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ORIGINAL ARTICLE

# Minimally invasive palliative procedures in oncology: a review of a multidisciplinary collaboration

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**Abstract**
*Introduction* Minimally invasive palliative procedures (MIPPs) are sometimes considered step 4 of the World Health Organization's three-step ladder. A case conference has been created at the BC Cancer Agency to facilitate access to MIPPs for advanced cancer patients with severe pain not responding to conventional analgesics. The twice monthly conference discusses referrals for pain control procedures and reviews imaging, with palliative care, musculoskeletal interventional radiology, radiation oncology, medical oncology, and anesthesia experts in attendance.
*Study objectives* The aims of this study are: first, to determine the benefit to patients from the procedures recommended by the case conference, and second, to explore the impact of the case conference on clinical decision-making.
*Methods* A retrospective review of electronic charts of all cancer patients referred to the MIPP case conference between December 20, 2011 and June 25, 2013.
*Results* There were 103 referrals, resulting in 69 procedures performed among 63 patients. Over 80 % of procedures provided analgesic benefit. Pain scores fell across all categories post-procedure. Mean worst pain scores fell from 8.1±1.4 to 4.6±2.8 ($P<0.001$). Patient function, mobility, and symptoms measured by the Edmonton Symptom Assessment System also improved post-procedure. At time of abstract submission, 37/63 (58.7 %) patients had died, and the mean survival post-procedure was 200 days. The documented rate of major adverse events attributable to MIPPs was 2/69 (2.9 %).
*Conclusions* MIPPs are valuable treatment options in patients with severe cancer pain despite use of appropriate step 3 WHO ladder medications. The case conference facilitates excellent communication and sharing of expertise, ensuring optimal patient care.

**Keywords** Pain · Cancer · Procedure · Interventional radiology · Cementoplasty · Palliative care

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## Background

Over 70 % of advanced cancer patients are affected by pain [1]. Most patients achieve pain control following the World Health Organization's three-step ladder [2]. However, up to 15 % of patients do not respond to conventional analgesics [3–6]. For some of these patients, minimally invasive palliative procedures (MIPP) are options now considered as step 4 of the WHO ladder [7, 8]. Multiple studies have shown significant pain reduction following MIPP including vertebroplasty, thermoablation, and cementoplasty. A systematic review of eight studies of vertebroplasty for spinal metastases found reduction in pain severity ranging from 47 to 87 % at 6 months [9]. A single-arm trial of 53 combined radiofrequency ablation and cementoplasty procedures for treatment of painful bone metastases in 36 patients reported 24 h post-

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procedure reductions in mean pain from 7.2/10 to 3.4/10 [10]. These are only a few examples of the many types on procedures that have become available for the treatment of pain in this large population of patients.

Despite clear evidence of effectiveness there are still many barriers to accessing MIPP, including the availability of trained staff, concerns regarding the impact of MIPP when used in conjunction with traditional methods like radiotherapy, and lack of awareness of available procedures and how to best utilize them. Cancer patients who may benefit from MIPP do not form homogenous groups of similar cases amenable to randomized intervention studies. Clinicians would not be comfortable comparing procedures they know have a chance of benefit (based on small studies, case reports, or anecdotal reports of effectiveness) with sham or placebo treatments. Choice of preferred interventions varies substantially from patient to patient even with the same illness due to diversity in disease location, comorbidities, and quality of available palliative care. There is also variability in procedure availability from place to place depending on training of local personnel and funding; some preferred procedures being essentially unavailable where the patient resides.

People living with advanced cancer often deteriorate unpredictably and also sometimes improve unexpectedly when response to disease-modifying treatment is delayed, so a decision which may have been appropriate at one point in time may become inappropriate quite quickly under new circumstances. It is important to have all relevant clinical information and multidisciplinary perspectives included to inform the decision-making process and also to be able to proceed with a potentially helpful procedure promptly.

Published recommendations for the sustainable implementation of MIPP include having a multidisciplinary team involved in decision-making and ensuring consistent communication between all parties involved in an individual's care [11]. In December 2011, a twice monthly case conference was started at the BC Cancer Agency (BCCA) in Vancouver, Canada. The 1-h conference discusses referrals for procedures with the goal of relieving cancer pain. Referring physicians are invited to present their patient's clinical history, with specialists in palliative care, musculoskeletal interventional radiology, radiation oncology, and medical oncology and anesthesia in attendance. Imaging is reviewed and recommendations for further management proposed. Videoconferencing is available to other provincial cancer centers on request.

The objectives of this report are, firstly, to share our observations of the impact on patients resulting from the diverse procedures recommended by the case conference and, secondly, to discuss the impact of the case conference on decision-making regarding our patient management. Our goal is simply to share our experience with staff from other tertiary referral centers which have access to a variety of possibly effective palliative procedures but who may be struggling with providing optimal care to patients with severe cancer pain. We hope our experience will assist programs in developing a process that ensures the most useful available palliative procedure(s) is/are offered to the right patient, at the right time, and by the right specialist(s).

## Materials and methods

This was a retrospective case series. Ethics board approval was obtained from the BCCA/University of British Columbia ethics review board. Electronic charts were reviewed for all patients referred to the MIPP conference between December 20, 2011 and June 25, 2013. All were cancer patients experiencing severe pain, though pain was not necessarily direct due to malignancy. The only criterion for inclusion was having been referred to MIPP conference up to the point where data collection was cut off for preparation of this report. No referred patients were excluded from the review. Life expectancy was not a criterion for referral for MIPP conference, but is taken into consideration in the discussion of each patient and often influences the choice of preferred management approach.

Our objectives were to assess the documented perception of pain relief from the procedures performed and to explore the role that the case conference played in clinical decision-making. Patients were not systematically assessed before and after the procedures, so a pragmatic approach of either a clinically meaningful reduction in maximum and average pain scores of at least 2 out of 10 [12] or a clear description of positive effect in the narrative chart was used to denote benefit. Patients were often referred through the Pain and Symptom Management/Palliative Care (PSMPC) clinic, but not all came to the case conference by that pathway as oncologists were encouraged to bring their patients forward for discussion directly as well. Those attending the PSMPC clinic routinely rated their minimum, maximum, and average pain, single-item quality of life (QOL) score, and Edmonton Symptom Assessment System (ESAS) scores. Also, Palliative Performance Scale (PPSv2) was documented by staff, amongst other data collected on a paper assessment tool which had been in use for many years, with contributions from patient self-report and also staff assessments. This tool was not used in oncology clinics; therefore, narrative references in patient charts to pain, function, and mobility before and after procedures were also noted.

Statistical analysis was limited in this simple observational study, but where appropriate was performed using Statistical Product and Service Solutions (SPSS) statistical software version 14.0, with comparisons conducted using a paired samples *t* test.

## Results

During these first 19 months of the MIPP conferences, there were 103 referrals among 97 patients. Most conferences discussed between two and five patient referrals and also often included informal follow-up clinical reporting on outcomes from previously discussed cases. This follow-up information was consistently identified as being very valuable to those performing the interventions.

The average age at referral was 63.8 years. The most common cancers were breast, lung, and prostate. The referring physicians' disciplines are presented in Fig. 1. Procedures were performed following 66 (64.1 %) of the referrals in 63 patients. Patient characteristics are described in Table 1. The reasons why the remaining 37 (35.9 %) case referrals did not undergo a procedure are shown in Table 2.

Sixty-nine procedures were performed in total (Table 3). Procedures were performed in two separate sittings for three cases. Thirty-six (52.2 %) procedures involved multiple interventions, for example, radiofrequency ablation plus vertebroplasty, cryoablation with vertebroplasty and nerve blocks, and multiple vertebroplasties.

In 28 (42.4 %) of the 66 referrals leading to procedures, the referring physicians specified a procedure to be considered. The conference concurred with the proposed procedure in 20 (71.4 %) of these cases, but recommended an alternative procedure in 8 (28.6 %). Sixty-two (93.9 %) procedures were performed in accordance with conference recommendations. Four procedures were performed which were different to the conference recommendation for a variety of reasons (see Table 4).

Pain scores were assessed on a numerical scale out of 10, in a modification of the ESAS. Minimum, maximum, and average pain scores both before and after a procedure were available for 23/69 (33.3 %), 40/69 (58.0 %), and 23/69 (33.3 %) cases, respectively (Table 5). In five cases where only one pain score was provided, it was categorized as maximum pain. Maximum pain is considered the most important of the three pain scores in terms of impact on function, which has a powerful impact on quality of life [13]. Post-procedure pain scores were collected days to weeks after the procedure, but were only available minutes to hours afterwards in six cases.

Mean pain scores were reduced in all three categories post-procedure. Maximum pain fell from 8.1±1.4 to 4.6±2.8 ($P<0.001$), average pain fell from 6.0±1.6 to 3.9±2.4 ($P=0.005$), and minimum pain fell from 3.7±2.1 to 1.5±1.6 ($P=0.001$).

Twenty-eight (40.6 %) patients had not attended the PSMPC clinic so there were no documented pain scores. There was, however, almost always adequate chart documentation with which to make a clear judgment about extent of benefit from the procedure. In fact, even when available, the impact of the procedure assessed by pain scores sometimes conflicted with the narrative, with scores tending to underreport benefit as compared with narrative statements. This is a well-described limitation of numerical pain scores, with some people having difficulty rating their pain numerically [13]. Two examples of this are:

- Pre-procedure pain scores (minimum, maximum, average) are 4, 6, 5; post-procedure pain scores are 5, 7, 6, respectively.

  Chart narrative: "*Following the procedure she felt a significant improvement* […] *and appears to be better from the pain perspective*."
- Pre-procedure pain scores are 2, 4, and 10; post-procedure pain scores are 2, 4, and 7.

  Chart narrative: "*He has done extremely well over the weekend and today says he essentially has no pain. He speaks of the procedure in terms of* "*wonderful*" *and* "*miraculous*"

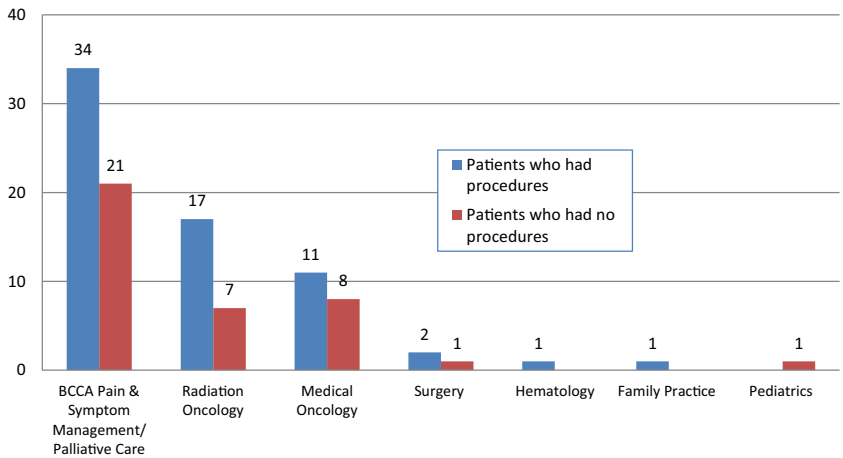


**Fig. 1** Outcome of referral by source discipline

**Table 1** Patient characteristics

| | | All patients *N*=97 (%) | Patients who had procedure(s) *N*=63 (%) | Patients who did not have a procedure *N*=34 (%) |
|---|---|---|---|---|
| Age | Median (range) | 65.1 (15.3–90.7) | 65.2 (39.0–90.7) | 62.6 (15.3–86.0) |
| Gender | Male | 52 (53.6) | 32 (50.8) | 20 (58.8) |
| Site of primary cancer | Breast | 17 (17.5) | 11 (17.5) | 6 (17.6) |
| | Lung | 15 (15.5) | 12 (19.0) | 3 (8.8) |
| | Prostate | 14 (14.4) | 9 (14.3) | 5 (14.7) |
| | Lower gastrointestinal tract (including anus) | 10 (10.3) | 6 (9.5) | 4 (11.8) |
| | Hematologic | 9 (9.3) | 8 (12.7) | 1 (2.9) |
| | Sarcoma (including adipose, bone, and muscle) | 9 (9.3) | 6 (9.5) | 3 (8.8) |
| | Gynecologic | 5 (5.2) | 3 (4.8) | 2 (5.9) |
| | Renal | 5 (5.2) | 1 (1.6) | 4 (11.8) |
| | Upper gastrointestinal (including liver and pancreas) | 4 (4.1) | 2 (3.2) | 2 (5.9) |
| | Head and neck | 4 (4.1) | 3 (4.8) | 1 (2.9) |
| | Bladder | 1 (1.0) | 0 (0.0) | 1 (2.9) |
| | Skin | 1 (1.0) | 1 (1.6) | 0 (0.0) |
| | Unknown | 3 (3.1) | 1 (1.6) | 2 (5.7) |

Age at first referral was used if patients were referred more than once

Of those without numerical pain scores, 21/28 had the clinical impact of the procedure documented clearly in their narrative chart. Examples include:

- "*He had approximate 40% improvement in his pain overall*."
- "*He says that the pain in his right groin is significantly improved ….. helped about 80% of the pain*."
- "*The patient was unable to evaluate his back pain on a visual analog scale but he reported mild improvement after the procedure*."
- "*The following day the patient described substantial improvement in pain, without the need of breakthrough pain medication and essentially no pain in bed*."
- "*She has had dramatic improvement in her pain. She is very happy with the outcome of the procedure. She has been able to cut down her gabapentin and hydromorphone doses substantially.*"

Fifty-nine (85.5 %) of the procedures provided a measure of pain relief. Of these, three patients experienced improvement for less than a week. It was not possible to determine benefit following two procedures; one where the patient left against medical advice and another who died before follow-up. In 8 (11.6 %) procedures, there was no apparent pain benefit (Table 6), in two of which failure was directly attributed to technical difficulties preventing completion of the desired procedure. Hence, overall 56/69 (81.2 %) of procedures produced clinically meaningful benefit which persisted for at least a week.

Most symptoms, apart from QOL and nausea, showed a trend toward improvement post-procedure (Table 7). Though this data was only available for a minority of patients, the documented individual impact was often substantial. Note that the QOL scale reports 10 as the best possible quality of life, whereas the pain and other symptom scores all denoted 10 as worst symptom severity.

**Table 2** Reasons for not having a minimally invasive palliative procedure

| | | |
|---|---|---|
| MIPP conference provided alternate recommendations | Optimize medical management first | 10 |
| | Repeat radiation therapy | 2 |
| | Cause of pain determined to be due to a stroke, and the patient was referred onto chronic non-cancer pain clinic | 1 |
| Patient factors | Patient improved on other therapy | 10 |
| | Patient died | 6 |
| | Patient improved spontaneously | 3 |
| | Procedural risk was too high for patient | 2 |
| | Patient progressed to spinal cord compression, leading to lack of mobilization and reduced pain | 1 |
| | Patient fell and was subsequently hospitalized | 1 |

**Table 3** Procedures performed

| | |
|---|---|
| Single intervention procedures | *N*=33 |
| Cementoplasty at one site | 12 |
| Nerve block/ablation | 11 |
| Epidural steroid injection | 6 |
| Tumor cryoablation | 2 |
| Spinal cord stimulator implant | 1 |
| Corticosteroid injection of one joint | 1 |
| Multiple intervention procedures | *N*=36 |
| Cementoplasty at two vertebral levels | 8 |
| Cementoplasty at three vertebral levels | 8 |
| Cementoplasty and tumor cryoablation | 7 |
| Multiple facet joint injections | 3 |
| Open spinal surgery | 4 |
| Cementoplasty, cryoablation, and nerve block/ablation | 2 |
| Cementoplasty and epidural steroid injection | 1 |
| Cementoplasty and facet joint injection | 1 |
| Cementoplasty and nerve block | 1 |
| Cementoplasty and tumor radiofrequency ablation | 1 |

- "*He says this has had a tremendous positive impact on his QOL, which he puts between 6 and 8/10. He is now off opioids completely, having decided against medical advice to go "cold turkey" but he is now 6 weeks opioid-free and is feeling very good about it.*"

Charts were also explored for effect of the procedures on function and/or mobility. Direct comparisons pre- and post-procedure were available for 43 out of the 69 procedures. Thirty (69.8 %) patients had improved functional outcomes. Reduced mobility was expected for one case; the patient made an informed decision to undergo rhizotomy in order to manage refractory leg pain, understanding that some motor loss would result.

Examples include:

- ***Pre-procedure*****:** *She is not working and has been off on disability for over 2 years*. ***Post-procedure*****:** *She is now working 4 full days a week with Wednesday off in the middle and feels she is coping very well …. She is not doing heavy physical work. ….working 9-h shifts and feels she can manage this.*
- ***Pre-procedure*****:** *He is unable to do any physical activity now, having been fairly active just over a month ago. He continues to walk with the assistance of a 4-wheel walker and two sticks. His days are spent seated due to his pain and persistent bilateral foot drops, making ambulation tiring and quite challenging.* ***Post-procedure*****:** *I note that he* [*is doing*] *a lot of fairly heavy physical work in the form of woodwork. He is helping to construct a sunroom on the back of his home and tells me that this morning, he was … in the basement and then carrying all the wood up and down the stairs.*
- ***Pre-procedure*****:** *He is walking approximately 4 blocks per day.* ***Post-procedure*****:** *…. he is walking much farther, now 6 blocks as opposed to 3 blocks, without becoming tired. …. since he is becoming more mobile his depression has eased and he is managing to sleep better.*

## Survival

Follow-up was attempted for all patients and to the time of submission 37/63 (58.7 %) patients had died. Survival post-procedure ranged from 22 to 557 days, with a mean of 200 days. The exact date of death could not be found for two patients and was estimated based on information in the patients' chart. Patients were referred from many different regions and were cared for by multiple referring physicians. The BCCA does not have inpatient palliative care beds, so patients were cared for by disparate palliative care teams when hospitalization was required, or by community hospice teams when patients were approaching end of life at home. Long-term follow-up information was therefore sometimes difficult to track down.

Examples of still-surviving patients include a patient with hereditary osteochondromatosis who underwent a C6 nerve root block which has been repeated several times since, and a patient with a prior history of lymphoma who underwent multiple vertebroplasties and subsequently discontinued all analgesics, remaining in remission to time of submission.

**Table 4** Procedures performed that were different from MIPP recommendations

| Conference recommendation | Procedure performed |
|---|---|
| L2 nerve block (and ablation if responsive) | Healthcare provider proceeded with T12 epidural steroid injection following discussion of symptoms with patient |
| Spinal surgery | Patient chose to proceed with a less invasive option (lumbar epidural steroid injection) instead |
| L5 nerve block, then consider vertebroplasty | Healthcare provider proceeded with L5 epidural steroid injection |
| Cementoplasty of 7th rib | Healthcare provider proceeded with 7th intercostal nerve block. |

**Table 5** Mean pain scores

| | Pre-procedure Mean score±SD | Post-procedure Mean score±SD | Difference (95 % CI) | *P* value |
|---|---|---|---|---|
| Minimum pain *N*=23 | 3.7±2.1 | 1.5±1.6 | 2.2 (1.1–3.3) | 0.001 |
| Maximum pain *N*=40 | 8.1±1.4 | 4.6±2.8 | 3.5 (2.6–4.4) | <0.001 |
| Average pain *N*=23 | 6.0±1.6 | 3.9±2.4 | 2.0 (0.7–3.4) | 0.005 |

Post-procedure pain scores were collected from the first documented chart entry after the procedure, which varied from days to weeks later, and were only available minutes to hours post-procedure in six cases

## Discussion

In the first year and a half of MIPP case conferences, the multidisciplinary discussion and detailed review of imaging was found to make a significant contribution to the course of patient management, with over 80 % of patients who went on to have procedures experiencing clinically significant analgesic benefit; sometimes remarkably so. Function also improved in many patients despite sometimes very advanced cancer. Review of imaging played a pivotal role in deciding on the optimal approach. For example, recommending epidural injection rather than cementoplasty due to identifying more extensive disease than previously recognized; or recommending cryoablation to a compressing mass rather than a nerve root block to treat causing pain from nerve root compression. All feedback solicited from referring physicians was positive, for example "trial of nerve block which would not have occurred to me as a potential treatment; saved a trip

**Table 6** Procedures which did not result in pain reduction

| Age (years) | Site of primary cancer | Procedure | Quote suggesting non-benefit | Reason attributed to unsuccessful procedure (if documented) |
|---|---|---|---|---|
| 39 | Myelin sheath | Spinal cord stimulator | "She had a 2-week trial of spinal cord stimulation. This was unsuccessful. Hardware was removed. She was discharged with her usual amount of pain." | |
| 67 | Esophagus | Vertebroplasty and cryoablation at T9 | "She underwent a vertebroplasty, but, unfortunately, she does not feel any different as compared to before." | Disease progression: she went on to have surgical decompression and removal of the lesion 2 months later |
| 48 | Bone marrow | Vertebroplasty and cryoablation at T8 | "He tells me that the T8 vertebroplasty he had was of dubious result; however, I think that his pain from his other levels is making it hard to judge this response." | Disease progression: he developed new compression fractures and underwent more cementoplasties |
| 55 | Nasopharynx | Nerve root block at C3 | "The patient did not feel any improvement, even transiently. He is wondering if it is possible that they 'missed' the proper nerve because it sounds like they did not have a long discussion prior to doing the procedure." | |
| 50 | Bone marrow | Nerve root block at S1 | "Overall, it did not appear that his pain has improved at all." | Non-neurogenic cause of pain: involvement of sacral ala and periosteum confused for nerve root pathology |
| 65 | Rectum | Open spinal surgery from C4 to T4 | "She has had increased pain in her neck. She is having difficulty lifting her legs up and she is unsteady and pain in her arms, particularly the right one has increased. At discharge, she had a persistent C5, C7, C8 and T1 palsy…" | Operative complication: no other explanation noted on CT |
| 64 | Anus | Vertebroplasties at L3 to L5 | "She tells me that since this procedure, she has had more pain in the mid back radiating to the lateral thigh on the left." | Operative complication: vertebroplasties may have irritated a nerve root |
| 65 | Liver | Vertebroplasty and radiofrequency ablation at T11 | "Vertebroplasty was a very painful procedure for him and did not relieve his pain. Since the procedure, he has had escalating lower back pain and burning pain in the anterior aspects of both thighs." | Disease progression: subsequent imaging found progressed T11 metastasis (unrelated to cementoplasty) compressing the spinal cord from the right laterally to cause spinal canal stenosis |

**Table 7** Changes in palliative performance scale, quality of life score, and Edmonton symptom assessment scale analysis

| Item/symptom score | Improvement ≥3 points | Improvement 1–2 points | No change | Decline 1–2 points | Decline ≥3 points |
|---|---|---|---|---|---|
| Palliative performance scale[a] (*N*=15) | 1 | 3 | 8 | 3 | 0 |
| Quality of life (*N*=17) | 4 | 3 | 2 | 8 | 0 |
| Tiredness (*N*=16) | 3 | 5 | 6 | 0 | 2 |
| Nausea (*N*=16) | 1 | 5 | 0 | 5 | 1 |
| Depression (*N*=18) | 2 | 7 | 4 | 3 | 2 |
| Anxiety (*N*=17) | 3 | 3 | 7 | 3 | 1 |
| Drowsiness (*N*=16) | 2 | 6 | 5 | 2 | 1 |
| Appetite (*N*=16) | 4 | 2 | 6 | 1 | 3 |
| Well-being (*N*=15) | 2 | 4 | 8 | 0 | 1 |
| Shortness of breath (*N*=16) | 2 | 5 | 5 | 1 | 3 |

[a] 1 point is equivalent to 10 % on the palliative performance scale

to Toronto or the US for an MRI-guided treatment that would not have been optimal." The only negative comments were around frustration at limited procedure availability (due to lack of dedicated interventional radiology time) and paucity of appropriately skilled interventionists outside Vancouver.

Four procedures were performed that differed from the conference recommendation (Table 4). Of these, one patient experienced only transient improvement in pain lasting 3 days; another patient experienced some improvement but had significant pain flares periodically, and the other two patients reported useful but limited benefit. Another patient was referred for consideration of vertebroplasty, but the conference recommended open spinal surgery. Initially, the patient received only radiation therapy, but, 2 months later, developed spinal cord compression and successful surgery was performed urgently at that time.

These results demonstrate that most patients derived a clear analgesic benefit from a diverse collection of recommended palliative procedures. Clinically, meaningful benefit is understood to be shown by a change of at least 1.2 points out on a 0–10 scale [12]. Our patients' mean maximum, minimum, and average pain scores fell by 3.5, 2.2, and 2.1 points, respectively. Most other symptoms also showed a trend toward improvement. While function and mobility improved in the majority of patients, a significant proportion (30.2 %) experienced no functional benefit. Change in function and mobility was generally correlated with change in pain. In eight patients, pain improved but function did not, but in no cases did function improve without lessening of pain.

Complication rates have been reported to be as high as 10 % for vertebroplasties in metastatic disease [14]. Four major complications were documented: extravasation of cement from vertebroplasty causing leg weakness; nerve root irritation from vertebroplasty; C5-T1 palsy resulting from open spinal surgery (not a minimally invasive procedure); and one patient experienced fever and diarrhea after removal of a temporary trial of spinal cord stimulator, which was most likely unrelated to the procedure. Thus, the rate of major adverse events directly attributable to a minimally invasive procedure was 2 out of 69 procedures (2.9 %). We consider this a very acceptable risk considering the severe pain the patients were suffering and the limited alternative treatment options.

## Limitations

This study has several limitations. Though most patients had their pain assessed by a validated assessment tool, not all patients were able to be thoroughly assessed before and after their procedure(s). There was no standardized method of assessing function and mobility, and referred patients were an unselected heterogeneous mix of people with different cancer types at different stages and with different reasons for consideration of a MIPP. Data was not able to be collected at a consistent interval following the procedures, and long term follow-up was very challenging because of patients being referred to our tertiary services from a wide geographic area.

Medication usage was not systematically documented, and minor adverse effects from procedures may not have been recorded in patient charts. Patients often have multiple different sources of pain and benefit in one may be overshadowed by development of another which can confound pain assessment. The rich narrative of the patients' charts was very helpful in evaluating effectiveness of procedures in the majority of the patients, and we feel this information is valid and useful.

Despite widespread use of numerical pain scales, their limitations were also well-illustrated by this study. The non-numerical outcomes documented in our study were often much more meaningful than the pain scores. In future studies, we propose that perceived percentage pain benefit, verbal impact scales (better/worse/same etc.), or functional capacity may be more appropriate methods of outcome evaluation than differences described purely by a numerical pain scale.

## Conclusion

Our mixed cancer patient population had severe pain despite use of appropriate analgesic medications, including access to methadone, lidocaine infusion, and transmucosal opioids. All cancer care settings have similar patients to these, and most tertiary referral centers have a wide variety of complex interventions available through different specialty colleagues. MIPPs can provide further valuable treatment options for some of these patients, and our oncologists were interested in learning more about these procedures. Despite often very complex comorbidities and logistical challenges, there was significant clinical benefit from over 80 % of the minimally invasive palliative procedures performed.

The multidisciplinary case conference made a significant impact on the course of patient management, with over a quarter of the conference recommendations differing from the procedure suggested by the referring physician. The presence of the referring physician, palliative care, and interventional specialists (in person or by video link) offered an excellent level of communication, allowing sharing of highly specialized expertise and understanding, and optimized the conditions around the procedures.

It is unlikely that large randomized controlled studies of these types of complex intervention will ever be achievable, thus reporting of case series is important in informing future cancer care service developments. The need to keep patients out of hospital has never been more acute, and early integration of palliative care into oncology is now the standard of care [15]. We hope that by reporting our experience with the BCCA MIPP conference other cancer centers will be encouraged to make minimally invasive palliative procedures more available to those suffering from severe pain and also to encourage all the related disciplines together to share their expertise in caring for these patients.

**Conflict of interest** This project received funding from the University of British Columbia via the "summer student" program to support Ms. Chu's participation. Also, Amgen provided an unrestricted educational grant to assist with providing refreshments for attendees at the MIPP conferences. The authors have full control of all primary data and agree to allow the journal to review their data if requested.

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