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Retrospective Study

Impact of Lead-shielding on the Utilization of Magnetic Resonance Imaging Among Patients with Spinal Cord Stimulation Systems: A Study of Retrospective Claims in the US

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Background: Spinal cord stimulation (SCS) is an effective approach to managing chronic, intractable pain. However, even when the designs of SCS devices are compatible with magnetic resonance imaging (MRI), migration and the fracture or wire breakage of epidural leads can result in increased lead impedance and a requirement that the devices be explanted before safe imaging can take place. Selected SCS systems are designed with other technical features. Specifically, lead shielding (lead wires are encased in a matrix-like tantalum shield) serves to dissipate radiofrequency energy along the lead to reduce the risk of thermal tissue damage during MRI scans- even when lead impedance is out of range.

Objectives: To compare the rates of MRI and SCS device explantation in patients who had SCS systems with lead-shielding SCS (LS-SCS) to those who had systems without lead-shielding SCS (non-LS-SCS), and to understand the clinical implications of those findings.

Study Design: A retrospective study of noninterventional administrative-claims data.

Setting: The Center for Medicare and Medicaid Services (CMS) Research Identifiable Files (RIF).

Methods: Any patient with continuous coverage who underwent implantation of an SCS system within the year 2018 and had no prior history of SCS, a failed neuromodulation device, or peripheral nerve stimulation was eligible. The analysis time frame included a one-year, pre-implantation baseline period and a 3-year post-implantation follow-up period. Claims were analyzed for post-implantation MRI use, SCS-system explantation, and post-MRI diagnoses. The measurements consisted of the time until the first MRI, the anatomic location of the MRI, the post-MRI diagnosis, the incidence of SCS explantation, and the time from explantation to MRI.

Results: Of the 27,636 patients (59% female, 72% aged 65 years or older, and 91% white) who met the eligibility criteria, 18% were implanted with LS-SCS, and 82% were implanted with non-LS-SCS devices between Jan 1 and Dec 31, 2018. Significantly more patients (37.6%) with LS-SCS devices underwent MRI than did patients with non-LS-SCS devices (24.3%; 54.7% relative difference, $P = 0.0007$), and significantly fewer LS-SCS patients underwent explantation followed by MRI than did patients in the non-LS-SCS cohort (18.9% vs. 28.8%, $P < 0.001$). Approximately half of the MRI procedures were for spinal imaging in both cohorts, and the most common new diagnoses in the 30 days after the MRI included osteoarthritis, non-VCF injury/fractures, and cancer. Bivariate survival analysis showed that patients with LS-SCS devices had a significantly higher probability of undergoing MRI sooner than patients with non-LS-SCS devices (71.6% higher in adjusted hazard analysis; $P < 0.001$).

Limitations: This study was a retrospective claims analysis, subject to potential inconsistencies in data quality and completeness, coding, availability of variables for study, and an inability to distinguish correlation from causation.

Conclusions: Patients with LS-SCS devices utilized MRI at meaningfully higher rates than

patients treated with non-LS-SCS, and nearly one-quarter of SCS-device explants were potentially associated with facilitating the safe use of MRI. The study results suggest that MRI compatibility has potential repercussions that should be considered in the selection of an SCS system.

Key words: spinal-cord stimulation, generator explant, magnetic resonance imaging, lead impedance, implantable electronic medical devices, epidural leads, chronic pain, implantable pulse generator

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Spinal cord stimulation (SCS) is an effective, device-based treatment for the management of chronic intractable pain (1,2). Typical SCS devices consist of an implantable pulse generator unit and one or more epidural leads that house the stimulation electrodes.

Like pacemakers, implantable defibrillators, and other electrically conductive medical devices, SCS systems have not always been compatible with magnetic resonance imaging (MRI) (3). This imaging technique involves the generation of strong electromagnetic fields, which impose rotational forces on implantable devices that can cause them to change position within the patient, sometimes with sufficient acceleration to cause injury. Implanted devices may also be subjected to current induction that can interfere with their function or cause them to overheat. In recent years, MRI protocols and implantable medical device technologies have co-evolved to improve the safety of MRI for patients with SCS devices. Implantable devices can now be broadly categorized as MR safe, MR conditional, or MR unsafe.

To ensure that patients are safe and that the devices pose no threat in MRI environments, certain specified conditions must be verified through device testing and configuration, as well as the use of specialized MRI protocols, before imaging begins. The MRI must be delayed until all conditions are met, or the device must be explanted if conditions cannot be met, before the patient can safely undergo imaging (4).

One of the conditions an MR-conditional SCS system must meet before a patient is eligible for an MRI is for that system's lead impedance—a measure of lead integrity—to fall within a specified range when tested prior to imaging. Elevated impedance in implanted leads is common (5) and is most often related to lead migration and breakage (4). A recent single-center retrospective analysis found that among patients undergoing SCS-lead impedance testing, the failure rate due to out-of-reach lead impedance reached 42.9% by the fifth year after implantation (3).

Meanwhile, it has been reported that more than 80% of patients with an SCS implant for the management of chronic back and leg pain will require at least one MRI procedure within 5 years of SCS-device implantation (6). Another recent single-center retrospective study of 96 SCS explanations in 400 patients found that 17.7% were due to the need for an MRI (7).

Newer SCS systems and features have been introduced to the market to improve the likelihood that an MR-conditional device meets safety criteria when tested. For example, Medtronic (Minneapolis, MN, USA), at the time of this publication, offers the only SCS system that does not limit MRI access based on impedance values. This is due to MRI labeling inclusive of lead-shielding technology. Lead shielding is the encasing of the lead wires in a matrix-like tantalum shield. This design dissipates radiofrequency energy along the entire length of the SCS lead, reducing the risk of thermal tissue damage during MRI scans, even when lead impedance is out of range. In contrast, non-lead-shielded systems lack this protective mechanism and may become MRI incompatible when out-of-range impedance (i.e., higher-than-normal resistance in the electrical circuit) occurs, such as through lead fracture or migration. Prior to undergoing MRI with an LS-SCS device, patients should consult with their pain specialists regarding the safety of imaging. Each patient must inform the pain specialist of the implanted LS-SCS device, provide MRI office staff with the device model number, and share the specialist's contact information to help the radiologist in determining MRI eligibility. If cleared for imaging, the SCS device should be set to MRI mode, which will deactivate the neurostimulator. Patients with MRI-compatible leads may experience the same adverse events as those with non-MRI-compatible leads, such as lead migration, fractures, disconnection, and pain at the implant site (1,6).

In the present study, we linked Medicare retrospective claims data from a nationally representative dataset with manufacturer SCS-device registration information. Our purposes were to compare the rates of MRI utilization and SCS explantation in patients who had SCS systems with lead shielding (LS-SCS) to those associated with patients who had non-shielded leads

(non-LS-SCS), and to understand the clinical implications of those findings.

Methods

Study Overview and Ethics

This project was a retrospective study of noninterventional, administrative claims data from the Center for Medicare and Medicaid Services (CMS) Research Identifiable Files (RIF). The primary objective was to compare the rate and timing of MRI use among patients using the LS-SCS system (SureScan™, Medtronic plc) to those of patients using commercially available non-LS-SCS leads. Secondary objectives included evaluating the most common clinical indications that led patients to undergo MRI, and the clinical implications of the MRI.

The identifiable data used in this research were protected under a data-use agreement with Medicare. The study protocol was reviewed and determined to be exempt from full board review and informed consent requirements by WIRB-Copernicus Group (WCG).

Data Source

Administrative claims data from the CMS RIF encompass all Medicare fee-for-service members and provide 100% of institutional, noninstitutional, and pharmacy claims, inclusive of Part D medication information. The CMS RIF data were linked to the Medtronic DTRAK device-registration system as part of the data-use agreement with CMS. This feature allowed for the identification of patients with an LS-SCS system versus patients with non-LS SCS devices.

Patient Selection and Study Timeline

Patients were selected for the study based on the presence of prespecified diagnosis (International Classification of Diseases, Tenth Revision [ICD-10]) and procedural (current procedural terminology [CPT]) codes (Appendix). The base population comprised patients who underwent an index procedure to implant an SCS generator and leads. For each patient, claims related to MRI use and SCS explantation were analyzed for a total of 3 years of follow-up (Fig. 1). Because, at the initiation of the project, CMS RIF data were available through the end of the year 2021, the identification window for index SCS implantation was limited to the year 2018.

Patients were required to have continuous enrollment in Medicare, beginning 12 full months prior to the index procedure (baseline period) and lasting through the end of the 3-year follow-up period. Patients were excluded if they had any history of the following: SCS treatment during the 2 years prior to the implanting of the index (Fig. 2), the explanting of other neuromodulation devices due to a failed lead (identified by CPT Modifier -53), or peripheral nerve stimulation.

Study Measures

Demographics and Clinical Characteristics

Patient age, race, and diagnosis or indication for SCS treatment were summarized as of the index procedure date. Other baseline clinical characteristics, including the patients' Charlson Comorbidity Index (CCI) scores, were analyzed from data in the 12 month-baseline period preceding the index procedure.

Post-Implantation MRI Use and SCS Explantation

Patient claims were analyzed for the use of MRI within 3 years following the index SCS implantation procedure. If an MRI was observed, the length of time from the implantation date to the date of the first MRI was recorded, regardless of whether the patient underwent additional, subsequent MRI procedures. Claims were also analyzed for the incidence of SCS-device explantation, defined as a visit with procedure codes indicating the removal of both the SCS generator and the lead(s).

Patients included in the final sample were categorized into mutually exclusive groups based on MRI

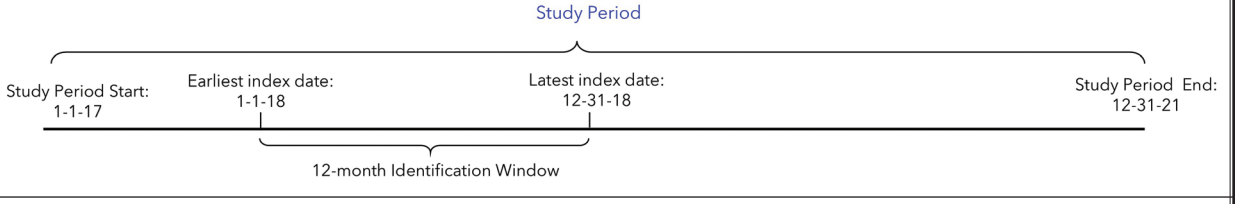

Fig. 1. *Study timeline.*

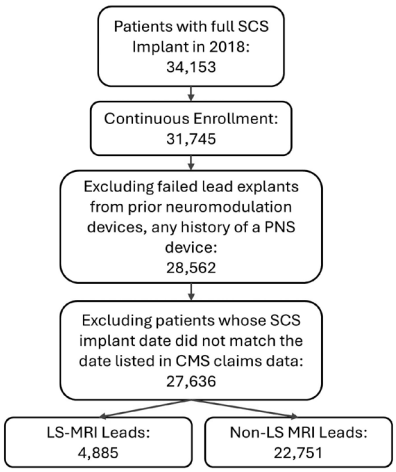

Fig. 2. *Patient disposition and cohort construction.*

use during follow-up (use or no use of MRI) and the presence or absence of SCS-device explantation. For patients with claims for both a device explantation and an MRI within 120 days thereof, the time between explantation and MRI was recorded. Any device explantation followed by an MRI within 120 days was categorized as potentially due to the need for MRI. This follow-up time frame was chosen in consultation with clinician-authors' expert opinion, with a rationale that MRIs that took place more than 4 months after the device explantation were most likely not related to that procedure. Patients with a device explantation not followed by an MRI within 120 days were categorized as not having received an MRI.

MRI Characteristics and Outcomes

The anatomic location of any MRI performed during follow-up was categorized as either a spinal MRI or a nonspinal MRI (abdomen, brain, lower extremity, pelvis, upper extremity, and other).

Post-MRI diagnoses were analyzed from the day of the imaging procedure up to 30 days after the MRI. Diagnoses were grouped based on categories from the Clinical Classifications Software Refined (Agency for Healthcare Research and Quality) and the Healthcare Cost and Utilization Project. These diagnoses were considered "new" if there was no prior evidence of the diagnosis during the pre-implantation baseline period (8). Diagnoses of interest included nonvertebral spine fracture, vertebral compression fracture (VCF), biliary tract disease, osteoarthritis, stroke, and cancer, including the proportion of cancer patients who initiated chemotherapy. The proportion of urgent/emergency MRIs that were performed on the same date as an emergency-department visit was also analyzed, as was the use of other non-MRI imaging techniques, including computed tomography, myelogram/myelography, and arthrogram/arthrography.

Analytical Methods

All analyses were performed using SAS® v9.4 in the CMS Virtual Research Data Center. Frequencies and percentages were used to describe unadjusted categorical variables by device manufacturer, whereas means and standard deviations were used to describe continuous variables. When unadjusted differences for categorical variables between LS-SCS and non-LS-SCS cohorts were compared, the chi-square test was used to assess statistical significance, while t-tests were used for continuous variables.

For unadjusted survival analyses, Kaplan–Meier curves and log-rank tests were used to compare the rate of MRI between LS-SCS and non-LS-SCS patients. The adjusted rate of MRI during follow-up was compared between LS-SCS and non-LS-SCS patients in a Cox proportional-hazards ratio model with covariates for gender, age group, race, and CCI score. Frequencies of less than 11 for any category were suppressed in accordance with a data-use agreement with CMS.

Results

Demographics and Clinical Characteristics

After all inclusion and exclusion criteria were applied, 27,636 patients (59% female, 72% aged 65 years or older, and 91% white) underwent implantation of an SCS system between January 1 and December 31, 2018 (Table 1). Of those, 18% were implanted with LS-SCS, and 82% were implanted with non-LS-SCS. Demographic and clinical characteristics were generally well balanced between the 2 SCS cohorts (Table 1), with no statistically significant differences in age, gender, race, or CCI score. The most frequent baseline diagnoses were chronic pain, failed back surgery syndrome, and radiculopathy.

Frequency of MRI and of Explantation

In the overall population, 7,368 patients (26.7%) received an MRI in the 3 years after SCS implantation (Table 2). There was a relative 54.7% difference in the number of LS-SCS patients who underwent an MRI at

any time during follow-up from the number of patients with non-LS-SCS systems who did the same (37.6% vs. 24.3% respectively; $P = 0.0007$).

Within 3 years of implantation, SCS systems were explanted for reasons unrelated to adverse events in a total of 2,614 patients (9.5%; Fig. 3). Of those, 27.3% of explantations were followed by an MRI within 120 days and therefore considered potentially related to MRI access. A significantly lower proportion of patients in the LS-SCS cohort underwent explantation followed by MRI than did patients in the non-LS-SCS cohort (18.9% vs. 28.8%, $P < 0.001$).

Imaging Characteristics and Outcomes

For patients who underwent MRI during the follow-up, approximately half were for imaging of the spine, and the other half were for the imaging of nonspinal locations (Table 2), including the brain (20.3% - 23.1%), a lower extremity (11.2% - 12.1%), an upper extremity (6.4% - 7.6%), the abdomen (2.3% - 3.5%), the pelvis (1.8% - 2.0%), and other locations (1.8% - 2.2%, Table 3). Between the LS-SCS and non-LS-SCS groups, there were no statistically significant differences in the distribution of anatomical locations of MRI, even when the results were stratified by age.

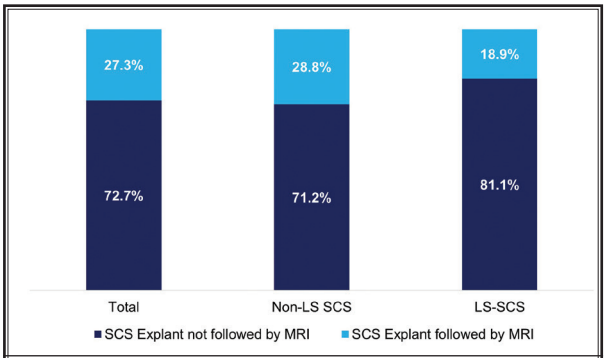

Fig. 3. *Summary of SCS explants, excluding adverse events, in each study cohort.*
*Within 120 days of SCS explant procedure.

Table 1. *Demographics and clinical characteristics.*

	Non-LS SCS n = 22,751	LS-SCS n = 4,885	*P*-value
Female, %	58.8	59.2	0.5623
Race, %			0.0321
White	90.9	91.8	
Black	5.5	4.5	
Other	1.5	1.7	
Asian	0.3	0.4	
Hispanic	1.3	1.0	
North American Native	0.5	0.6	
Age 65 or older, %	71.9	71.1	0.2846
Charlson Comorbidity Index score	2.9 ± 2.6	2.8 ± 2.6	0.0548
Diagnoses at implantation, %			0.0040
Chronic pain	29.8	28.8	
Failed back surgery syndrome	11.1	12.4	
Radiculopathy	7.6	8.5	
Attention to device*	1.7	2.1	
Complex regional pain syndrome	1.4	1.3	
Diabetic peripheral neuropathy	0.4	0.3	
Other	48.1	46.6	

Data are presented as % or mean ± SD.
Abbreviations: LS, lead-shielding; MRI, magnetic resonance imaging; SCS, spinal cord stimulation
*Encounter for adjustment and management of implanted device.

Table 2. *MRI anatomic location by device type and age.*

	≥ 65		< 65	
	Non-LS SCS n = 4,083	LS-SCS n = 1,359	Non-LS SCS n = 1,449	LS-SCS n = 477
Spine	2,118 (51.9)	736 (54.2)	772 (53.3)	244 (51.2)
Non-spine*	1,965 (48.1)	623 (45.8)	677 (46.7)	233 (48.8)

Data are presented as n (%). *P*-value > 0.05 (no significant difference) for both comparisons.
Abbreviations: LS, lead-shielding; SCS, spinal cord stimulation
* Non-spine locations include the abdomen, brain, lower extremity, pelvis, and upper extremity, and a category labeled "other" for all other MRI scans.

Table 3. *MRI anatomic location by device type.*

	Non-LS SCS n = 5,532	LS-SCS n = 1,836
Spine	2,890 (52.2)	980 (53.4)
Non-spine		
Abdomen	130 (2.4)	65 (3.5)
Brain	1,278 (23.1)	373 (20.3)
Upper Extremity	354 (6.4)	139 (7.6)
Lower Extremity	672 (12.2)	205 (11.2)
Pelvis	111 (2.0)	33 (1.8)
Other	97 (1.8)	41 (2.2)

Data are presented as n (%). *P*-value > 0.05 (no significant difference) for both comparisons.
Abbreviations: LS, lead-shielding; SCS, spinal cord stimulation

Table 4. *New diagnoses within 30 days following MRI.*

	All n = 27,636	Non-LS SCS n = 22,751	LS-SCS n = 4,885	*P*-value
Total with MRI	7,368 (26.7)	5,532 (24.3)	1,836 (37.6)	0.0007
ED-related MRI	689 (2.5)	514 (2.3)	175 (3.6)	0.0435
New condition diagnosed within 30 days after MRI				
Any of the below diagnoses	1,209 (4.4)	912 (4.0)	297 (6.1)	< 0.0001
Biliary tract disease	108 (0.4)	70 (0.3)	38 (0.8)	< 0.0001
Cancer*	413 (1.5)	312 (1.4)	101 (2.1)	0.0003
Cancer with chemotherapy	98 (23.7)	69 (22.1)	29 (28.7)	0.1755
Non-VCF injury/fractures	446 (1.6)	340 (1.5)	106 (2.2)	0.0007
Osteoarthritis	502 (1.8)	367 (1.6)	135 (2.8)	< 0.0001
Stroke	353 (1.3)	274 (1.2)	79 (1.6)	0.0197
VCF	39 (0.1)	24 (0.1)	15 (0.3)	0.0007

Data are presented as n (%).
Abbreviations: ED, emergency department; LS, lead-shielding; MRI, magnetic resonance imaging; SCS, spinal cord stimulation; VCF, vertebral compression fracture
*New cancer identified at the HCUP-CCSR diagnosis category level. Chemotherapy represents the proportion of patients newly diagnosed with cancer and starting chemotherapy (i.e., conditional proportion).

Among the total population of patients who underwent MRI, the most common new diagnoses in the 30 days after that procedure included osteoarthritis, non-VCF injury/fractures, and cancer (Table 4). There were numerically small but statistically significant differences between the LS-SCS and non-LS-SCS group for many diagnoses observed. Most notably, significantly more LS-SCS patients underwent MRI in an emergency setting than did non-LS-SCS patients (3.6% vs 2.3%, *P* =.0453).

The proportion of patients in the LS-SCS cohort who underwent non-MRI imaging of any kind during follow-up was significantly lower than in the non-LS-SCS cohort (76% versus 81%; $P < 0.001$).

Time from Implantation to First MRI

A bivariate survival analysis of MRI procedures over time during follow-up showed that patients with LS-SCS system were significantly likely to receive an MRI before non-LS-SCS patients were (Fig. 4; $P < 0.001$). The same observation held when patient subgroups with new diagnoses of cancer, osteoarthritis, biliary tract disease, and VCF were analyzed (all comparisons $P < 0.001$).

In an adjusted hazard analysis, the odds of an MRI occurring during follow-up were 71.6% higher among patients with LS-SCS systems than those with non-LS-SCS systems (Table 5, $P < 0.001$). Other covariates in the model that correlated significantly with an increased probability of MRI included a CCI score of 2 or higher ($P = 0.0384$), an age of 65 or older ($P < 0.001$), and a non-white racial designation ($P < 0.001$).

Discussion

This study compared patterns and timing of MRI use and post-imaging findings in patients with LS-SCS systems to those who had non-LS-SCS systems. Among a study population of 27,636 patients who received full SCS system implants in 2018, we compared 4,885 (18%) patients treated with LS-SCS systems to 22,751 (82%) with non-LS-SCS systems, using a dataset of retrospective administrative claims linked to the LS-SCS manufacturer's device-registration information.

Overall, we found that 54.7% more patients treated with LS-SCS systems underwent MRI in the 3 years following SCS implantation than did patients with non-LS-SCS systems (37.6% vs. 24.3%; $P = 0.001$). Of these, almost half of the MRI procedures occurred in non-spinal locations, suggesting that the reasons for MRI were unrelated to the devices. When the results were adjusted for gender, age, race, and CCI score, patients with LS-SCS systems had a 71.6% higher likelihood of having received an MRI during the 3-year follow-up period compared to patients with non-LS-SCS systems.

It has previously been demonstrated that a patient's ability to access MRI can be hindered when an

SCS system is determined to be MR unsafe, a condition often identified only upon impedance independence testing (3). Patients may then experience delayed MRI scheduling while waiting for a device explantation to be performed, or they may choose to forgo the MRI altogether (9). Several findings from the present study are consistent with these prior reports, showing that patients with LS-SCS leads have a higher rate of MRI access and a reduced chance of requiring an explant before proceeding with MRI. We found that 9.9% fewer patients with LS-SCS systems underwent an explant followed closely by an MRI than did patients with non-LS-SCS systems, representing a relative difference of 34.4% (Fig. 3, $P < 0.0001$).

We also found that patients with LS-SCS systems who received an MRI were likely to undergo the imaging procedure sooner than their counterparts with non-LS-SCS systems. Furthermore, in an observation consistent with a prior study (9), patients in our study who had an LS-SCS system used non-MRI imaging techniques less frequently than did patients with non-LS-SCS systems. This "substitution" effect toward other imaging modalities among patients with non-LS-SCS systems is of interest because, while non-MRI imaging techniques are sometimes valid alternatives to an MRI, they are often not direct replacements, especially when used for detecting stroke and other urgent or emergent conditions (10). Our study showed that nearly one in 10 post-implantation MRIs were performed in an emergency setting (Table 4), and nearly a quarter (20% to 23%) of all post-implantation MRIs were performed to image the brain. Thus, it is conceivable that some proportion of non-LS-SCS patients still underwent MRI even with an SCS system that was considered MR unsafe, due to the emergent situation.

Furthermore, in the case of other conditions such as cancer, VCF, non-VCF injuries or fractures, biliary tract disease, and osteoarthritis, among others, timely access to MRI and other diagnostic testing is essential to faster diagnosis, treatment planning, and therapy initiation (11-14). While this efficiency is especially crucial for diagnosing and treating cancer, early treatment and management can lessen the clinical and economic burden posed by any progressive disease, for both patients and payers. In this context, SCS systems that do not require lead testing and are therefore less likely to delay MRI may facilitate earlier diagnosis and treatment. Our study confirmed that patients with LS-SCS systems had not only a higher rate of MRI access but also a faster time from implantation to an observed MRI in adjusted Kaplan–Meier analysis. This finding, along with the existing literature, confirms the superiority of MRI for identifying severe diagnoses rapidly and enabling early treatment initiation.

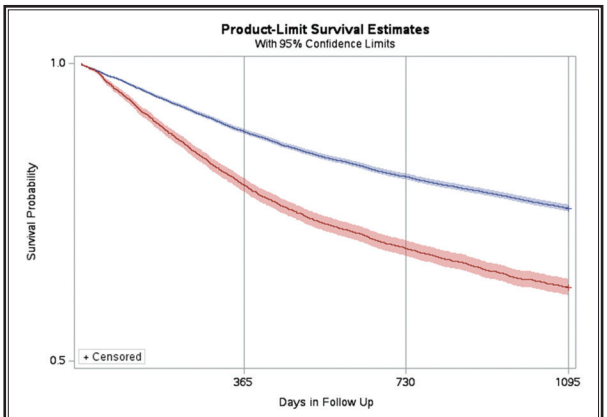

Fig. 4. *Bivariate survival analysis of time to first MRI after SCS implantation.*
Comparison of the time from SCS implant to first MRI between patients with LS-SCS (red line) and non-LS-SCS (blue line) over 3 years of follow up. the shaded areas indicate 95% confidence.

Table 5. *Cox proportional hazard ratio: factors associated with higher risk of subsequent treatment.*

	AHR	*P*-value
LS-SCS (reference: non-LS SCS)	1.716	< 0.001
Male gender (reference: female)	0.978	0.359
Race (reference: white)		
Asian	1.079	0.695
Black	1.053	0.321
Hispanic	0.984	0.884
North American Native	1.299	0.072
Other	1.434	< 0.001
CCI score (reference: 0)		
1	1.025	0.515
2	1.087	0.038
3	1.080	0.020
Age 65+ (reference: <65)	1.115	< 0.001

Abbreviations: AHR, adjusted hazard ratio; CCI, Charlson Comorbidity Index; LS, lead-shielding; SCS, spinal cord stimulation

Limitations

This study has some of the limitations inherent to retrospective claims analyses. These include the exclusive analysis of a Medicare population, potential inconsistencies in data quality or completeness,

possible miscoding of diagnosis or procedure codes, and inability to infer causality. Due to the nature of claims data, we were unable to determine definitively whether, for either cohort, explant procedures followed by MRI within 120 days were due to MRI incompatibility, since we did not have access to lead-impedance testing information or required scan conditions.

Another limitation was the existence of only one set of procedure codes that could be assigned to all SCS leads, meaning the "non-LS-SCS" cohort included a mix of SCS systems from various other manufacturers with varying levels of MR-conditional features. Although this study does not explore causative factors, the higher proportion of MRI use among patients with LS-SCS systems may reflect greater feasibility and clinician confidence in performing MRI on patients with these devices. Conversely, the lower MRI rates in non-LS-SCS patients highlights a potential barrier to imaging access. Differences in patient characteristics or clinical decision-making, which were not captured in this dataset, may also contribute to this trend. By focusing on only a single year of index SCS implantations (2018), we excluded patients who might have received SCS treatment for more recently approved indications, such as diabetic peripheral neuropathy. Further research with more recent data, potentially evaluating a younger, non-Medicare population, would be valuable to validate our findings in this study.

Conclusion

Patients with LS-SCS devices utilized MRI at a rate that was 54.7% higher than patients treated with non-LS-SCS devices. Nearly one-quarter of SCS-device explants that occurred in the 3 years after the initiation of SCS therapy were potentially related to facilitating the safe use of MRI. Additionally, a significantly higher rate of non-MRI imaging was observed among patients with non-LS-SCS device, suggesting that potentially less appropriate imaging was substituted. Given these findings, clinicians should educate their patients regarding the potential repercussions of MRI compatibility when choosing a specific SCS system at the time of SCS therapy initiation.

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Author Contributions

Conception and design: CW, MM, NG, CR, YS, NA, SS
Acquisition of data: CW, MM
Analysis of data: CW, MM, NG
Interpretation of data: CW, MM, NG, CR, YS, NA, SS
Drafting and revision of publication: CW, MM, NG, CR, YS, NA, SS
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Appendix. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
SCS	CPT	Procedure	63661	Removal of spinal neurostimulator electrode percutaneous array(s), including fluoroscopy, when performed
SCS	CPT	Procedure	63662	Removal of spinal neurostimulator electrode plate/paddle(s) placed via laminotomy or laminectomy, including fluoroscopy, when performed
SCS	CPT	Procedure	63663	Revision including replacement, when performed, of spinal neurostimulator electrode percutaneous array(s), including fluoroscopy, when performed
SCS	CPT	Procedure	63664	Revision including replacement, when performed, of spinal neurostimulator electrode plate/paddle(s) placed via laminotomy or laminectomy, including fluoroscopy, when performed
SCS	CPT	Procedure	63685	Insertion or replacement of spinal neurostimulator pulse generator or receiver, direct or inductive coupling
SCS	CPT	Procedure	63688	Revision or removal of implanted spinal neurostimulator pulse generator or receiver
SCS	CPT	Procedure	63650	Percutaneous implantation of neurostimulator electrode array, epidural
SCS	ICD-10	Procedure	0JH70BZ	Insertion of Single Array Stimulator Generator into Back Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH70CZ	Insertion of Single Array Rechargeable Stimulator Generator into Back Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH70DZ	Insertion of Multiple Array Stimulator Generator into Back Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH70EZ	Insertion of Multiple Array Rechargeable Stimulator Generator into Back Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH80BZ	Insertion of Single Array Stimulator Generator into Abdomen Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH80CZ	Insertion of Single Array Rechargeable Stimulator Generator into Abdomen Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH80DZ	Insertion of Multiple Array Stimulator Generator into Abdomen Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JH80EZ	Insertion of Multiple Array Rechargeable Stimulator Generator into Abdomen Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JPT0MZ	Removal of Stimulator Generator from Trunk Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JPT3MZ	Removal of Stimulator Generator from Trunk Subcutaneous Tissue and Fascia, Percutaneous Approach
SCS	ICD-10	Procedure	0JWT0MZ	Revision of Stimulator Generator in Trunk Subcutaneous Tissue and Fascia, Open Approach
SCS	ICD-10	Procedure	0JWT3MZ	Revision of Stimulator Generator in Trunk Subcutaneous Tissue and Fascia, Percutaneous Approach
SCS	ICD-10	Procedure	0JWTXMZ	Revision of Stimulator Generator in Trunk Subcutaneous Tissue and Fascia, External Approach
SCS	ICD-10	Procedure	00HU0MZ	Insertion of Neurostimulator Lead into Spinal Canal, Open Approach
SCS	ICD-10	Procedure	00HU3MZ	Insertion of Neurostimulator Lead into Spinal Canal, Percutaneous Approach
SCS	ICD-10	Procedure	00HV0MZ	Insertion of Neurostimulator Lead into Spinal Cord, Open Approach
SCS	ICD-10	Procedure	00HV3MZ	Insertion of Neurostimulator Lead into Spinal Cord, Percutaneous Approach
SCS	ICD-10	Procedure	00PU0MZ	Removal of Neurostimulator Lead from Spinal Canal, Open Approach
SCS	ICD-10	Procedure	00PU3MZ	Removal of Neurostimulator Lead from Spinal Canal, Percutaneous Approach
SCS	ICD-10	Procedure	00PV0MZ	Removal of Neurostimulator Lead from Spinal Cord, Open Approach
SCS	ICD-10	Procedure	00PV3MZ	Removal of Neurostimulator Lead from Spinal Cord, Percutaneous Approach
SCS	ICD-10	Procedure	00WU0MZ	Revision of Neurostimulator Lead in Spinal Canal, Open Approach
SCS	ICD-10	Procedure	00WU3MZ	Revision of Neurostimulator Lead in Spinal Canal, Percutaneous Approach

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
SCS	ICD-10	Procedure	00WV0MZ	Revision of Neurostimulator Lead in Spinal Cord, Open Approach
SCS	ICD-10	Procedure	00WV3MZ	Revision of Neurostimulator Lead in Spinal Cord, Percutaneous Approach
SCS	CPT	Procedure Modifier	53	Discontinued procedure indicates that a surgical or diagnostic procedure was started but discontinued
PNS	CPT	Procedure	64555	Percutaneous implantation of neurostimulator electrode array; peripheral nerve (excludes sacral nerve)
PNS	CPT	Procedure	64575	Open implantation of neurostimulator electrode array; peripheral nerve (excludes sacral nerve)
PNS	CPT	Procedure	64596	Insertion or replacement of percutaneous electrode array, peripheral nerve, with integrated neurostimulator, including imaging guidance, when performed; initial electrode array
Imaging Type	Coding System	Code Type	Code	Description
MRI	CPT	Procedure	70336	Magnetic resonance (eg, proton) imaging, temporomandibular joint(s)
MRI	CPT	Procedure	70540	Magnetic resonance (eg, proton) imaging, orbit, face, and/or neck; without contrast material(s)
MRI	CPT	Procedure	70542	Magnetic resonance (eg, proton) imaging, orbit, face, and/or neck; with contrast material(s)
MRI	CPT	Procedure	70543	Magnetic resonance (eg, proton) imaging, orbit, face, and/or neck; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	70544	Magnetic resonance angiography, head; without contrast material(s)
MRI	CPT	Procedure	70545	Magnetic resonance angiography, head; with contrast material(s)
MRI	CPT	Procedure	70546	Magnetic resonance angiography, head; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	70547	Magnetic resonance angiography, neck; without contrast material(s)
MRI	CPT	Procedure	70548	Magnetic resonance angiography, neck; with contrast material(s)
MRI	CPT	Procedure	70549	Magnetic resonance angiography, neck; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	70551	Magnetic resonance (eg, proton) imaging, brain (including brain stem); without contrast material
MRI	CPT	Procedure	70552	Magnetic resonance (eg, proton) imaging, brain (including brain stem); with contrast material(s)
MRI	CPT	Procedure	70553	Magnetic resonance (eg, proton) imaging, brain (including brain stem); without contrast material, followed by contrast material(s) and further sequences
MRI	CPT	Procedure	70554	Magnetic resonance imaging, brain, functional MRI; including test selection and administration of repetitive body part movement and/or visual stimulation, not requiring physician or psychologist administration
MRI	CPT	Procedure	70555	Magnetic resonance imaging, brain, functional MRI; requiring physician or psychologist administration of entire neurofunctional testing
MRI	CPT	Procedure	70557	Magnetic resonance (eg, proton) imaging, brain (including brain stem and skull base), during open intracranial procedure (eg, to assess for residual tumor or residual vascular malformation); without contrast material
MRI	CPT	Procedure	70558	Magnetic resonance (eg, proton) imaging, brain (including brain stem and skull base), during open intracranial procedure (eg, to assess for residual tumor or residual vascular malformation) ;with contrast material(s)

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	CPT	Procedure	70559	Magnetic resonance (eg, proton) imaging, brain (including brain stem and skull base), during open intracranial procedure (eg, to assess for residual tumor or residual vascular malformation); without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	71550	Magnetic resonance (eg, proton) imaging, chest (eg, for evaluation of hilar and mediastinal lymphadenopathy); without contrast material(s)
MRI	CPT	Procedure	71551	Magnetic resonance (eg, proton) imaging, chest (eg, for evaluation of hilar and mediastinal lymphadenopathy); with contrast material(s)
MRI	CPT	Procedure	71552	Magnetic resonance (eg, proton) imaging, chest (eg, for evaluation of hilar and mediastinal lymphadenopathy); without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	71555	Magnetic resonance angiography, chest (excluding myocardium), with or without contrast material(s)
MRI	CPT	Procedure	72141	Magnetic resonance (eg, proton) imaging, spinal canal and contents, cervical; without contrast material
MRI	CPT	Procedure	72142	Magnetic resonance (eg, proton) imaging, spinal canal and contents, cervical; with contrast material(s)
MRI	CPT	Procedure	72146	Magnetic resonance (eg, proton) imaging, spinal canal and contents, thoracic; without contrast material
MRI	CPT	Procedure	72147	Magnetic resonance (eg, proton) imaging, spinal canal and contents, thoracic; with contrast material(s)
MRI	CPT	Procedure	72148	Magnetic resonance (eg, proton) imaging, spinal canal and contents, lumbar; without contrast material
MRI	CPT	Procedure	72149	Magnetic resonance (eg, proton) imaging, spinal canal and contents, lumbar; with contrast material(s)
MRI	CPT	Procedure	72156	Magnetic resonance (eg, proton) imaging, spinal canal and contents, without contrast material, followed by contrast material(s) and further sequences; cervical
MRI	CPT	Procedure	72157	Magnetic resonance (eg, proton) imaging, spinal canal and contents, without contrast material, followed by contrast material(s) and further sequences; thoracic
MRI	CPT	Procedure	72158	Magnetic resonance (eg, proton) imaging, spinal canal and contents, without contrast material, followed by contrast material(s) and further sequences; lumbar
MRI	CPT	Procedure	72195	Magnetic resonance (eg, proton) imaging, pelvis; without contrast material(s)
MRI	CPT	Procedure	72196	Magnetic resonance (eg, proton) imaging, pelvis; with contrast material(s)
MRI	CPT	Procedure	72197	Magnetic resonance (eg, proton) imaging, pelvis; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	73218	Magnetic resonance (eg, proton) imaging, upper extremity, other than joint; without contrast material(s)
MRI	CPT	Procedure	73219	Magnetic resonance (eg, proton) imaging, upper extremity, other than joint; with contrast material(s)
MRI	CPT	Procedure	73220	Magnetic resonance (eg, proton) imaging, upper extremity, other than joint; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	73221	Magnetic resonance (eg, proton) imaging, any joint of upper extremity; without contrast material(s)
MRI	CPT	Procedure	73222	Magnetic resonance (eg, proton) imaging, any joint of upper extremity; with contrast material(s)
MRI	CPT	Procedure	73223	Magnetic resonance (eg, proton) imaging, any joint of upper extremity; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	73225	Magnetic resonance angiography, upper extremity, with or without contrast material(s)
MRI	CPT	Procedure	73718	Magnetic resonance (eg, proton) imaging, lower extremity other than joint; without contrast material(s)
MRI	CPT	Procedure	73719	Magnetic resonance (eg, proton) imaging, lower extremity other than joint; with contrast material(s)

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	CPT	Procedure	73720	Magnetic resonance (eg, proton) imaging, lower extremity other than joint; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	73721	Magnetic resonance (eg, proton) imaging, any joint of lower extremity; without contrast material
MRI	CPT	Procedure	73722	Magnetic resonance (eg, proton) imaging, any joint of lower extremity; with contrast material(s)
MRI	CPT	Procedure	73723	Magnetic resonance (eg, proton) imaging, any joint of lower extremity; without contrast material(s), followed by contrast material(s) and further sequences
MRI	CPT	Procedure	73725	Magnetic resonance angiography, lower extremity, with or without contrast material(s)
MRI	CPT	Procedure	74181	Magnetic resonance (eg, proton) imaging, abdomen; without contrast material(s)
MRI	CPT	Procedure	74182	Magnetic resonance (eg, proton) imaging, abdomen; with contrast material(s)
MRI	CPT	Procedure	74183	Magnetic resonance (eg, proton) imaging, abdomen; without contrast material(s), followed by with contrast material(s) and further sequences
MRI	CPT	Procedure	74185	Magnetic resonance angiography, abdomen, with or without contrast material(s)
MRI	CPT	Procedure	74712	Magnetic resonance (eg, proton) imaging, fetal, including placental and maternal pelvic imaging when performed; single or first gestation
MRI	CPT	Procedure	74713	Magnetic resonance (eg, proton) imaging, fetal, including placental and maternal pelvic imaging when performed; each additional gestation (List separately in addition to code for primary procedure)
MRI	CPT	Procedure	75557	Cardiac magnetic resonance imaging for morphology and function without contrast material;
MRI	CPT	Procedure	75559	Cardiac magnetic resonance imaging for morphology and function without contrast material; with stress imaging
MRI	CPT	Procedure	75561	Cardiac magnetic resonance imaging for morphology and function without contrast material(s), followed by contrast material(s) and further sequences;
MRI	CPT	Procedure	75563	Cardiac magnetic resonance imaging for morphology and function without contrast material(s), followed by contrast material(s) and further sequences; with stress imaging
MRI	CPT	Procedure	75565	Cardiac magnetic resonance imaging for velocity flow mapping (List separately in addition to code for primary procedure)
MRI	CPT	Procedure	76390	Magnetic resonance spectroscopy
MRI	CPT	Procedure	76391	Magnetic resonance (eg, vibration) elastography
MRI	ICD-10-PCS	Procedure	B030Y0Z	Magnetic Resonance Imaging (MRI) of Brain using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B030YZZ	Magnetic Resonance Imaging (MRI) of Brain using Other Contrast
MRI	ICD-10-PCS	Procedure	B030ZZZ	Magnetic Resonance Imaging (MRI) of Brain
MRI	ICD-10-PCS	Procedure	B039Y0Z	Magnetic Resonance Imaging (MRI) of Sella Turcica/Pituitary Gland using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B039YZZ	Magnetic Resonance Imaging (MRI) of Sella Turcica/Pituitary Gland using Other Contrast
MRI	ICD-10-PCS	Procedure	B039ZZZ	Magnetic Resonance Imaging (MRI) of Sella Turcica/Pituitary Gland
MRI	ICD-10-PCS	Procedure	B03BY0Z	Magnetic Resonance Imaging (MRI) of Spinal Cord using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B03BYZZ	Magnetic Resonance Imaging (MRI) of Spinal Cord using Other Contrast
MRI	ICD-10-PCS	Procedure	B03BZZZ	Magnetic Resonance Imaging (MRI) of Spinal Cord
MRI	ICD-10-PCS	Procedure	B03CY0Z	Magnetic Resonance Imaging (MRI) of Acoustic Nerves using Other Contrast, Unenhanced and Enhanced

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B03CYZZ	Magnetic Resonance Imaging (MRI) of Acoustic Nerves using Other Contrast
MRI	ICD-10-PCS	Procedure	B03CZZZ	Magnetic Resonance Imaging (MRI) of Acoustic Nerves
MRI	ICD-10-PCS	Procedure	B231Y0Z	Magnetic Resonance Imaging (MRI) of Multiple Coronary Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B231YZZ	Magnetic Resonance Imaging (MRI) of Multiple Coronary Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B231ZZZ	Magnetic Resonance Imaging (MRI) of Multiple Coronary Arteries
MRI	ICD-10-PCS	Procedure	B233Y0Z	Magnetic Resonance Imaging (MRI) of Multiple Coronary Artery Bypass Grafts using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B233YZZ	Magnetic Resonance Imaging (MRI) of Multiple Coronary Artery Bypass Grafts using Other Contrast
MRI	ICD-10-PCS	Procedure	B233ZZZ	Magnetic Resonance Imaging (MRI) of Multiple Coronary Artery Bypass Grafts
MRI	ICD-10-PCS	Procedure	B236Y0Z	Magnetic Resonance Imaging (MRI) of Right and Left Heart using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B236YZZ	Magnetic Resonance Imaging (MRI) of Right and Left Heart using Other Contrast
MRI	ICD-10-PCS	Procedure	B236ZZZ	Magnetic Resonance Imaging (MRI) of Right and Left Heart
MRI	ICD-10-PCS	Procedure	B330Y0Z	Magnetic Resonance Imaging (MRI) of Thoracic Aorta using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B330YZZ	Magnetic Resonance Imaging (MRI) of Thoracic Aorta using Other Contrast
MRI	ICD-10-PCS	Procedure	B330ZZZ	Magnetic Resonance Imaging (MRI) of Thoracic Aorta
MRI	ICD-10-PCS	Procedure	B335Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Common Carotid Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B335YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Common Carotid Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B335ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Common Carotid Arteries
MRI	ICD-10-PCS	Procedure	B338Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Internal Carotid Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B338YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Internal Carotid Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B338ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Internal Carotid Arteries
MRI	ICD-10-PCS	Procedure	B33GY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Vertebral Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33GYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Vertebral Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33GZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Vertebral Arteries
MRI	ICD-10-PCS	Procedure	B33HY0Z	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33HYZZ	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33HZZZ	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Arteries

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B33JY0Z	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33JYZZ	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33JZZZ	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Arteries
MRI	ICD-10-PCS	Procedure	B33KY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33KYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33KZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Arteries
MRI	ICD-10-PCS	Procedure	B33MY0Z	Magnetic Resonance Imaging (MRI) of Spinal Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33MYZZ	Magnetic Resonance Imaging (MRI) of Spinal Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33MZZZ	Magnetic Resonance Imaging (MRI) of Spinal Arteries
MRI	ICD-10-PCS	Procedure	B33QY0Z	Magnetic Resonance Imaging (MRI) of Cervico-Cerebral Arch using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33QYZZ	Magnetic Resonance Imaging (MRI) of Cervico-Cerebral Arch using Other Contrast
MRI	ICD-10-PCS	Procedure	B33QZZZ	Magnetic Resonance Imaging (MRI) of Cervico-Cerebral Arch
MRI	ICD-10-PCS	Procedure	B33RY0Z	Magnetic Resonance Imaging (MRI) of Intracranial Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B33RYZZ	Magnetic Resonance Imaging (MRI) of Intracranial Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B33RZZZ	Magnetic Resonance Imaging (MRI) of Intracranial Arteries
MRI	ICD-10-PCS	Procedure	B430Y0Z	Magnetic Resonance Imaging (MRI) of Abdominal Aorta using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B430YZZ	Magnetic Resonance Imaging (MRI) of Abdominal Aorta using Other Contrast
MRI	ICD-10-PCS	Procedure	B430ZZZ	Magnetic Resonance Imaging (MRI) of Abdominal Aorta
MRI	ICD-10-PCS	Procedure	B431Y0Z	Magnetic Resonance Imaging (MRI) of Celiac Artery using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B431YZZ	Magnetic Resonance Imaging (MRI) of Celiac Artery using Other Contrast
MRI	ICD-10-PCS	Procedure	B431ZZZ	Magnetic Resonance Imaging (MRI) of Celiac Artery
MRI	ICD-10-PCS	Procedure	B434Y0Z	Magnetic Resonance Imaging (MRI) of Superior Mesenteric Artery using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B434YZZ	Magnetic Resonance Imaging (MRI) of Superior Mesenteric Artery using Other Contrast
MRI	ICD-10-PCS	Procedure	B434ZZZ	Magnetic Resonance Imaging (MRI) of Superior Mesenteric Artery
MRI	ICD-10-PCS	Procedure	B438Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Renal Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B438YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Renal Arteries using Other Contrast

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B438ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Renal Arteries
MRI	ICD-10-PCS	Procedure	B43CY0Z	Magnetic Resonance Imaging (MRI) of Pelvic Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B43CYZZ	Magnetic Resonance Imaging (MRI) of Pelvic Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B43CZZZ	Magnetic Resonance Imaging (MRI) of Pelvic Arteries
MRI	ICD-10-PCS	Procedure	B43FY0Z	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B43FYZZ	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B43FZZZ	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Arteries
MRI	ICD-10-PCS	Procedure	B43GY0Z	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B43GYZZ	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B43GZZZ	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Arteries
MRI	ICD-10-PCS	Procedure	B43HY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Arteries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B43HYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Arteries using Other Contrast
MRI	ICD-10-PCS	Procedure	B43HZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Arteries
MRI	ICD-10-PCS	Procedure	B531Y0Z	Magnetic Resonance Imaging (MRI) of Cerebral and Cerebellar Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B531YZZ	Magnetic Resonance Imaging (MRI) of Cerebral and Cerebellar Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B531ZZZ	Magnetic Resonance Imaging (MRI) of Cerebral and Cerebellar Veins
MRI	ICD-10-PCS	Procedure	B532Y0Z	Magnetic Resonance Imaging (MRI) of Intracranial Sinuses using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B532YZZ	Magnetic Resonance Imaging (MRI) of Intracranial Sinuses using Other Contrast
MRI	ICD-10-PCS	Procedure	B532ZZZ	Magnetic Resonance Imaging (MRI) of Intracranial Sinuses
MRI	ICD-10-PCS	Procedure	B535Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Jugular Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B535YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Jugular Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B535ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Jugular Veins
MRI	ICD-10-PCS	Procedure	B538Y0Z	Magnetic Resonance Imaging (MRI) of Superior Vena Cava using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B538YZZ	Magnetic Resonance Imaging (MRI) of Superior Vena Cava using Other Contrast
MRI	ICD-10-PCS	Procedure	B538ZZZ	Magnetic Resonance Imaging (MRI) of Superior Vena Cava
MRI	ICD-10-PCS	Procedure	B539Y0Z	Magnetic Resonance Imaging (MRI) of Inferior Vena Cava using Other Contrast, Unenhanced and Enhanced

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B539YZZ	Magnetic Resonance Imaging (MRI) of Inferior Vena Cava using Other Contrast
MRI	ICD-10-PCS	Procedure	B539ZZZ	Magnetic Resonance Imaging (MRI) of Inferior Vena Cava
MRI	ICD-10-PCS	Procedure	B53BY0Z	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53BYZZ	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53BZZZ	Magnetic Resonance Imaging (MRI) of Right Lower Extremity Veins
MRI	ICD-10-PCS	Procedure	B53CY0Z	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53CYZZ	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53CZZZ	Magnetic Resonance Imaging (MRI) of Left Lower Extremity Veins
MRI	ICD-10-PCS	Procedure	B53DY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53DYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53DZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Lower Extremity Veins
MRI	ICD-10-PCS	Procedure	B53HY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Pelvic (Iliac) Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53HYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Pelvic (Iliac) Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53HZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Pelvic (Iliac) Veins
MRI	ICD-10-PCS	Procedure	B53LY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Renal Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53LYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Renal Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53LZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Renal Veins
MRI	ICD-10-PCS	Procedure	B53MY0Z	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53MYZZ	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53MZZZ	Magnetic Resonance Imaging (MRI) of Right Upper Extremity Veins
MRI	ICD-10-PCS	Procedure	B53NY0Z	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53NYZZ	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53NZZZ	Magnetic Resonance Imaging (MRI) of Left Upper Extremity Veins
MRI	ICD-10-PCS	Procedure	B53PY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53PYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53PZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Upper Extremity Veins

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B53SY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Pulmonary Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53SYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Pulmonary Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53SZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Pulmonary Veins
MRI	ICD-10-PCS	Procedure	B53TY0Z	Magnetic Resonance Imaging (MRI) of Portal and Splanchnic Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53TYZZ	Magnetic Resonance Imaging (MRI) of Portal and Splanchnic Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53TZZZ	Magnetic Resonance Imaging (MRI) of Portal and Splanchnic Veins
MRI	ICD-10-PCS	Procedure	B53VY0Z	Magnetic Resonance Imaging (MRI) of Other Veins using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B53VYZZ	Magnetic Resonance Imaging (MRI) of Other Veins using Other Contrast
MRI	ICD-10-PCS	Procedure	B53VZZZ	Magnetic Resonance Imaging (MRI) of Other Veins
MRI	ICD-10-PCS	Procedure	B835Y0Z	Magnetic Resonance Imaging (MRI) of Right Eye using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B835YZZ	Magnetic Resonance Imaging (MRI) of Right Eye using Other Contrast
MRI	ICD-10-PCS	Procedure	B835ZZZ	Magnetic Resonance Imaging (MRI) of Right Eye
MRI	ICD-10-PCS	Procedure	B836Y0Z	Magnetic Resonance Imaging (MRI) of Left Eye using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B836YZZ	Magnetic Resonance Imaging (MRI) of Left Eye using Other Contrast
MRI	ICD-10-PCS	Procedure	B836ZZZ	Magnetic Resonance Imaging (MRI) of Left Eye
MRI	ICD-10-PCS	Procedure	B837Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Eyes using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B837YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Eyes using Other Contrast
MRI	ICD-10-PCS	Procedure	B837ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Eyes
MRI	ICD-10-PCS	Procedure	B930Y0Z	Magnetic Resonance Imaging (MRI) of Ear using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B930YZZ	Magnetic Resonance Imaging (MRI) of Ear using Other Contrast
MRI	ICD-10-PCS	Procedure	B930ZZZ	Magnetic Resonance Imaging (MRI) of Ear
MRI	ICD-10-PCS	Procedure	B932Y0Z	Magnetic Resonance Imaging (MRI) of Paranasal Sinuses using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B932YZZ	Magnetic Resonance Imaging (MRI) of Paranasal Sinuses using Other Contrast
MRI	ICD-10-PCS	Procedure	B932ZZZ	Magnetic Resonance Imaging (MRI) of Paranasal Sinuses
MRI	ICD-10-PCS	Procedure	B936Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Parotid Glands using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B936YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Parotid Glands using Other Contrast

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	B936ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Parotid Glands
MRI	ICD-10-PCS	Procedure	B939Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Submandibular Glands using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B939YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Submandibular Glands using Other Contrast
MRI	ICD-10-PCS	Procedure	B939ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Submandibular Glands
MRI	ICD-10-PCS	Procedure	B93DY0Z	Magnetic Resonance Imaging (MRI) of Bilateral Salivary Glands using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B93DYZZ	Magnetic Resonance Imaging (MRI) of Bilateral Salivary Glands using Other Contrast
MRI	ICD-10-PCS	Procedure	B93DZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Salivary Glands
MRI	ICD-10-PCS	Procedure	B93FY0Z	Magnetic Resonance Imaging (MRI) of Nasopharynx/Oropharynx using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B93FYZZ	Magnetic Resonance Imaging (MRI) of Nasopharynx/Oropharynx using Other Contrast
MRI	ICD-10-PCS	Procedure	B93FZZZ	Magnetic Resonance Imaging (MRI) of Nasopharynx/Oropharynx
MRI	ICD-10-PCS	Procedure	B93JY0Z	Magnetic Resonance Imaging (MRI) of Larynx using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	B93JYZZ	Magnetic Resonance Imaging (MRI) of Larynx using Other Contrast
MRI	ICD-10-PCS	Procedure	B93JZZZ	Magnetic Resonance Imaging (MRI) of Larynx
MRI	ICD-10-PCS	Procedure	BB34Z3Z	Magnetic Resonance Imaging (MRI) of Bilateral Lungs using Hyperpolarized Xenon 129 (Xe-129)
MRI	ICD-10-PCS	Procedure	BB3GY0Z	Magnetic Resonance Imaging (MRI) of Lung Apices using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BB3GYZZ	Magnetic Resonance Imaging (MRI) of Lung Apices using Other Contrast
MRI	ICD-10-PCS	Procedure	BB3GZZZ	Magnetic Resonance Imaging (MRI) of Lung Apices
MRI	ICD-10-PCS	Procedure	BF35Y0Z	Magnetic Resonance Imaging (MRI) of Liver using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BF35YZZ	Magnetic Resonance Imaging (MRI) of Liver using Other Contrast
MRI	ICD-10-PCS	Procedure	BF35ZZZ	Magnetic Resonance Imaging (MRI) of Liver
MRI	ICD-10-PCS	Procedure	BF36Y0Z	Magnetic Resonance Imaging (MRI) of Liver and Spleen using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BF36YZZ	Magnetic Resonance Imaging (MRI) of Liver and Spleen using Other Contrast
MRI	ICD-10-PCS	Procedure	BF36ZZZ	Magnetic Resonance Imaging (MRI) of Liver and Spleen
MRI	ICD-10-PCS	Procedure	BF37Y0Z	Magnetic Resonance Imaging (MRI) of Pancreas using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BF37YZZ	Magnetic Resonance Imaging (MRI) of Pancreas using Other Contrast
MRI	ICD-10-PCS	Procedure	BF37ZZZ	Magnetic Resonance Imaging (MRI) of Pancreas

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BG32Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Adrenal Glands using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BG32YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Adrenal Glands using Other Contrast
MRI	ICD-10-PCS	Procedure	BG32ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Adrenal Glands
MRI	ICD-10-PCS	Procedure	BG33Y0Z	Magnetic Resonance Imaging (MRI) of Parathyroid Glands using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BG33YZZ	Magnetic Resonance Imaging (MRI) of Parathyroid Glands using Other Contrast
MRI	ICD-10-PCS	Procedure	BG33ZZZ	Magnetic Resonance Imaging (MRI) of Parathyroid Glands
MRI	ICD-10-PCS	Procedure	BG34Y0Z	Magnetic Resonance Imaging (MRI) of Thyroid Gland using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BG34YZZ	Magnetic Resonance Imaging (MRI) of Thyroid Gland using Other Contrast
MRI	ICD-10-PCS	Procedure	BG34ZZZ	Magnetic Resonance Imaging (MRI) of Thyroid Gland
MRI	ICD-10-PCS	Procedure	BH30Y0Z	Magnetic Resonance Imaging (MRI) of Right Breast using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH30YZZ	Magnetic Resonance Imaging (MRI) of Right Breast using Other Contrast
MRI	ICD-10-PCS	Procedure	BH30ZZZ	Magnetic Resonance Imaging (MRI) of Right Breast
MRI	ICD-10-PCS	Procedure	BH31Y0Z	Magnetic Resonance Imaging (MRI) of Left Breast using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH31YZZ	Magnetic Resonance Imaging (MRI) of Left Breast using Other Contrast
MRI	ICD-10-PCS	Procedure	BH31ZZZ	Magnetic Resonance Imaging (MRI) of Left Breast
MRI	ICD-10-PCS	Procedure	BH32Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Breasts using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH32YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Breasts using Other Contrast
MRI	ICD-10-PCS	Procedure	BH32ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Breasts
MRI	ICD-10-PCS	Procedure	BH3DY0Z	Magnetic Resonance Imaging (MRI) of Head/Neck Subcutaneous Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH3DYZZ	Magnetic Resonance Imaging (MRI) of Head/Neck Subcutaneous Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BH3DZZZ	Magnetic Resonance Imaging (MRI) of Head/Neck Subcutaneous Tissue
MRI	ICD-10-PCS	Procedure	BH3FY0Z	Magnetic Resonance Imaging (MRI) of Upper Extremity Subcutaneous Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH3FYZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Subcutaneous Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BH3FZZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Subcutaneous Tissue
MRI	ICD-10-PCS	Procedure	BH3GY0Z	Magnetic Resonance Imaging (MRI) of Thorax Subcutaneous Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH3GYZZ	Magnetic Resonance Imaging (MRI) of Thorax Subcutaneous Tissue using Other Contrast

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BH3GZZZ	Magnetic Resonance Imaging (MRI) of Thorax Subcutaneous Tissue
MRI	ICD-10-PCS	Procedure	BH3HY0Z	Magnetic Resonance Imaging (MRI) of Abdomen and Pelvis Subcutaneous Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH3HYZZ	Magnetic Resonance Imaging (MRI) of Abdomen and Pelvis Subcutaneous Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BH3HZZZ	Magnetic Resonance Imaging (MRI) of Abdomen and Pelvis Subcutaneous Tissue
MRI	ICD-10-PCS	Procedure	BH3JY0Z	Magnetic Resonance Imaging (MRI) of Lower Extremity Subcutaneous Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BH3JYZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Subcutaneous Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BH3JZZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Subcutaneous Tissue
MRI	ICD-10-PCS	Procedure	BL30Y0Z	Magnetic Resonance Imaging (MRI) of Upper Extremity Connective Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BL30YZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Connective Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BL30ZZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Connective Tissue
MRI	ICD-10-PCS	Procedure	BL31Y0Z	Magnetic Resonance Imaging (MRI) of Lower Extremity Connective Tissue using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BL31YZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Connective Tissue using Other Contrast
MRI	ICD-10-PCS	Procedure	BL31ZZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Connective Tissue
MRI	ICD-10-PCS	Procedure	BL32Y0Z	Magnetic Resonance Imaging (MRI) of Upper Extremity Tendons using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BL32YZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Tendons using Other Contrast
MRI	ICD-10-PCS	Procedure	BL32ZZZ	Magnetic Resonance Imaging (MRI) of Upper Extremity Tendons
MRI	ICD-10-PCS	Procedure	BL33Y0Z	Magnetic Resonance Imaging (MRI) of Lower Extremity Tendons using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BL33YZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Tendons using Other Contrast
MRI	ICD-10-PCS	Procedure	BL33ZZZ	Magnetic Resonance Imaging (MRI) of Lower Extremity Tendons
MRI	ICD-10-PCS	Procedure	BN39YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Temporomandibular Joints using Other Contrast
MRI	ICD-10-PCS	Procedure	BN39ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Temporomandibular Joints
MRI	ICD-10-PCS	Procedure	BT30Y0Z	Magnetic Resonance Imaging (MRI) of Bladder using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BT30YZZ	Magnetic Resonance Imaging (MRI) of Bladder using Other Contrast
MRI	ICD-10-PCS	Procedure	BT30ZZZ	Magnetic Resonance Imaging (MRI) of Bladder
MRI	ICD-10-PCS	Procedure	BT31Y0Z	Magnetic Resonance Imaging (MRI) of Right Kidney using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BT31YZZ	Magnetic Resonance Imaging (MRI) of Right Kidney using Other Contrast

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BT31ZZZ	Magnetic Resonance Imaging (MRI) of Right Kidney
MRI	ICD-10-PCS	Procedure	BT32Y0Z	Magnetic Resonance Imaging (MRI) of Left Kidney using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BT32YZZ	Magnetic Resonance Imaging (MRI) of Left Kidney using Other Contrast
MRI	ICD-10-PCS	Procedure	BT32ZZZ	Magnetic Resonance Imaging (MRI) of Left Kidney
MRI	ICD-10-PCS	Procedure	BT33Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Kidneys using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BT33YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Kidneys using Other Contrast
MRI	ICD-10-PCS	Procedure	BT33ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Kidneys
MRI	ICD-10-PCS	Procedure	BT39Y0Z	Magnetic Resonance Imaging (MRI) of Kidney Transplant using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BT39YZZ	Magnetic Resonance Imaging (MRI) of Kidney Transplant using Other Contrast
MRI	ICD-10-PCS	Procedure	BT39ZZZ	Magnetic Resonance Imaging (MRI) of Kidney Transplant
MRI	ICD-10-PCS	Procedure	BU33Y0Z	Magnetic Resonance Imaging (MRI) of Right Ovary using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU33YZZ	Magnetic Resonance Imaging (MRI) of Right Ovary using Other Contrast
MRI	ICD-10-PCS	Procedure	BU33ZZZ	Magnetic Resonance Imaging (MRI) of Right Ovary
MRI	ICD-10-PCS	Procedure	BU34Y0Z	Magnetic Resonance Imaging (MRI) of Left Ovary using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU34YZZ	Magnetic Resonance Imaging (MRI) of Left Ovary using Other Contrast
MRI	ICD-10-PCS	Procedure	BU34ZZZ	Magnetic Resonance Imaging (MRI) of Left Ovary
MRI	ICD-10-PCS	Procedure	BU35Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Ovaries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU35YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Ovaries using Other Contrast
MRI	ICD-10-PCS	Procedure	BU35ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Ovaries
MRI	ICD-10-PCS	Procedure	BU36Y0Z	Magnetic Resonance Imaging (MRI) of Uterus using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU36YZZ	Magnetic Resonance Imaging (MRI) of Uterus using Other Contrast
MRI	ICD-10-PCS	Procedure	BU36ZZZ	Magnetic Resonance Imaging (MRI) of Uterus
MRI	ICD-10-PCS	Procedure	BU39Y0Z	Magnetic Resonance Imaging (MRI) of Vagina using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU39YZZ	Magnetic Resonance Imaging (MRI) of Vagina using Other Contrast
MRI	ICD-10-PCS	Procedure	BU39ZZZ	Magnetic Resonance Imaging (MRI) of Vagina
MRI	ICD-10-PCS	Procedure	BU3BY0Z	Magnetic Resonance Imaging (MRI) of Pregnant Uterus using Other Contrast, Unenhanced and Enhanced

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BU3BYZZ	Magnetic Resonance Imaging (MRI) of Pregnant Uterus using Other Contrast
MRI	ICD-10-PCS	Procedure	BU3BZZZ	Magnetic Resonance Imaging (MRI) of Pregnant Uterus
MRI	ICD-10-PCS	Procedure	BU3CY0Z	Magnetic Resonance Imaging (MRI) of Uterus and Ovaries using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BU3CYZZ	Magnetic Resonance Imaging (MRI) of Uterus and Ovaries using Other Contrast
MRI	ICD-10-PCS	Procedure	BU3CZZZ	Magnetic Resonance Imaging (MRI) of Uterus and Ovaries
MRI	ICD-10-PCS	Procedure	BV30Y0Z	Magnetic Resonance Imaging (MRI) of Corpora Cavernosa using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV30YZZ	Magnetic Resonance Imaging (MRI) of Corpora Cavernosa using Other Contrast
MRI	ICD-10-PCS	Procedure	BV30ZZZ	Magnetic Resonance Imaging (MRI) of Corpora Cavernosa
MRI	ICD-10-PCS	Procedure	BV33Y0Z	Magnetic Resonance Imaging (MRI) of Prostate using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV33YZZ	Magnetic Resonance Imaging (MRI) of Prostate using Other Contrast
MRI	ICD-10-PCS	Procedure	BV33ZZZ	Magnetic Resonance Imaging (MRI) of Prostate
MRI	ICD-10-PCS	Procedure	BV34Y0Z	Magnetic Resonance Imaging (MRI) of Scrotum using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV34YZZ	Magnetic Resonance Imaging (MRI) of Scrotum using Other Contrast
MRI	ICD-10-PCS	Procedure	BV34ZZZ	Magnetic Resonance Imaging (MRI) of Scrotum
MRI	ICD-10-PCS	Procedure	BV35Y0Z	Magnetic Resonance Imaging (MRI) of Right Testicle using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV35YZZ	Magnetic Resonance Imaging (MRI) of Right Testicle using Other Contrast
MRI	ICD-10-PCS	Procedure	BV35ZZZ	Magnetic Resonance Imaging (MRI) of Right Testicle
MRI	ICD-10-PCS	Procedure	BV36Y0Z	Magnetic Resonance Imaging (MRI) of Left Testicle using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV36YZZ	Magnetic Resonance Imaging (MRI) of Left Testicle using Other Contrast
MRI	ICD-10-PCS	Procedure	BV36ZZZ	Magnetic Resonance Imaging (MRI) of Left Testicle
MRI	ICD-10-PCS	Procedure	BV37Y0Z	Magnetic Resonance Imaging (MRI) of Bilateral Testicles using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BV37YZZ	Magnetic Resonance Imaging (MRI) of Bilateral Testicles using Other Contrast
MRI	ICD-10-PCS	Procedure	BV37ZZZ	Magnetic Resonance Imaging (MRI) of Bilateral Testicles
MRI	ICD-10-PCS	Procedure	BW30Y0Z	Magnetic Resonance Imaging (MRI) of Abdomen using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW30YZZ	Magnetic Resonance Imaging (MRI) of Abdomen using Other Contrast
MRI	ICD-10-PCS	Procedure	BW30ZZZ	Magnetic Resonance Imaging (MRI) of Abdomen

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BW33Y0Z	Magnetic Resonance Imaging (MRI) of Chest using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW33YZZ	Magnetic Resonance Imaging (MRI) of Chest using Other Contrast
MRI	ICD-10-PCS	Procedure	BW38Y0Z	Magnetic Resonance Imaging (MRI) of Head using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW38YZZ	Magnetic Resonance Imaging (MRI) of Head using Other Contrast
MRI	ICD-10-PCS	Procedure	BW38ZZZ	Magnetic Resonance Imaging (MRI) of Head
MRI	ICD-10-PCS	Procedure	BW3FY0Z	Magnetic Resonance Imaging (MRI) of Neck using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW3FYZZ	Magnetic Resonance Imaging (MRI) of Neck using Other Contrast
MRI	ICD-10-PCS	Procedure	BW3FZZZ	Magnetic Resonance Imaging (MRI) of Neck
MRI	ICD-10-PCS	Procedure	BW3GY0Z	Magnetic Resonance Imaging (MRI) of Pelvic Region using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW3GYZZ	Magnetic Resonance Imaging (MRI) of Pelvic Region using Other Contrast
MRI	ICD-10-PCS	Procedure	BW3GZZZ	Magnetic Resonance Imaging (MRI) of Pelvic Region
MRI	ICD-10-PCS	Procedure	BW3HY0Z	Magnetic Resonance Imaging (MRI) of Retroperitoneum using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW3HYZZ	Magnetic Resonance Imaging (MRI) of Retroperitoneum using Other Contrast
MRI	ICD-10-PCS	Procedure	BW3HZZZ	Magnetic Resonance Imaging (MRI) of Retroperitoneum
MRI	ICD-10-PCS	Procedure	BW3PY0Z	Magnetic Resonance Imaging (MRI) of Brachial Plexus using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BW3PYZZ	Magnetic Resonance Imaging (MRI) of Brachial Plexus using Other Contrast
MRI	ICD-10-PCS	Procedure	BW3PZZZ	Magnetic Resonance Imaging (MRI) of Brachial Plexus
MRI	ICD-10-PCS	Procedure	BY30Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Head using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY30YZZ	Magnetic Resonance Imaging (MRI) of Fetal Head using Other Contrast
MRI	ICD-10-PCS	Procedure	BY30ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Head
MRI	ICD-10-PCS	Procedure	BY31Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Heart using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY31YZZ	Magnetic Resonance Imaging (MRI) of Fetal Heart using Other Contrast
MRI	ICD-10-PCS	Procedure	BY31ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Heart
MRI	ICD-10-PCS	Procedure	BY32Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Thorax using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY32YZZ	Magnetic Resonance Imaging (MRI) of Fetal Thorax using Other Contrast
MRI	ICD-10-PCS	Procedure	BY32ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Thorax

Appendix cont. *Code list*.

Inclusion/ Exclusion	Coding System	Code Type	Code	Description
MRI	ICD-10-PCS	Procedure	BY33Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Abdomen using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY33YZZ	Magnetic Resonance Imaging (MRI) of Fetal Abdomen using Other Contrast
MRI	ICD-10-PCS	Procedure	BY33ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Abdomen
MRI	ICD-10-PCS	Procedure	BY34Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Spine using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY34YZZ	Magnetic Resonance Imaging (MRI) of Fetal Spine using Other Contrast
MRI	ICD-10-PCS	Procedure	BY34ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Spine
MRI	ICD-10-PCS	Procedure	BY35Y0Z	Magnetic Resonance Imaging (MRI) of Fetal Extremities using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY35YZZ	Magnetic Resonance Imaging (MRI) of Fetal Extremities using Other Contrast
MRI	ICD-10-PCS	Procedure	BY35ZZZ	Magnetic Resonance Imaging (MRI) of Fetal Extremities
MRI	ICD-10-PCS	Procedure	BY36Y0Z	Magnetic Resonance Imaging (MRI) of Whole Fetus using Other Contrast, Unenhanced and Enhanced
MRI	ICD-10-PCS	Procedure	BY36YZZ	Magnetic Resonance Imaging (MRI) of Whole Fetus using Other Contrast
MRI	ICD-10-PCS	Procedure	BY36ZZZ	Magnetic Resonance Imaging (MRI) of Whole Fetus