

Surgical Considerations of Entire Lumbar Spine Hardware Removal via a Minimally Invasive Approach

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A retrospective analysis of 13 patients who underwent endoscopic hardware removal to resolve residual foraminal stenosis issues was performed to determine the feasibility and validity of utilizing endoscopic techniques to entirely remove spinal hardware. Tubular retractors were utilized for the procedure with a diameter of 15 to 18 mm. Surgical times ranged from 58 to 268 minutes, with the largest time delay being the need to cut the crossbars in vivo due to stripped screws, bony overgrowth, or bent hardware. Entire hardware systems can be removed via an endoscopic approach. Blood loss averaged around 90 cc but surgical times were over an hour for most procedures. Endoscopic removal of entire hardware systems can be accomplished but it offers little advantage over conventional hardware removal. The main advantages include reduced trauma and the ability of the surgery to be performed on an outpatient basis. (Journal of Surgical Orthopaedic Advances 17(2):82–84, 2008)

Key words: endoscopic spine surgery, hardware removal, minimally invasive spinal surgery

Pedicle screw fixation is a common instrumentation technique to stabilize the lumbar spine after decompression-type surgery or for other spinal instability issues (1). In rare cases, patients may continue to have neural impingement due to residual bony compression or from the hardware itself (2, 3). In these cases, removal of the hardware may be necessary to gain access to the spinal cord so as to decompress the neural tissues and thus resolve the radiculopathy. Usually, a conventional approach is utilized for removal of the hardware in these cases (4). The conventional approach essentially incorporates the same incision as was created during the initial hardware insertion. This conventional hardware removal thus creates a large incision of usually greater than 3 to 4 inches and this obviously increases tissue damage and scarring of the lumbar region (5). Complications associated with the hardware removal have been noted to be as high as 6%, with complications such as infections, seromas, and neurological sequela (5). In an attempt to reduce complications and trauma, recent advancements in spinal surgery have pushed for a more minimally invasive approach (6). Minimally invasive techniques have been utilized for the implantation of spinal hardware for the

past few years with success rates similar to conventional surgery (7, 8). The belief with most minimally invasive approaches is that reduced tissue trauma will lead to less scarring and a quicker recovery. Nonetheless, no studies to date have shown that endoscopic approaches are superior to conventional techniques for essentially any type of spinal surgery (1, 9). In the literature, a few studies mention the removal of fixation screws alone for treatment of migration issues. Although mentioned as a rare complication, screw migration can require removal and this has been accomplished via a minimally invasive approach (10, 11). These studies reveal that endoscopic removal of a fixation screw can be technically challenging but is possible. A small study of 10 patients evaluated the usage of endoscopic techniques on the removal of lumbar fixation screws in patients with residual radiculopathy (11). In that study, the patients underwent removal of hardware screws via an endoscopic tubular retractor approach. Results of that study revealed that the screws could be removed via an endoscopic approach with relative ease and case times were usually less than 30 minutes. To date, there have not been any studies involving the total removal of a hardware system via an endoscopic or minimally invasive approach. In our study, we not only removed the screws endoscopically, but also the crossbars and other attachments. This article presents our findings on utilizing an endoscopic approach to the removal of spinal hardware, the complications associated with this technique, and other related technical issues that would be pertinent to the surgeon. Our endoscopic approach utilized a minimally invasive technique, which has been defined in previous studies as involving an incision of 1 inch or less (12).

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Materials and Methods

The study is a retrospective analysis of 13 patients who required removal of their hardware because of residual neural compression due to either the hardware or foraminal stenosis. These surgeries were performed between 2001 and 2003 with follow-up at 6-month intervals. Both Oswestry and visual analog scale (VAS) pain scores were utilized to determine patient outcomes. During the surgery, only the hardware was removed because of the uncertainty of technique and time constraints with the endoscopic approach. Patients understood that they would probably have to undergo a decompressive surgery later to resolve their spinal or foraminal stenosis issues. The patients included “all comers” during the time frame and no one was preselected for the study. The study included seven males and six females with the median age of the patients being 52 and an age range of 37 to 70 years. The time since hardware insertion ranged from 1.8 years to 6 years. Of the 13 patients, 10 underwent endoscopic decompressive surgery at a later date for the residual radicular complaints, while the other three did not undergo the endoscopic decompressive surgery.

The study included removal of seven different hardware systems. These hardware systems included: DePuy Moss Miami, DePuy Timx, Sofamor Danek, Stryker Osteonic RPS, Sultz Spine Tech, Sultz Silhouette, and Synthes. Unknown physicians had installed each hardware system and thus our spine surgeons were not familiar with some of the hardware systems and this necessitated the use of representatives from the respective companies to assist in understanding each hardware system. Spinal x-rays were utilized to determine instability after the hardware removal. X-rays were obtained prior to surgery and at least 6 months postsurgery.

The procedure commenced with the appropriate prepping and draping of the patients. Anesthesia consisted of a sedation mixture of opiates and benzodiazepines, which allowed the patient to be awake but comfortable during the surgery. This communication was deemed helpful in reducing neurological complications because the patients could alert the surgeon to changes in their pain or even neural compression symptoms during the operation. Fluoroscopy was utilized to locate the incision site(s) and a $\frac{3}{4}$ -inch incision was made at this location. A guide pin was inserted through the incision down to the screws of the hardware. Over this guide pin, sequentially larger tubes were inserted until a working port of 15 mm was obtained. In some cases, it was necessary to enlarge the work port to 18 mm diameter because of the dimensions of the screws themselves being larger than 15 mm across. Most screw systems required brand-specific tools to remove the screws and these special tools were inserted down the working port to the screws. Visualization

included a 5-mm 0° endoscope with 30 times magnification. Occasionally, a 2.7-mm 0° endoscope was used when it was necessary to place the brand-specific tools onto the hardware and screws, because both the 5-mm endoscope and the tools could not fit within the working port at the same time. Both electrocautery and a holmium laser were utilized for coagulation. The holmium laser settings were 10 watts at 10 repetitions per second. Pituitaries and Kerrisons are the main tools used to remove soft tissue and bone obstructing the removal of the hardware. Once the screws were removed, it then became possible to remove the crossbars or other supports. In about seven of the cases, the crossbars and other support structures could be pulled out through the tubular retractors after minor angulations of the retractor. In six of the cases, the crossbar or support structure had to be cut in vivo. The method of cutting these crossbars involved the development of a specialized cutting tool that used a carbide burr and a specialized cooling chamber both to keep the crossbars from overheating and also to remove the metallic fragments during the cutting process. The carbide bit was 6 mm in diameter and utilized conventional electric burr systems or a compressed nitrogen system. Once all the hardware was removed, the incisions were closed. The number of incisions made (number of port entry sites) was usually one per side, but in some cases up to four port sites were needed to access the hardware. The fact that the tubular retractors were not fixated allowed for one entry site to be utilized for the removal of multiple hardware items. All procedures were performed on an outpatient basis.

Results

Each hardware system was removed via the endoscopic approach but some difficulties were noted. The surgical times ranged from 58 to 268 minutes with an average surgical time of 151 minutes. Unfamiliarity with the hardware systems because these hardware systems were implanted by other surgeons, having to cut the crossbars, and stripped screws from the original hardware insertion led to most of the extra time required for the hardware removal. One difficulty was that the screws were quite large, which required us to enlarge the working tube diameter to 18 mm for some of the hardware systems. Other issues included bone fusion material obstructing visualization of the hardware and thus resulting in the need to burr the bone away from the hardware without damaging the screws. Stripped screw heads from the hardware insertion made their removal difficult and, in one case, the screw head had to be ground away via our carbide burr system, which added significantly to the overall time of the surgery. Cutting of the crossbars amounted to an extra 15 minutes for stainless steel crossbars and up to 1 hour

for titanium units. Titanium crossbars proved to be quite durable and even with a carbide burr they were very difficult to cut. Reasons for the crossbar needing to be cut usually involved issues such as inability to remove stripped screws, bent bars, or bone fusion overgrowth, which caused the bar to be immobile.

Blood loss ranged from 80 to 250 cc with an average blood loss of 120 cc. All the surgeries were performed on an outpatient basis and no perioperative complications were noted in any of the surgeries. One of the patients developed signs of instability after the removal of their hardware and this was confirmed with sequential spinal x-ray series. This individual underwent a repeat fusion operation at a later date. After the hardware removal, one patient developed 50% relief of his back and radicular pain, which lasted after their 2-year follow-up. Other than that single patient, no other patients developed any significant improvement with the hardware removal. Ten of the original 13 patients went on to undergo decompressive surgery to eliminate the radicular symptoms. Of the other three patients who did not undergo the decompressive surgery, one of the patients was the individual who claimed significant improvement after the hardware removal alone, the next developed instability and thus required reinsertion of the hardware, and the third patient opted not to undergo the decompressive surgery. Of the 10 patients who underwent endoscopic decompressive surgery following the hardware removal, two patients developed 1% to 24% improvement, two developed 25% to 49% improvement, and one developed 50% to 74% improvement. Of the other five patients, four claimed no change in their pain levels following the decompressive surgery and one claimed a 1% to 24% increase in their pain postsurgery. The endoscopic decompressive surgery consisted of either an endoscopic laminotomy or laminoforaminoplasty. Because of the small group size, statistical significance could not be determined.

Conclusions

As more and more procedures move toward a minimally invasive technique, spinal surgery is also exploring minimally invasive modalities. So far, minimally invasive spinal surgery has not led to better outcomes than conventional surgery but it does generally result in less tissue trauma. Our study has shown that complete removal of spinal hardware can be performed via a minimally invasive approach. Nonetheless, issues such as blood loss, surgical times, success rates, and complications are similar to conventional hardware removal (3). Other studies have shown that endoscopic screw removal or revision can be done relatively easily, but in our experience with total hardware removal, the most significant difficulty comes from removal of the other hardware items, such as the

crossbars (11). The difficulties with stripped screws, bent hardware, or bony overgrowth also generally resulted in increased surgery times and blood loss. Possible benefits include reduced down time and tissue trauma, but this cannot be determined with this small study size. Of the 13 individuals who underwent the hardware removal, only one developed any significant improvement following the hardware removal alone. Although not the main issue of our study, it is noteworthy that of the 10 patients who underwent a minimally invasive decompressive surgery after the endoscopic hardware removal, improvement occurred in less than 50% of those patients and those who did claim improvement generally had less than 50% Oswestry and VAS score decreases. Also, as noted previously, one individual developed instability that necessitated reinsertion of his hardware.

Therefore, it is our opinion that endoscopic hardware removal is an alternative to conventional hardware removal but not superior to it. Also, removal of the hardware alone rarely results in significant pain or function improvement. Finally, further decompressive surgery in these cases results in mediocre improvement levels and thus should be considered only as a last resort for patients who have exhausted all other less invasive options.

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