

# Prevention of Sciatic Nerve Palsy in Complex Total Hip Arthroplasty Using the Checkpoint Nerve Stimulator

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## Introduction

Sciatic nerve injury is a rare but potentially devastating complication of total hip arthroplasty. Though it only occurs in about 1% of all cases and carries a good prognosis with at least partial recovery in 85% of palsies, it remains a feared complication for hip arthroplasty surgeons [1]. In the recorded literature, roughly half of palsies compromise isolated peroneal division of the sciatic nerve while the remaining affects both tibial and peroneal divisions [2]. There are several factors that predispose patients to development of a post-operative sciatic palsy such as development dysplasia of the hip (DDH), prior total hip arthroplasty, and severe degenerative joint disease (DJD) associated with significant shortening (>2cm) of the affected limb. Additionally, this complication is most commonly seen following THA in female patients [1].

Though in cases of severe pre-operative limb shortening, such as Crowe III and IV hip dysplasia, a femoral shortening osteotomy may be planned, less obvious cases may benefit tremendously from a means to monitor how nerve stretch and tensioning is affecting motor innervation [3]. Simple intra-operative measurements of nerve function pre- and post-trial reduction during THA may provide the surgeon with valuable information to guide implant selection and need for additional measures, such as adjunct femoral shortening osteotomy, in order to prevent a post-operative sciatic nerve palsy.

## Intra-operative Motor Nerve Assessment Procedure

The Checkpoint hand-held biphasic nerve stimulator (Checkpoint Surgical, Cleveland, OH) may be used intra-operatively during hip arthroplasty to assess sciatic nerve function. After isolating the sciatic nerve during a posterior approach to the hip, the Checkpoint® nerve stimulator is used to ascertain the baseline, pre-reduction and pre-lengthening threshold of the nerve. This is defined as the lowest amplitude (measured from 0.5mA to 20mA) and pulse width (0  $\mu$ s-200  $\mu$ s) that evokes a muscle contraction.

Additionally, it is vital that a muscular response is evoked for the peroneal division of the sciatic nerve as it is almost always involved in a palsy associated with the posterior approach. This is best accomplished by witnessing dorsiflexion of the ankle and great toe.

Technically, the author's preferred method of establishing the baseline threshold is to set the Checkpoint® to the lowest amplitude (0.5mA) and the pulse width to 0 microseconds initially. Find the sciatic nerve by gross palpation and apply the stimulator tip to the nerve, making sure that the ground is inserted in nearby tissue. The sciatic nerve does not need to be dissected out, and this may in fact disrupt nerve blood supply. Next, slowly increase the pulse width until ankle dorsiflexion is observed (*Figure 1*). This is the baseline threshold. If the pulse width is increased to 200 microseconds and no response is evoked at 0.5 mA, first check that the sciatic nerve is properly identified. Then, if still no response, increase the amplitude and start the process over, slowly increasing the pulse width from 0 microseconds until the desired response is achieved. The baseline threshold is recorded for later comparison after trial reduction.



*Figure 1: Dorsiflexion of the ankle is observed with stimulation of the sciatic nerve*

After the acetabulum is implanted, attention is turned to the femur and trial components are placed. The hip is then reduced and direct stimulation of the sciatic nerve is again performed. If the amplitude and or pulse width needed to evoke dorsiflexion at the ankle has increased, the sciatic nerve may be under undue tension and the patient may be at an increased risk of post-operative nerve palsy.

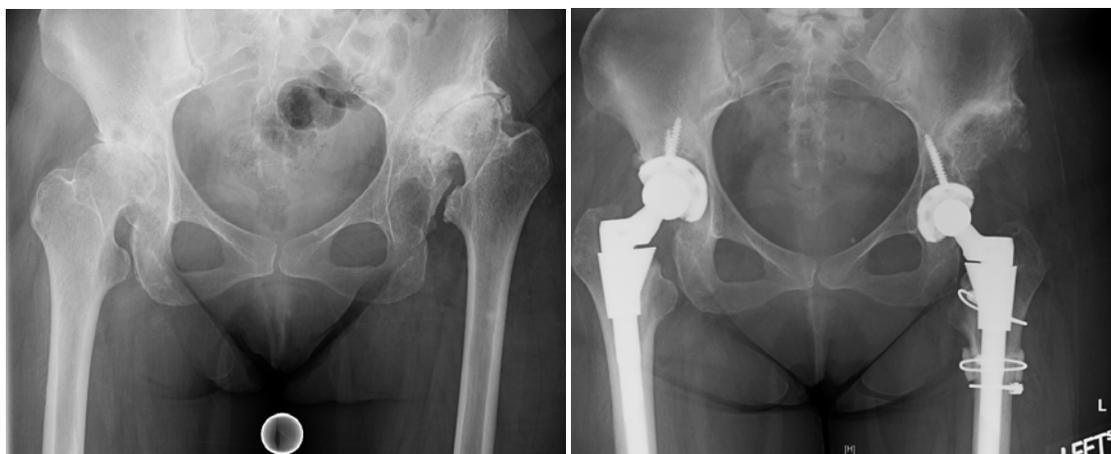
In this scenario the surgeon has several options:

- The femoral head neck length can be downsized (if possible) to achieve a stimulus close to the baseline threshold while maintaining acceptable hip stability.
- The femoral component neck angle and/or offset may be adjusted to decrease length.
- The femoral component may be downsized and placed deeper in the femur, effectively lowering the neck cut and shortening the femur.
- If all of the above modalities of decreasing tension do not yield an acceptable threshold, femoral shortening osteotomy should strongly be considered.

Additional causes of a decreased nerve conduction intra-operatively compared to baseline do exist, such as retractor compression and iatrogenic injury. Also, reversible threshold changes can be caused by minor stretching injuries. However, forceful stretching can cause a prolonged neuropraxia or even axonal damage which are not reversible when the stretch is removed. For these reasons, it is imperative to remain cognizant of the relative location of the sciatic nerve when placing retractors, suture-tagging capsule, and during instrumentation of either the femur or acetabulum. Also, forceful reduction of markedly oversized components should be avoided and stretching manipulations, such as hip flexion, should not be performed until stimulation at the threshold confirms that nerve conduction is normal. The Checkpoint® stimulator is a useful adjunct but it cannot differentiate these causes of decreased signal transduction from over lengthening, and as such, should not be used as the sole decision-making tool.

### **Case 1:**

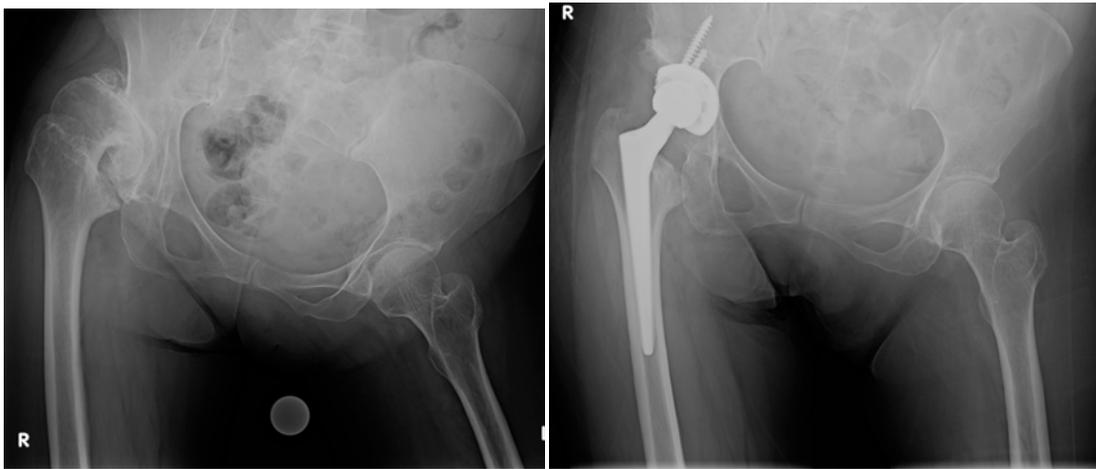
MN is a 48 year old female with a Crowe IV DDH deformity of the left hip who elected to undergo a THA. Intraoperative use of the Checkpoint® stimulator was part of the intraoperative algorithm to determine the necessity of a subtrochanteric shortening osteotomy to avoid sciatic nerve palsy. In the operating room, a baseline stimulus of amplitude and pulse width was obtained. After the acetabular component was inserted, the femoral component was trialed and reduced and the sciatic nerve was again stimulated. Both the minimal amplitude and pulse width required to elicit ankle dorsiflexion were increased from the baseline stimulus. Thus, the decision was made to perform a femoral shortening osteotomy. After the osteotomy, the femoral component was trialed and reduced and the Checkpoint® was again used to stimulate the sciatic nerve, which now elicited a motor response at the baseline amplitude and pulse width. The patient did well post-operatively without sciatic nerve palsy. Of note, she eventually underwent a right hip replacement, which had less of a deformity. The same process of intra-operative nerve stimulation using the Checkpoint® was performed. However, this time, no decrease in stimuli was noted after trial reduction and thus no femoral shortening osteotomy was performed (*Figures 2a and 2b*).



*Figures 2a and 2b: Pre and post-operative films showing evidence of a femoral shortening osteotomy on the left and a modular femoral implant without shortening osteotomy on the right.*

## Case 2

HW is a 58 year old female with a Crowe III DDH deformity of the right hip who elected to undergo a THA. Her deformity was such that a subtrochanteric shortening osteotomy of the femur might have been necessary to avoid sciatic nerve palsy as the amount of leg lengthening to restore hip center of rotation (2-3cm) was at the maximum cut-off value recommended in the existing literature for performing such an osteotomy. For this reason, the Checkpoint® stimulator was used to help ascertain an intra-operative decision regarding the necessity of performing the osteotomy. As with the previous case, a baseline amplitude and pulse width was obtained after the femur was exposed and again after the acetabular component and femoral trial was inserted and the hip reduced. This time, the value was concordant with the baseline value and the decision was made to proceed without a shortening osteotomy (*Figures 3a and 3b*). The patient tolerated the procedure well and had no sequelae of sciatic nerve palsy post operatively. This case highlights the utility of using an intraoperative direct nerve stimulator like the Checkpoint® to avoid a potentially morbid osteotomy that would have likely been performed in the absence of this powerful tool.



*Figures 3a and 3b: Pre- and post-operative AP pelvis.  
3b demonstrates a fully coated femoral stem without the need for a femoral shortening osteotomy*

## Case 3

PH is a 45-year-old male with a Crowe III DDH of the right hip who elected to undergo a THA. As with the previous case, the amount of leg lengthening necessary to correct PH's deformity (2-3cm) was in the territory for consideration of a femoral shortening osteotomy to avoid undue tension on the sciatic nerve. Again, the Checkpoint® stimulator was used both pre- and post-trial component implantation. In this case, a plus-size head was used for the initial trial reduction, however an increase from baseline value for both amplitude and pulse width was required to elicit the desired motor response, indicating over-lengthening and tension on the sciatic nerve. To reconcile this, the hip was again dislocated and a neutral or zero head was used, affording 5mm less length than the previous sizing with acceptable stability assessed intraoperatively. Upon reduction, the Checkpoint® stimulator was again used and demonstrated a motor response at levels equal to baseline. The patient did go on to have a brief post-operative peroneal nerve palsy that quickly resolved, with return of full strength to ankle dorsiflexion by postoperative day 10. This case highlights the use of the Checkpoint® stimulator not only in the decision-making process of when a shortening osteotomy is necessary, but also how it can be used for appropriate sizing of components. Of course, stability cannot be compromised, but when a smaller offset head affords equal stability without inadvertent stretching of the sciatic nerve, an osteotomy can be avoided. Additionally, this case elicits the sensitivity of the sciatic nerve to stretch, and how small durations of heavy tension (in this case less than 5 minutes of reduction) can cause prolonged neuropraxia.



*Figures 4a and 4b: Pre- and post-operative AP pelvis.  
4b demonstrates a fully coated femoral stem with a high hip center.*

## Summary

Identifying excessive tension on the sciatic nerve in THA is critical to optimizing post-operative outcomes and avoiding the feared complication of sciatic nerve palsy. The Checkpoint® nerve stimulator may help prevent this feared complication. While not necessary for every THA, the author's preferred indication for use is in revision cases and primary cases where a significant (>2cm) limb length discrepancy exists.

## References

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