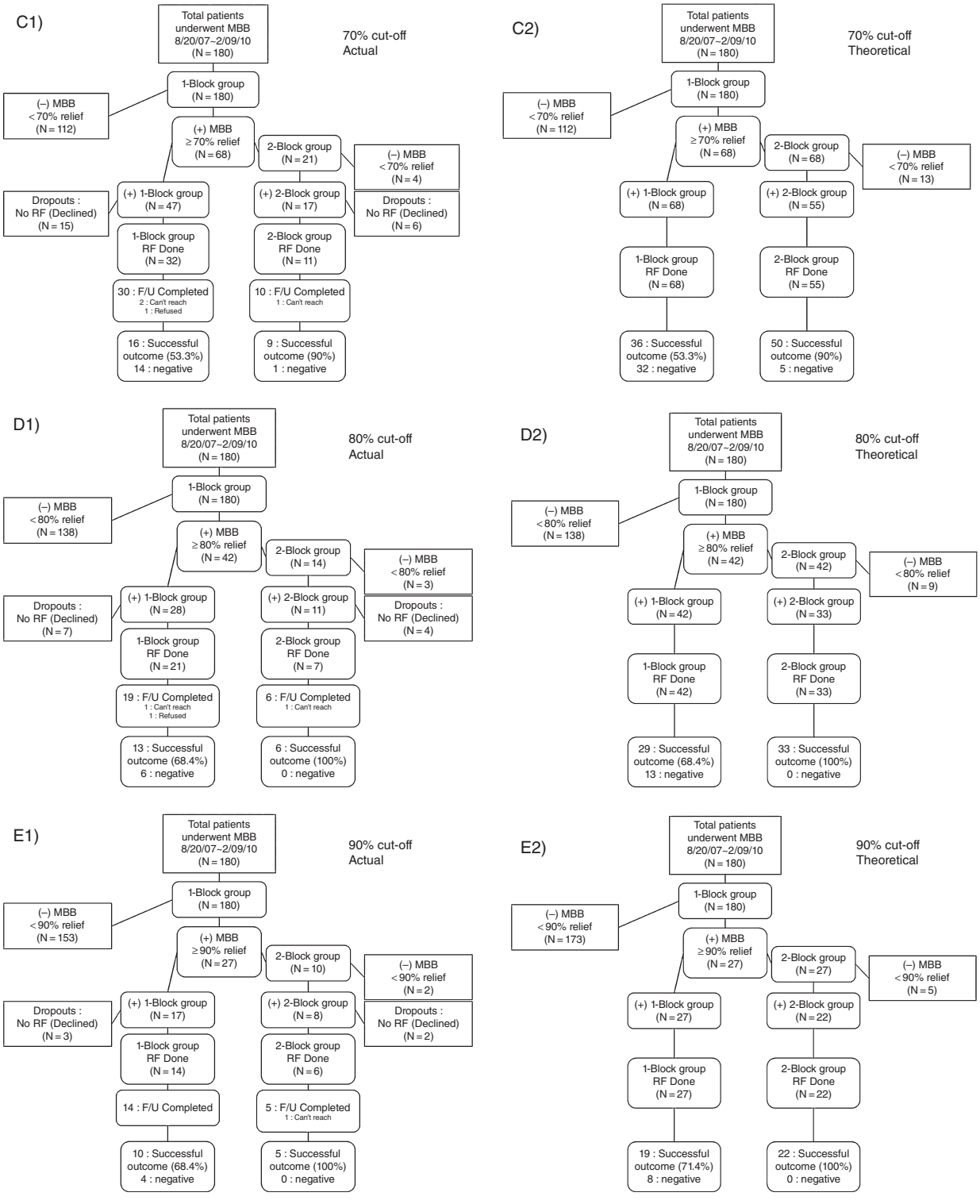

Figure 2 Continued.

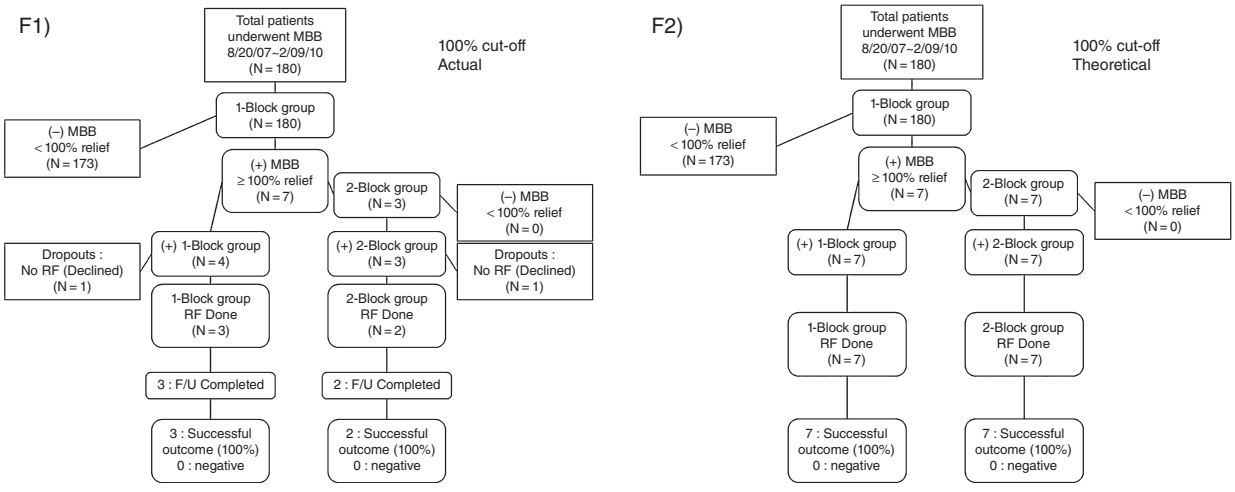

Figure 2 Continued.

Results of Total Procedures Cost

The total cost per patient and cost per successful treatment for each cutoff values including 5 years analysis are given in Figure 3 and Tables 4–7.

- Total cost/patient
  All actual analysis that includes our "actual" findings including a theoretical 5-year analysis of total cost per patient for each cutoff value was statistically least expensive ($P < 0.001$) for the single- or double-block group (see Figure 3 and Tables 4–5).The theoretical analysis of total cost per patient that is more representative of Cohen's data was statistically the least expensive from 60% to 100% cutoff values ($P < 0.001$) in the single MBB group and the least expensive at the 50% cutoff for the 0-block group, but without statistical confirmation ($P = 0.6$). The 5 years theoretical analysis of total cost per patient was statistically least expensive at 80%, 90%, and 100% cutoff values ($P < 0.001$) in the single-block group. From 50% to 70% cutoff values, the least expensive was the 0-block group, but without statistical significance at 50% and 60% ($P = 0.052$, $P = 0.063$), and only 70% cutoff values showed statistical significance ($P < 0.001$) (see Figure 3 and Tables 6–7).
- Cost/Successful treatment
  All actual analysis including 5-year analysis of cost per successful treatment for each cutoff value showed 0-block group as the statistical least expensive ($P < 0.001$) MBB protocol (see Figure 3 and Tables 4–5). The theoretical analysis including 5-year analysis of cost per successful treatment showed single- or double-block group as the statistical least expensive in the 50–80% cutoff values ($P < 0.001$), but 90% and 100% cutoff values showed 0-block group as the statistical least expensive group ($P < 0.001$) (see Figure 3 and Tables 6–7).

Discussion

We analyzed average costs of 1 and 2 MBB protocols and estimated costs of a 0-MBB protocol using both average costs (actual cost analysis) and with an intention to treat patient group (theoretical cost analysis) which were those patients reporting equal or more pain relief than the MBB cutoff value but declining MBN. The theoretical cost analysis assumed that all patients meeting the chosen cutoff values of MBB results undergo an MBN. The analysis was performed to both facilitate the comparison with Cohen et al.'s [3] study (see Table 8), where all patients reporting 50% or more relief following MBB underwent MBN and to compare other clinical practice results with our data where the dropout rate for reason other than MBB results may be different than our patient population. We calculated the theoretical groups MBN results by matching individual dropout patients (intention to treat) to those patients undergoing MBN reporting the same degree of pain relief post MBB. For the theoretical analysis of the two-block protocol, we used the MBB results of patient undergoing a second MBB to determine the number of patients that would theoretically undergo MBN using a two-block MBB protocol. To provide a more generalized results, we purposely used average facility and professional costs at an MBB : MBN cost ratio of 1:2 rather than the actual costs that were used by Cohen et al. study. We also omitted Cohen et al. minor theoretical costs other than professional and facility charges as these charges did not change our results. We emphasize that both our study and Cohen study only address the primary charges and not potential cost savings or additional costs attributable to successful or failed MBN.

As expected, we found the number of patients excluded using diagnostic MBB increased as we increased the cutoff subjective relief value for MBB (see Table 1) that

Table 1 The actual analysis of success rate of MBN for each cutoff value and excluded rate based on MBB result

	50% cutoff	60% cutoff	70% cutoff	80% cutoff	90% cutoff	100% cutoff
Success rate	0 group: 18.2% (27/148) Single: 47.2% (17/36) Double: 83.3% (10/12)	0 group: 18.2% (27/148) Single: 50% (17/34) Double: 81.8% (9/11)	0 group: 18.2% (27/148) Single: 53.3% (16/30) Double: 90% (9/10)	0 group: 18.2% (27/148) Single: 68.4% (13/19) Double: 100% (6/6)	0 group: 18.2% (27/148) Single: 71.4% (10/14) Double: 100% (5/5)	0 group: 18.2% (27/148) Single: 100% (3/3) Double: 100% (2/2)
Excluded % Based on MBB result	Single: 44.4% (80/180) Double: 53.3% (96/180) 2nd only: 44.4% (16/36)	Single: 56.1% (101/180) Double: 58.9% (106/180) 2nd only: 21.7% (5/23)	Single: 62.2% (112/180) Double: 64.4% (116/180) 2nd only: 19% (4/21)	Single: 76.7% (138/180) Double: 78.3% (141/180) 2nd only: 21.4% (3/14)	Single: 85% (153/180) Double: 86.1% (155/180) 2nd only: 20% (2/10)	Single: 96.1% (173/180) Double: 96.1% (173/180) 2nd only: 0% (0/3)

MBB = medial branch block; MBN = medial branch neurotomy.

would qualify a patient for MBN [12]. Our actual and theoretical analysis at a 50% cutoff showed a similar but less dramatic total cost savings by eliminating diagnostic MBB compared with our calculation of Cohen's unreported total costs (see Table 8). However, as we raised the cutoff values for a successful diagnostic MBB by 10% increments from 50% to 100%, the number of excluded patients proportionally increased and the theoretical cheapest total cost shifted to the one- or two-block MBB protocol.

In addition to the cost ratio and dropout rate, the cheapest diagnostic protocol calculated by cost per successful outcome is dependent on the prevalence of lumbar posterior element pain, the ability of MBBs to predict outcome, and ones qualifications for a successful outcome. To compare our results with Cohen et al., we used a 50% overall pain reduction for a minimum of 3 months and as predicted found both an increasing percentage of successful MBN in both the one- and two-block protocols as the criteria of a successful MBB was raised from 50 to 100 per cent in 10% increments. Similar to Cohen et al. we found an increased success rate of MBN outcomes between the one block and two-block protocol by presumably excluding false positive MBB responders (see Figure 2, A1). Unlike Cohen et al.'s results, our theoretical analysis showed that excluding patients for MBN based on a one- or two-block protocol resulted in the lowest total cost (see Tables 6 and 7) with the exception a slightly lower total cost when using a 90% or 100% MBB cutoff value.

Our actual total costs and costs per successful treatment, however, were influenced by a significant drop out rate for reasons other than MBB results. That is, even though patients meet the MBB subjective relief cutoff, after being informed of an estimated MBN success rate of between 50% and 60%, a number of patients elected not to proceed with MBN. The effect of the additional dropout of patients that were candidates for MBN further decreased total costs in the most cost-effective strategy of using a single- or double-block protocol. On the other hand, the dropout of patients that would potentially benefit from MBN resulted in the 0-block protocol being the cheapest per successful outcome. However, the calculated costs over a 5-year period assuming successful repeat MBN every 8 months, the difference in costs between the three MBB diagnostic protocols was marginal at all cutoff value (see Figure 3 and Tables 5 and 7) in both the actual and theoretical groups. We did not, however, estimate nor include in our theoretical calculations the significant number of patients that might refuse MBN in the 0-MBB protocol if they were informed that their chances of success were 20–30% or lower.

As we did not perform MBN without at least one diagnostic MBB, our 0-block success rate of 18% was calculated by dividing the number of successful procedures by the total number of patients minus the patients who decided not to have an MBN. Our calculated 18% 0-block success rate is consistent with the reported prevalence of "lumbar

Table 2 Demographic and clinical characteristics of study patients who were included in the follow-up analysis

	Single-Block (N = 36)	Double-Block (N = 12)	*P* value
Age (years)	59.3 ± 12.5	58.6 ± 10.7	0.859
Gender			
Male (%)	50.0%	50.0%	1.000
Female (%)	50.0%	50.0%	
Duration of symptoms (years)	8.5 ± 10.2	17.5 ± 11.9	0.052
Narcotic use			
None	25.0%	12.5%	0.611
Occasional non narcotic	6.3%	12.5%	
Daily non narcotic	6.3%	0%	
Occasional narcotic	6.3%	25.0%	
Daily narcotic	56.2%	50.0%	
Number of levels treated	3.6 ± 0.5	3.5 ± 1.2	0.820
Laterality			
Unilateral	50.0%	66.7%	0.505
Bilateral	50.0%	33.3%	
Previous surgery (%)	10.7%	30.0%	0.310
Baseline NRS pain of low back	72.9 ± 19.5	72.5 ± 19.1	0.952
Baseline NRS pain of leg pain	25.3 ± 19.8	23.0 ± 17.7	0.743
Baseline sitting tolerance (minutes)	31.7 ± 30.1	32.1 ± 17.5	0.979
Baseline standing tolerance (minutes)	25.4 ± 18.4	30.0 ± 21.6	0.675
Baseline lie down tolerance (minutes)	34.6 ± 16.2	43.3 ± 17.6	0.480
Psychological score (DRAM)			
Normal	50.0%	66.7%	0.700
At risk	43.8%	33.3%	
Distressed depressive	6.2%	0%	
Distressed somatic	0%	0%	
WC			
Yes (%)	42.4%	50.0%	0.738
No (%)	57.6%	50.0%	

DRAM = Distress and Risk Assessment Method; NRS = numerical rating score; WC = workers' compensation.

Table 3 The results of two treatment groups

	Single-Block (N = 36)	Double-Block (N = 12)	*P* value
Number of patients with relief ≥50% following MBN	58.3%	91.7%	0.033*
(Mean relief of the patientss with ≥50%)	(77.9%)	(71.1%)	
Number of patients with duration of relief ≥3 months following MBN	52.8%	91.7%	0.015*
(Mean duration of the patients with ≥3 months)	(10.2 months)	(9.3 months)	
Medication reduction (number of patients) following MBN	58.1%	81.8%	0.148
Number of patients with daily activity improvement ≥50% following MBN	52.8%	54.5%	0.597
Number of other doctor's visit for this pain following MBN	67.7%	81.8%	0.318
Satisfaction (number of patients) following MBN			0.357
1. The treatment met my expectations	48.4%	50.0%	
2. I did not improve as much as I had hoped, but I would undergo the same treatment for the same outcome	12.9%	33.3%	
3. The treatment helped, but I would not undergo the same procedure for the same outcome	19.4%	16.7%	
4. I am the same or worse than before the treatment.	19.4%	8.3%	

* = statistically significant difference.
MBN = medial branch neurotomy.

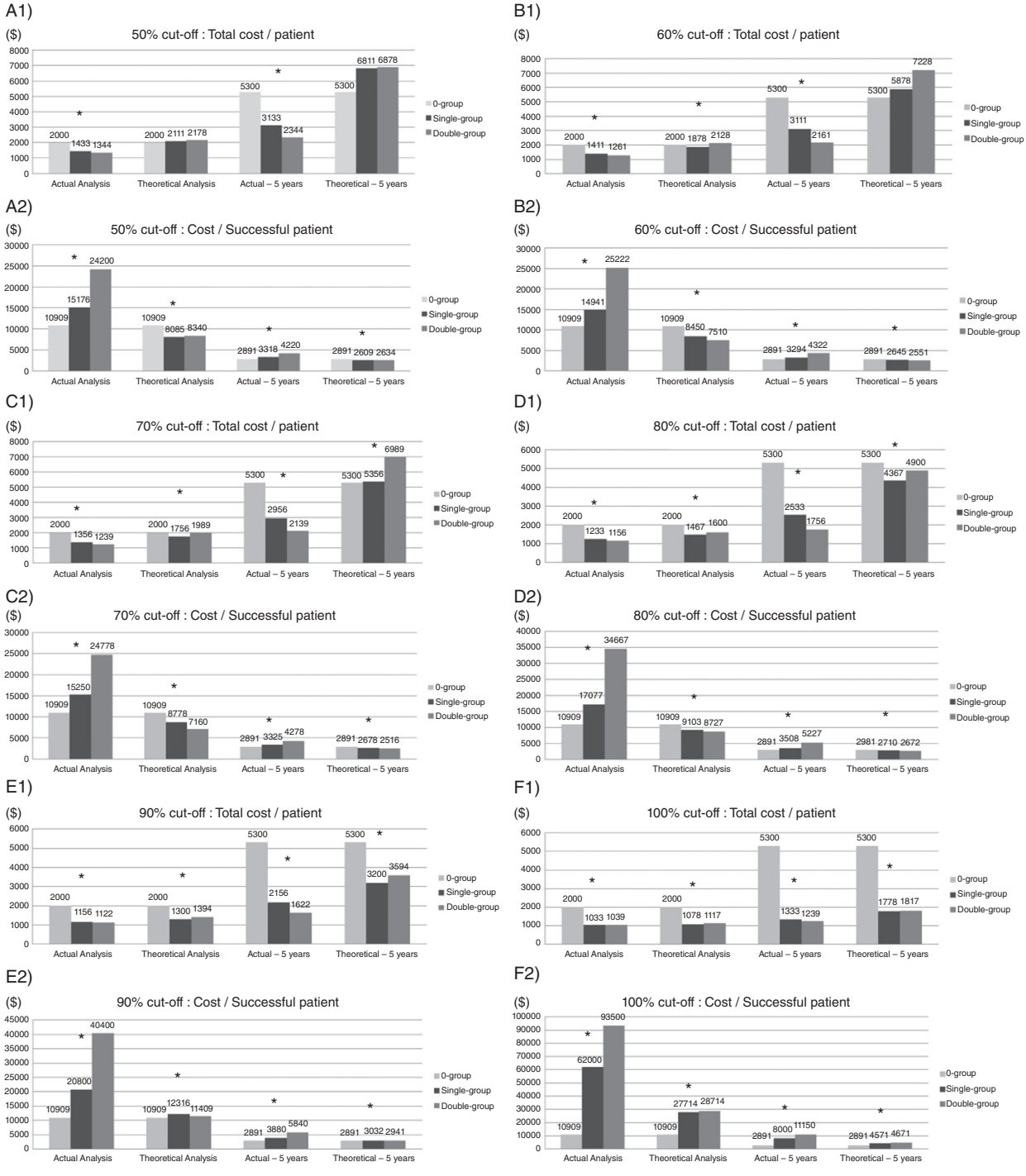

Figure 3 The results of the actual and the theoretical analysis including a 5-year projection of a total cost per patient, and cost per successful treatment for each cutoff value of medial branch block (MBB) (A1,2: analysis based on 50% cutoff value of MBB; B1,2: analysis based on 60% cutoff value of MBB; C1,2: analysis based on 70% cutoff value of MBB; D1,2: analysis based on 80% cutoff value of MBB; E1,2: analysis based on 90% cutoff value of MBB; F1,2: analysis based on 100% cutoff value of MBB). * = statistically significant difference.

Table 4 The actual analysis of total cost per patient and cost per successful treatment based on a cutoff value

	50% Cutoff	60% Cutoff	70% Cutoff	80% Cutoff	90% Cutoff	100% Cutoff
Total cost/ patient	Double < Single < 0 group $1,344 $1,433 $2,000	Double < Single < 0 group $1,261 $1,411 $2,000	Double < Single < 0 group $1,239 $1,356 $2,000	Double < Single < 0 group $1,156 $1,233 $2,000	Double < Single < 0 group $1,122 $1,156 $2,000	Single <Double < 0 group $1,033 $1,039 $2,000
Cost/successful patient	0 group < Single < Double $10,909 $15,176 $24,200	0 group < Single < Double $10,909 $14,941 $25,222	0 group < Single < Double $10,909 $15,250 $24,778	0 group < Single < Double $10,909 $17,077 $34,667	0 group < Single < Double $10,909 $20,800 $40,400	0 group < Single <Double $10,909 $62,000 $93,500

Table 5 The 5 year actual analysis of total cost per patient and cost per successful treatment based on a cutoff value

	50% Cutoff	60% Cutoff	70% Cutoff	80% Cutoff	90% Cutoff	100% Cutoff
Total cost/ patient	Double < Single < 0 group $2,344 $3,133 $5,300	Double < Single < 0 group $2,161 $3,111 $5,300	Double < Single < 0 group $2,139 $2,956 $5,300	Double < Single < 0 group $1,756 $2,533 $5,300	Double < Single < 0 group $1,622 $2,156 $5,300	Double < Single < 0 group $1,239 $1,333 $5,300
Cost/successful patient	0 group < Single < Double $2,891 $3,318 $4,220	0 group < Single < Double $2,891 $3,294 $4,322	0 group < Single < Double $2,891 $3,325 $4,278	0 group < Single < Double $2,891 $3,508 $5,227	0 group < Single < Double $2,891 $3,880 $5,840	0 group < Single <Double $2,891 $8,000 $11,150

Table 6 The theoretical analysis of total cost per patient and cost per successful treatment based on a cutoff value

	50% Cutoff	60% Cutoff	70% Cutoff	80% Cutoff	90% Cutoff	100% Cutoff
Total cost/ patient	0 group < Single < Double $2,000 $2,111 $2,178	Single < 0 group < Double $1,878 $2,000 $2,128	Single < Double < 0 group $1,756 $1,989 $2,000	Single < Double < 0 group $1,467 $1,600 $2,000	Single < Double < 0 group $1,300 $1,394 $2,000	Single < Double < 0 group $1,078 $1,117 $2,000
Cost/successful patient	Single < Double < 0 group $8,085 $8,340 $10,909	Double < Single < 0 group $7,510 $8,450 $10,909	Double < Single < 0 group $7,160 $8,778 $10,909	Double < Single < 0 group $8,727 $9,103 $10,909	0 group < Double < Single $10,909 $11,409 $12,316	0 group < Single < Double $10,909 $27,714 $28,714

Table 7 The 5 year theoretical analysis of total cost per patient and cost per successful treatment based on a cutoff value

	50% Cutoff	60% Cutoff	70% Cutoff	80% Cutoff	90% Cutoff	100% Cutoff
Total cost/patient	0 group < Single < Double $5,300 $6,811 $6,878	0 group < Single < Double $5,300 $5,878 $7,228	0 group < Single < Double $5,300 $5,356 $6,989	Single < Double < 0 group $4,367 $4,900 $5,300	Single < Double < 0 group $3,200 $3,594 $5,300	Single < Double < 0 group $1,778 $1,817 $5,300
Cost/successful patient	Single < Double < 0 group $2,609 $2,634 $2,891	Double < Single < 0 group $2,551 $2,645 $2,891	Double < Single < 0 group $2,516 $2,678 $2,891	Double < Single < 0 group $2,672 $2,710 $2,891	0 group < Double < Single $2,891 $2,941 $3,032	0 group < Single < Double $2,891 $4,571 $4,671

Table 8 Cohen's table of cost-effectiveness analysis (total cost and total cost per patient were added based on his data showed.)

Cohen	0-Block Paradigm	Single-Block Paradigm	Double-Block Paradigm
Number of patients in a group	51 (successful patient: 17)	49 (successful patient: 8)	49 (successful patient: 11)
Total cost per patient	$ 2,017.89	$ 2,650.75	$ 3,196.01
Cost per successful treatment	$ 6,053.68	$ 16,236.12	$ 14,237.76
Total cost	$ 102,912.51	$ 129,886.84	$ 156,604.36
Total cumulative costs for facility fees	$ 63,936	$ 86,247.00	$ 103,563.00
Total cumulative costs for diagnostic blocks (physician fee)	$ 0	$ 29,294.38	$ 42,718.26
Total cumulative costs RF denervation (physician fee)	$ 38,976.51	$ 14,345.46	$ 10,323.10

RF = radiofrequency.

facet pain" calculated using a two-block protocol [7,12]. Cohen et al.'s high 37% MBN success rate in his 0-block group was a primary factor for his 0-MBB group having the lowest costs per successful treatment. This unexpected high success rate compared with the one-block group suggests a high false negative MBB rate [11,12,19]. Cohen et al.'s MBB protocol using a "standard" single 0.5 ml injection of local anesthetic may have a significantly higher false negative rate compared with our protocol of injecting a minimum of three separate locations along the course of the MB at the base of the SAP with 0.2–0.3 ml volumes of 0.5 or 0.75% bupivacaine. We cannot, however, rule out the possibility that using a lenient 50% pain relief for 3 months, the number of patients meeting the criteria of success in our estimated 0-block group would be closer Cohen's 37%.

Our theoretical lower cost per successful MBN using a one- or two-block protocol compared with Cohen et al. was primarily due to our higher percentage of postitive MBN outcomes in the 1 and 2 MBB groups and our lower 18% estimated success rate in the 0-block group compared with Cohen's 37% success rate. Although better outcome is typically reported in retrospective compared with prospective studies, our higher percentage of positive outcomes may be due to a more effective MBN technique. We used an 18-gauge needle with 1 cm exposed tip and a minimum of two single lesions or one bipolar lesion at each level compared with Cohen et al. that used one lesion using a 20-gauge needle with a .5 cm exposed tip. On the other hand, such a conjecture would imply that we would have had a success rate in our 0-group higher than our estimated 18% and closer if not higher than Cohen et al.'s 37%.

In summary, we calculated average total facility and profession costs at incremental 10% diagnostic MBB cutoff values of 50–100%. We calculated both actual costs and

Table 9 Additional analysis using 50% cutoff value with 1:4 (MBB : MBN = $1,000:$4,000) ratio

Actual			
Actual		Actual-5 years	
Total cost/patient*	Cost/ success patient*	Total cost/patient*	Cost/ success patient*
Double < Single < 0 group	Single < 0 group < Double	Double < Single < 0 group	Single < 0 group < Double
$1,489 $1,867 $4,000	$19,765 $21,818 $26,800	$3,489 $5,267 $10,600	$5,576 $5,782 $6,280
Theoretical			
Theoretical		Theoretical-5 years	
Total cost/patient*	Cost/ success patient*	Total cost/pt*	Cost/ success pt*
Double < Single < 0 group	Double < Single < 0 group	0 group < Double < Single	Double < Single < 0 group
$2,800 $3,222 $4,000	$10,723 $12,340 $21,818	$10,600 $12,200 $12,622	$4,672 $4,834 $5,782

* = statistically significant difference.
MBB = medial branch block; MBN = medial branch neurotomy.

the costs assuming all patients that meet a particular MBB cutoff value would undergo MBN. Diagnostic MBB using progressively stringent MBB cutoff values incrementally excluded patients without posterior element pain as evidenced by incremental increase in positive outcomes. The exclusion of patients at higher cutoff values typically offset the added costs of MBB resulting in lowered total costs in the 1 and 2 MBB groups compared with the 0-block group. Patients declining MBN for reasons other than their MBB results resulted in additional total cost saving, however, these dropouts lowered the cost-effectiveness of MBB when analyzed as cost per successful procedure. However, costs over 5 years per successful procedure using 0, 1, or a 2 diagnostic MBB protocol were similar at all MBB cutoff values. Further cost savings in favor of performing MBB will be realized in countries where the cost differential between MBB and MBN is higher than the US average 1:2 ratio. As an example, we included analysis of cost differential between MBB and MBN at a 1:4 ratio, showing significant cost savings for third party payers using diagnostic MBB prior to MBN at that reimbursement ratio (see Table 9).

References

1 Cohen S, Hurley R, Christo P, et al. Clinical predictors of success and failure for lumbar facet radiofrequency denervation. Clin J Pain 2007;23(1):45–52.

2 Bogduk N, Holmes S. Controlled zygapophysial joint blocks: The travesty of cost-effectiveness. Pain Med 2000;1(1):24–34.

3 Cohen S, Williams K, Kurihara C, et al. Multicenter, randomized, comparative cost-effectiveness study comparing 0, 1, and 2 diagnostic medial branch (facet joint nerve) block treatment paradigms before lumbar facet radiofrequency denervation. Anesthesiology 2010;113(2):395–405.

4 Sluijter ME. Chapter 4. Radiofrequency treatment. In: Sluijter ME, ed. Radiofrequency Part 1: The Lumbosacral Region. Meggen (LU), Switzerland: FlivoPress SA; 2001:73–87.

5 Dreyer SJ, Dreyfuss PH. Low back pain and the zygapophysial (facet) joints. Arch Phys Med Rehabil 1996;77(3):290–300.

6 Dreyfuss PH, Dreyer SJ, Herring SA. Lumbar zygapophysial (facet) joint injections. Spine 1995;20(18): 2040–7.

7 Schwarzer AC, Aprill CN, Derby R, et al. Clinical features of patients with pain stemming from the lumbar zygapophysial joints. Is the lumbar facet syndrome a clinical entity? Spine 1994;19(10):1132–7.

8 Schwarzer AC, Derby R, Aprill CN, et al. Pain from the lumbar zygapophysial joints: A test of two models. J Spinal Disord 1994;7(4):331–6.

9 Schwarzer AC, Wang SC, O'Driscoll D, et al. The ability of computed tomography to identify a painful zygapophysial joint in patients with chronic low back pain. Spine 1995;20(8):907–12.

10 Revel M, Poiraudeau S, Auleley GR, et al. Capacity of the clinical picture to characterize low back pain relieved by facet joint anesthesia. Proposed criteria to identify patients with painful facet joints. Spine 1998;23(18):1972–6.

11 Van Zundert J, Mekhail N, Vanelderen P, van Kleef M. Diagnostic medial Branch blocks before lumbar radiofrequency zygapophysial (facet) joint denervation: Benefit or burden? Anesthesiology 2010;113(2): 276–8.

12 Schwarzer AC, Aprill CN, Derby R, et al. The false-positive rate of uncontrolled diagnostic blocks of the lumbar zygapophysial joints. Pain 1994;58(2):195–200.

13 Centers for Medicare and Medicaid Services (CMS). Fee schedule. 2010. Available at: https://www.cms.gov/ (accessed December 10, 2011).

14 Manchikanti L, Damron KS, Rivera JJ, et al. Evaluation of the effect of sedation as a confounding factor in the diagnostic validity of lumbar facet joint pain: A prospective, randomized, double-blind, placebo-controlled evaluation. Pain Physician 2004;7(4):411–7.

15 Manchikanti L, Pampati V, Damron KS, et al. A randomized, prospective, double-blind, placebo-controlled evaluation of the effect of sedation on diagnostic validity of cervical facet joint pain. Pain Physician 2004;7(3):301–9.

16 Manchikanti L, Pampati V, Damron KS, et al. The effect of sedation on diagnostic validity of facet joint nerve blocks: An evaluation to assess similarities in population with involvement in cervical and lumbar regions (ISRCTNo: 76376497). Pain Physician 2006; 9(1):47–51.

17 Manchikanti L, Pampati V, Damron K. The role of placebo and nocebo effects of perioperative administration of sedatives and opioids in interventional pain management. Pain Physician 2005;8(4):349–55.

18 Sehgal N, Dunbar EE, Shah RV, Colson J. Systematic review of diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: An update. Pain Physician 2007;10(1):213–28.

19 van Kleef M, Vanelderen P, Cohen SP, et al. 12. Pain originating from the lumbar facet joints. Pain Pract 2010;10(5):459–69.

20 Bogduk N. Practice guidelines for spinal diagnostics and treatment procedures. In: Bogduk N, ed.

Percutaneous Radiofrequency Lumbar Medial Branch Neurotomy. San Francisco, CA: International Spine Intervention Society; 2004:188–218.

21 Bogduk N. International Spinal Injection Society guidelines for the performance of spinal injection procedures. Part 1: Zygapophysial joint blocks. Clin J Pain 1997;13(4):285–302.

22 Bogduk N. Evidence-informed management of chronic low back pain with facet injections and radiofrequency neurotomy. Spine J 2008;8(1):56–64.