# Posterior hip pericapsular neurolysis (PHPN) for inoperable hip fracture: an adjunct to anterior hip pericapsular neurolysis

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## ABSTRACT

**Background** The development of anterior hip neurolysis has made an appreciable impact on the management of patients with inoperable hip fracture. Nonetheless, suboptimal analgesic benefit was still observed in some patients. We therefore developed a novel posterior hip pericapsular neurolysis (PHPN) to complement anterior hip neurolysis in inoperable hip fracture.

**Methods** In this retrospective review, we analyzed patients who responded suboptimally (defined as composite pain score moderate or higher on hip flexion 80°) to the anterior hip neurolysis from July 2019 to March 2021. The patients received additional PHPN if the composite pain score was suboptimal. The percentage of patients with dynamic composite pain scores on hip flexion to 80° and on gentle hip external and internal rotation on post-intervention day 5 was then evaluated.

**Results** Among the 70 patients who were reviewed in the study period, 20 patients who partially responded to anterior hip neurolysis received an addition of diagnostic posterior hip pericapsular block. Eighteen patients were the positive responders and PHPN was then performed. Among the PHPN recipients, a high percentage with satisfactory dynamic pain control was observed with 78% on hip flexion 80° and 83% on hip external/internal rotation on day 5 following the intervention. No procedural adverse event was noted.

**Conclusions** While most patients responded satisfactorily to anterior hip neurolysis, we concluded PHPN could be an effective adjunct to manage suboptimal pain control after anterior hip neurolysis in inoperable hip fracture.

**Trial registration number** NTWC/REC/21061.

## INTRODUCTION

Geriatric hip fracture instigates a significant burden to healthcare systems worldwide. Many patients have multiple comorbidities, some of which may be severe enough to impose unacceptable perioperative risks to anesthesia. For those who are wheelchair users or bedridden patients, rehabilitation potential after hip surgery remains low. Since we incorporated anterior hip pericapsular neurolysis to manage pain associated with inoperable hip fractures in 2016,[1 2] this is now a standard management option for patients with hip fracture with significant comorbidities and poor rehabilitation potential at our institution. In those patients who received anterior hip neurolysis, we noticed a small subpopulation did not obtain an analgesic effect sufficient enough to progress in their recovery and rehabilitation. Therefore, we added a novel posterior hip pericapsular neurolysis (PHPN). The objective of this retrospective review is to examine the analgesic and functional benefit of the addition of PHPN to anterior hip neurolysis.

## METHODS

### Study design

#### Inclusion and exclusion criteria

This was a retrospective review of the cohort of patients with inoperable hip fractures referred to New Territories West Cluster Pain Management Unit for possible hip neurolysis from July 2019 to March 2021. To be eligible for neurolysis, the following criteria were established: (1) radiographic confirmation of acute traumatic hip fracture (neck of femur or trochanteric) within 4 weeks with failed conservative pain treatments (tractions, oral or injectable analgesics); (2) surgical inoperability defined as unacceptable perioperative risks jointly agreed by orthopedic surgeon and anesthetist; (3) moderate-to-severe pain according to patients or their caregivers; (4) minimal ambulatory potential as determined by orthopedic surgeon and (5) positive diagnostic block. The service excluded the following for neurolysis: (1) inability to lay supine; (2) significant cardiac morbidity with hemodynamic instability; (3) respiratory failure requiring >50% $O_2$ supplement or assisted ventilation; (4) previous ipsilateral total hip arthroplasty or hip neurolysis; and (5) platelet count $<50 \times 10^9$/L or international normalized ratio >1.5. For eligible cases, written informed consent was sought from the patients, their powers of attorney or legal caregivers subject to the cognitive status of patients.

From July 2019 onwards, as a standard institutional practice, we added this new posterior approach when anterior hip neurolysis failed to offer satisfactory pain relief for our patients. We defined the criterion as a moderate or higher dynamic composite pain score on hip flexion 80° 20 min after anterior hip neurolysis. Both the anterior and possible posterior chemical neurolysis procedures were performed in the same setting for a couple of practical reasons (figure 1). First, this patient population was associated with significant multiple comorbidities, and so we sought to minimize interfacility patient transfers. Second, our institution was the only facility to offer this neurolysis procedure, and therefore access to this service was limited.

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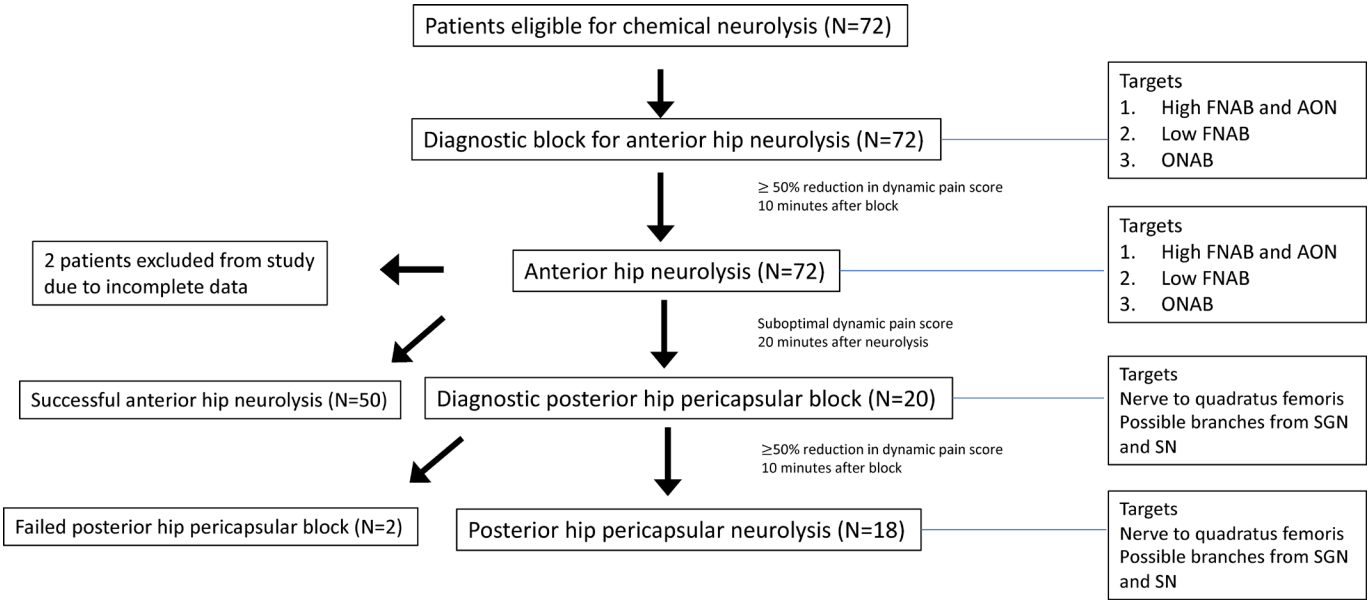


**Figure 1** A flow chart to show the sequence of anterior and posterior diagnostic block and neurolysis, as well as the sequential points to patient status at each step. AON, accessory obturator nerve; FNAB, femoral nerve articular branches; ONAB, obturator nerve articular branches; SGN, superior gluteal nerve; SN, sciatic nerve.

### Pain assessment

Due to the challenge of applying a single pain assessment tool to our patients given the high prevalence of cognitive impairment or limited mental capacity, we used the Numeric Rating Scale (NRS), the Verbal Descriptive Scale (VDS), or the Pain Assessment in Advanced Dementia Scale (PAINAD) when applicable.[3–6] The VDS quantifies subjective painful sensations through words representing different intensities of pain, such as none, mild, moderate, severe pain, very severe pain, and most intense pain possible. Studies demonstrated that older adults preferred the VDS when given a choice.[5 7] The PAINAD is a 5-item observational tool with numerical equivalents for each of the five behavior items (breathing, negative vocalizations, facial expression, body language, and consolability). Each of the five assessments contains a range from 0 to 2, with total scores ranging from 0 to 10. The PAINAD was noted to be an accurate assessment tool in the adult patient population for whom self-reporting was unreliable due to their altered cognitive abilities. Studies showed a positive correlation between PAINAD and NRS and demonstrated equivalency between NRS and VDS.[8] Therefore, we categorized the above tools into four composite pain scores to enable statistical analyses (table 1). This method was adopted in the assessment in our first case series.[2]

### The modified approach of anterior hip articular branches chemical ablation

The technique of anterior hip neurolysis was described previously with slight modifications.[2] Patients received a diagnostic block at the anterior hip articular branches, followed by alcohol neurolysis in the same setting for those with positive diagnostic block under real-time ultrasound guidance (Samsung RS85, 5–12 MHz linear probe or 2–8 MHz curved probe depending on the depth of target). In summary, this pericapsular approach consisted of three separate diagnostic injections. The target of the first injection was between the anterior inferior iliac spine and the iliopubic eminence deep to the psoas tendon for the high femoral nerve articular branches and accessory obturator nerve.[9 10] The target of the second injection was superficial to the iliofemoral ligament over the femoral head (low femoral nerve articular branches).[10] The target of the third injection was at the inferomedial acetabulum for articular branches of obturator nerve.[9 10] The medication used was levobupivacaine 0.25%–0.5% with volumes 4, 3 and 2 mL, respectively, at those three sites. A positive diagnostic block was defined as a decrease of ≥50% in the composite pain score with hip flexion to 45° 10 min after the block. For the responders, the same amount of 100% alcohol (4, 3 and 2 mL, respectively) was administered to the above targets in the same setting.

### Posterior hip pericapsular neurolysis

For those patients with suboptimal pain control (composite pain score moderate or higher on hip flexion to 80° 20 min after anterior hip neurolysis), PHPN was offered if a positive diagnostic posterior pericapsular block while the patient was still in the procedure room (figure 1).

The PHPN was performed in a lateral decubitus position with the fracture limb as the non-dependent side. The non-dependent hip could be flexed as tolerated. The target was the superolateral

**Table 1** The categorization of NRS, VDS and PAINAD into the composite pain score

| Composite pain score | No pain | Mild pain | Moderate pain | Severe pain |
|---|---|---|---|---|
| NRS | 0 | 1–3 | 4–6 | 7–10 |
| PAINAD | 0 | 1–3 | 4–6 | 7–10 |
| VDS | No pain | Slight to mild pain | Moderate pain | Severe, very severe, and the most intense pain possible |

NRS, Numeric Rating Scale; PAINAD, Pain Assessment in Advanced Dementia Scale; VDS, Verbal Descriptive Scale.



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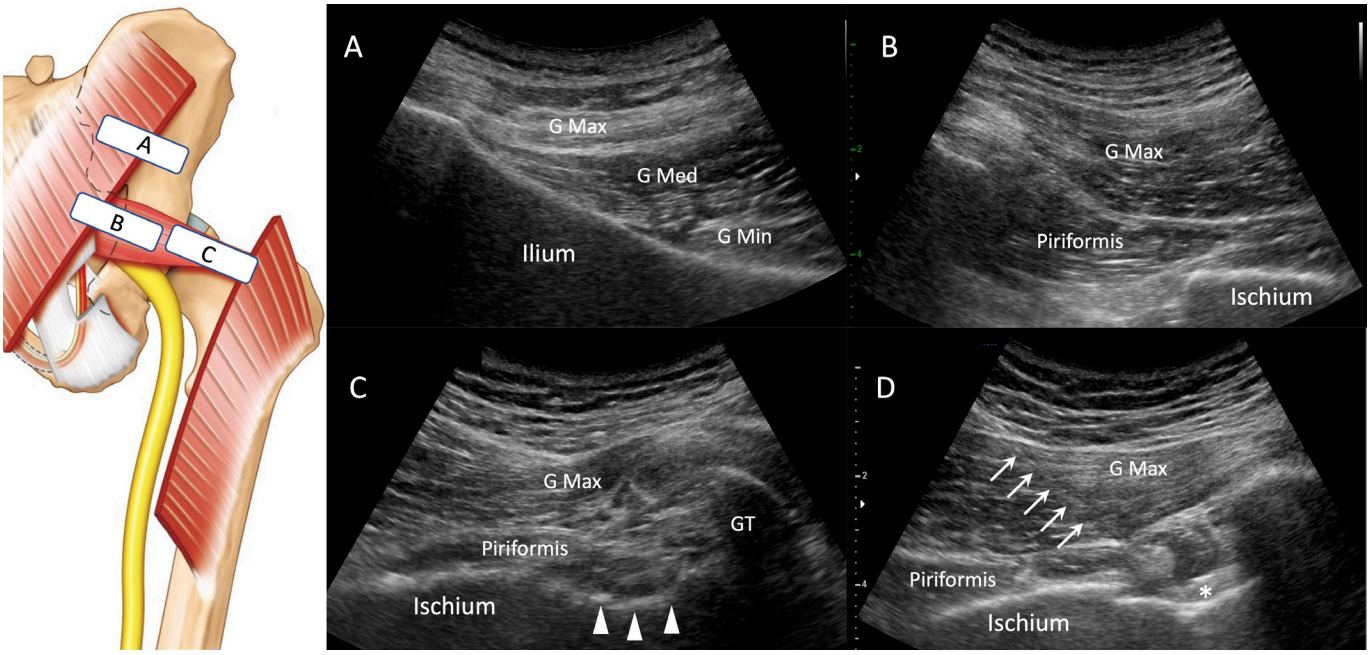


**Figure 2** The schematic diagram and sonographic images for PHPN. The schematic diagram on the left shows the positions of probe. (A) The probe is over the ilium showing the three gluteus muscles. (B) The probe is at the greater sciatic foramen and both the G Max and piriformis are revealed. (C) The probe is slid laterally along the piriformis plane over ischium and GT. At this scan, the superolateral part of posterior hip capsule (white arrowheads) is visualized. (D) A needle (white arrows) is inserted in a medial-to-lateral direction towards the ischiofemoral ligament over the superolateral part of posterior capsule. Local anesthetic, followed by alcohol, is then injected between piriformis and ischiofemoral ligament (*). G Max, gluteus maximus; G Med, gluteus medius; G Min, gluteus minimus; GT, greater trochanter; PHPN, posterior hip pericapsular neurolysis. Reprinted with permission from Philip Peng Educational Series.

part of the posterior capsule where it was further away from the sciatic nerve and could be easily identified. A curved probe 2–8 MHz was initially placed over the ilium and then slid caudally until the greater sciatic foramen was visualized (figure 2). From there, the probe was moved laterally along the piriformis until the greater trochanter and the superolateral part of posterior hip capsule came into view. A 22-gage 10 cm Quincke needle was then inserted towards the plane between piriformis and the ischiofemoral ligament in a medial-to-lateral direction and 1–1.5 mL 0.25%–0.5% levobupivacaine was injected after negative aspiration. A positive diagnostic block was defined as a reduction of the respective pain score more than 50% on gentle hip internal and external rotation to around 5° in the lateral decubitus position after 10 min while the needle was kept in situ. For the positive responder, the needle position was reconfirmed by ultrasound before injecting 1–1.5 mL absolute alcohol. The stylet was reinserted before needle withdrawal. The inferoposterior hip capsule was spared.

### Post-intervention assessment

For the postoperative surveillance, we visited all patients for complications and efficacy after hip neurolysis as our standard departmental practice. All the assessments were carried out by pain nurses. The follow-up pain assessments were performed 20 min after the neurolytic procedure and on post-intervention day 5 at the hospital. We measured the pain intensity on hip flexion 80° in the recumbent position and during gentle internal and external rotation of the hip by an appropriate pain scoring tool, as explained above. We also documented any lower limb neurological deficit.

### Study outcomes

We chose the outcomes that reflected the need for the nursing and medical teams in providing the care for this challenging group of patients as our primary outcome, that is, the percentage of patients with an acceptable composite pain score mild pain or lower on hip flexion 80° and on gentle internal/external rotation on post-intervention day 5. The former parameter allowed the patients to sit up in the chair and the latter one allowed the nursing team to turn the patients. Post-intervention day 5 was chosen as the timing of assessment because the full effects of alcohol neurolysis usually take a few days according to our institutional experience. It is also impractical to call back fragile patients for follow-up assessments at a later time point since many of them would be discharged in a week if the pain control was satisfactory without any active medical issues.

Since most hip fractures would take 12 weeks or so to heal, long-term pain control was documented in the outpatient clinic 4–6 months after the intervention. The incidence of any lower limb neurological deficits was also recorded.

## RESULTS

Seventy-two patients were included in the review period. Only 70 patients were analyzed because of incomplete data in two patients. Following the anterior neurolysis, satisfactory pain control was achieved in 50 patients (71%). Therefore, 20 patients with suboptimal dynamic pain score were identified and diagnostic posterior pericapsular block was then performed to these patients according to our institutional protocol. Eighteen of them responded to the diagnostic posterior pericapsular blocks and subsequently proceeded to PHPN (figure 1). The demographics of patients who received PHPN are shown in table 2.



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**Table 2** Patient demographics (N=18)

| | |
|---|---|
| Mean age (years) | 88.5 |
| Range (years) | 76–103 |
| Sex | M:F 7:11 |
| Fracture type | Neck of femur: 6<br>Trochanter of femur: 12 |
| Other regional block for analgesia before neurolysis | Nil |
| Reason for neurolysis | Acute stroke: 2<br>Acute coronary syndrome: 2<br>Advanced congestive heart failure: 3<br>Severe aortic stenosis and chronic bilateral subdural effusion: 1<br>Advanced age with recent intraoperative supraventricular tachycardia: 1<br>Severe pulmonary hypertension with poor global myocardial function: 1<br>Advanced dementia and poor ambulatory potential: 4<br>Advanced age with end-stage renal failure: 2<br>Cancer for palliative care with a very limited lifespan: 2 |

Among these 18 PHPN recipients, on post-intervention day 5, 14 (78%) of 18 patients managed to attain a satisfactory range of hip flexion 80° or more after PHPN. Likewise, there were 14 (78%) and 15 (83%) of them who received PHPN managed to tolerate the dynamic pain on hip flexion 80° and on gentle external and internal hip rotation with the composite pain score mild or lower, respectively. The graphical illustration of the above outcomes is shown in figure 3.

During the long-term follow-up at 4–6 months in the review period, 7 out of the 18 PHPN recipients returned to the follow-up clinic, and 6 of them reported satisfactory pain control (composite pain score mild or lower). The remaining nine patients either defaulted or passed away. The overall 30-day mortality rate was 14%. There was no report of lower limb neurological deficit as a result of sciatic nerve block in all patients with PHPN.

## DISCUSSION

Hip neurolysis under ultrasound guidance has provided an important treatment option in the management of frail patients with hip fracture with severe comorbidities. In this study, as a result of a change in joint geometry, we demonstrated that the posterior capsule innervation could contribute to pain in a subpopulation (approximately 30%) of patients with hip fracture after anterior hip neurolysis. To address this, PHPN was developed and our study showed it could provide additional pain relief for this subpopulation with a positive response rate of about 80%.

The observation of suboptimal pain relief after anterior hip chemical neurolysis in a minority of patients led to further explorations of the functional anatomy of the hip joint. Gerhardt *et al* found that the highest concentration of nociceptive fibers was located in the anterior and superolateral hip capsule while the innervation of posterior and inferior capsule was mainly mechanoreceptors.[11] Recent anatomical studies also identified that the superoposterior labrum is richer in nociceptors than the inferoposterior one, although the density of nociceptors is richer in the anterior capsule.[12] The innervation of the posterior capsule came from nerve to the quadratus femoris (NQF), superior gluteal nerve and branches from the sciatic nerve. However, NQF provides the most consistent innervation to the posterior capsule.[13 14] This forms the anatomical basis of PHPN. From the safety point of view, Nagpal *et al* revealed approaching the articular branch of NQF could potentially block the sciatic nerve and/or denervate the quadratus femoris muscle.[14] The location of the sciatic nerve at this level may vary among individuals. To avoid the needle target from being too close to the sciatic nerve, we opted to target the superolateral part of posterior hip capsule which is more easily accessible by ultrasound with a bigger safety margin. This is also the location where the articular branch of NQF enters the posterior hip capsule.

We hypothesized, in some cases, the fractures may cause marked capsular distortion of hip as a result of a change of joint geometry. The capsular distortion would cause certain degrees of discomfort through posterior proprioceptors and the nociceptors concentrated in the superoposterior labrum. This can be reflected by the analgesic benefit of posterior hip block on the pain caused by gentle hip external and internal rotation in our study. Furthermore, joint innervation consists of silent nociceptors which are mechanoinsensitive when the joint is normal.[15] They, however, can be crucially involved in sensitized pain responses to low pH induced by PGE2 in humans.[16] Not surprisingly, such a rise in inflammatory mediators in the hip joint capsule is expected to be present in the context of fracture. Hence, the concept of silent nociceptor activation can contribute to the augmented pain intensity over posterior hip capsule despite successful anterior hip neurolysis. Another explanation is that pain hypersensitivity can be a consequence of cognitive impairment, which is common in this population.[17]

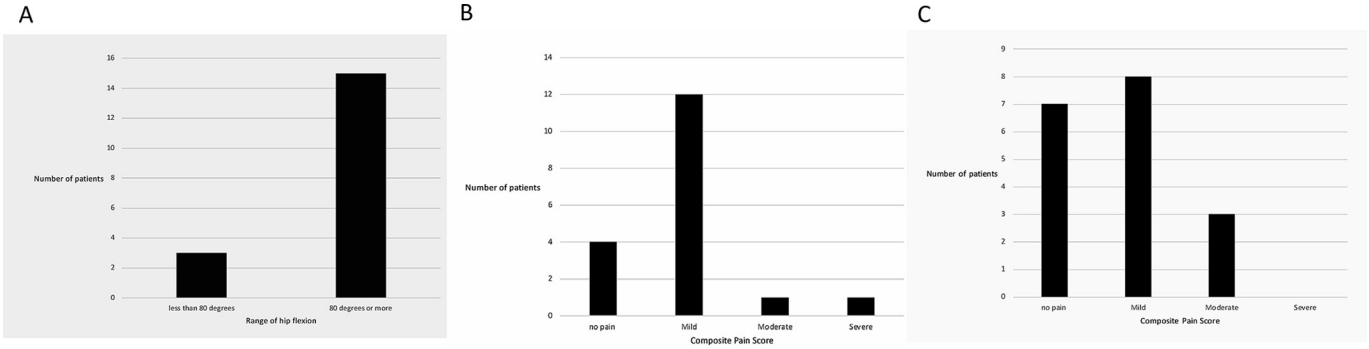


**Figure 3** The graphical illustration of outcomes after anterior hip neurolysis and PHPN on post-intervention day 5. (A) The range of movement on hip flexion that the patients could attain. (B) The composite pain score distribution on gentle hip internal and external rotation. (C) The composite pain score distribution on hip flexion to 80°. PHPN, posterior hip pericapsular neurolysis.



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Although we did not identify any lower limb numbness reflecting sciatic nerve injury, we cannot entirely exclude such a possibility with the small sample size of our cohort. Therefore, it is prudent to screen for any neurological deficit along the sciatic nerve distribution in the post-intervention assessment routinely. Piriformis may also be irritated by alcohol through the needle tract and this may manifest as gluteal pain with or without pseudo-sciatica symptoms. The use of absolute alcohol injection may lead to transient hemodynamic disturbances such as hypotension and tachyarrhythmia in susceptible individuals after the neurolysis.

We noticed most of the patients in the outpatient clinic follow-up 4–6 months after the neurolysis could attain satisfactory pain relief. This might be explained by the fact that most of the painful pathological processes would have subsided as a result of fracture healing by the time of follow-up.

There are several limitations in this study. It is a retrospective review and is limited by various biases. A retrospective methodology also leads to issues related to measurement, alignment of outcomes and prespecification of analyses. The anterior and posterior diagnostic block as well as neurolysis were all performed in the same setting without longer period for further real-time observation and assessment. However, the practicability of multiple transfers of this group of fragile population with comorbidities and the limitation of our resource were discussed previously. Unlike the anterior procedure, this technique requires the patient in a lateral position and this can be a disadvantage. However, all patients should have anterior neurolysis done first, thus a certain degree of analgesic benefit before turning. There is also a risk of inadvertent intra-articular injection and needle injury to the sciatic nerve. Despite a medial-to-lateral needle trajectory approach and a relatively farther distance from the sciatic nerve, it is still unknown about the optimal volume of absolute alcohol balancing the safety of sciatic nerve involvement and maximum analgesic benefit.

## CONCLUSIONS

We conclude that anterior hip neurolysis provides satisfactory analgesic benefit to most of the patients with inoperable hip fracture while the PHPN can be a useful adjunct when the pain relief is suboptimal after anterior hip neurolysis. We need a larger sample size and a randomized controlled trial to fully evaluate the safety and value of this technique in inoperable hip fracture and other chronic hip pain conditions. Further studies are warranted to evaluate the optimal volume of injectate for this approach.

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