

## Transvenska ekstrakcija elektroda elektrostimulatora: prva iskustva u Kliničkom bolničkom centru Rijeka

### Transvenous Pacemaker Lead Extraction: First Experiences in the University Hospital Centre Rijeka

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**SAŽETAK:** Posljednih godina dolazi do znatnog porasta broja implantiranih elektrostimulatora srca. Posljedično tomu raste i broj mogućih komplikacija te potreba za njihovom ekstrakcijom. Najčešća indikacija za ekstrakciju elektrostimulatora jest lokalizirana ili sustavna infekcija. S obzirom na to da je riječ o najkompleksnijim i najrizičnijim zahvatima iz područja kardiologije, iz godine u godinu razvijaju se nove tehnike i alati koji znatno olakšavaju ekstrakciju i smanjuju rizik od nastanka mogućih, pokatkad i vrlo teških komplikacija. S obzirom na navedeno, potrebno je organizirati dovoljan broj adekvatnih centara u kojima bi djelovao specijalizirani multidisciplinarni tim educiran za provođenje navedenih zahvata.

Od početka 2013. godine na Odjelu za aritmije i elektrostimulaciju Zavoda za kardiovaskularne bolesti Kliničkog bolničkog centra Rijeka započeo je program ekstrakcija elektroda. U razdoblju od dvije i pol godine učinjeno je ukupno 27 zahvata te je uklonjena ukupno 51 elektroda, od čega su dvije bile defibrilatorske. Glavni uzrok ekstrakcije elektroda bila je lokalizirana infekcija / dekubitus lože, dok je sustavna infekcija bila mnogo rjeđa. U postupku ekstrakcije prevladava tehnika trakcije i „locking” stileta. Najznačajnija je komplikacija razvoj simptomatskoga perikardijalnog izljeva. Smrtnih ishoda nije bilo.

**SUMMARY:** During recent years there has been a significant increase in pacemaker implantation. Consequently, the number of possible complications and the need for pacemaker lead extraction has grown as well. The most common indication for pacemaker lead extraction is localized or systemic infection. Since lead extraction is among the most complex and dangerous cardiologic procedures, new techniques and tools are being developed on a yearly basis that significantly facilitate extraction and reduce the risk of possible, often very severe, complications. Considering the above, it is necessary to organize enough appropriate centers with specialized multidisciplinary teams trained for the performance of these procedures.

Since early 2013, a pacemaker lead extraction program was started at the Department for Arrhythmia and Electrical Stimulation at the University Hospital Centre Rijeka. Over a period of two and a half years, a total of 27 procedures have been performed and 51 pacemaker leads were extracted, of which two were defibrillator leads. The main cause of lead extraction was localized infection/pocket decubitus, while the incidence of systemic infection was much lower. Extraction techniques used were predominantly traction and locking stylet extractions. The most significant complication was the development of symptomatic pericardial effusion. There were no fatal outcomes.

**KLJUČNE RIJEČI:** elektrostimulator, elektroda, infekcija, ekstrakcija, komplikacije.

**KEYWORDS:** pacemaker, lead, infection, extraction, complications.

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## Uvod

Elektrostimulacijski sustavi srca imaju važnu ulogu u liječenju bolesti srca. Svjedoci smo znatnog porasta broja implantiranih uređaja. U svijetu ima više od 4,3 milijuna bolesnika kojima je implantirana jedna od nekoliko vrsta elektrostimulatora i njihov broj iz dana u dan sve je veći. Riječ je o uređajima za liječenje bradikardnih poremećaja ritma, implantabilnim kardioverter-skim defibrilatorima ili o uređajima za srčanu resinkronizaciju. S obzirom na znatan porast broja implantacija te na to da je riječ uglavnom o starijim bolesnicima sa sve brojnijim komorbiditetima, posljedično se povećava i broj mogućih komplikacija te potrebe za njihovom ekstrakcijom. Najčešće indikacije za ekstrakciju elektrostimulatorskog sustava srca jesu lokalizirana ili sustavna infekcija (infekcija lože, vegetacija zalistka, sepsa), fraktura, odnosno malfunkcija elektrode, nadogradnja sustava, zaostala elektroda, odnosno zaostali dio elektrode te venska opstrukcija.

Uklanjanje elektrostimulatorskog sustava sastoji se od dva dijelova: uklanjanja pulsog generatora, nakon čega slijedi uklanjanje jedne ili više elektroda, uključujući i sve dodatne sastavnice sustava kao što su adapteri, šavovi itd. Uklanjanje generatora relativno je jednostavan postupak, ali kada je prisutna infekcija lože, potrebno je učiniti opsežnu resekciju i debridman zaraženoga tkiva. Transvensko uklanjanje nedavno implantiranih elektroda (razdoblje kraće od 3 mjeseca od implantacije – tada govorimo o **eksplantaciji**) može se postići metodom direktne trakcije, ali posebni su problem starije elektrode koje su fibrozno inkapsulirane (proteklo vrijeme od implantacije duže od godinu dana – govorimo o **ekstrakciji**). Adhezije su prisutne na dodirnom mjestu vrha elektrode i miokarda, ali i na ostalim dodirnim mjestima u venskom sustavu, u području zalistka i endokarda, zbog čega sam postupak trakcije nije dovoljan te, ako se s njim i pokuša, često dovodi do raspada elektrode, što dodatno komplicira postupak ekstirpacije. Zbog navedenog se zadnjih dvadeset godina razvijaju nove metode i alati za njihovo sigurno transvensko uklanjanje.

## Kratki pregled postupaka i alata primjenjivanih u uklanjanju elektroda

Glavno načelo u eksplantaciji/ekstrakciji elektrode se sastoji u tome da je rizik od postupka manji od mogućih komplikacija zbog njezina zadržavanja. U današnje vrijeme većina postupaka se provodi perkutanom transvenskom metodom. Kirurški je zahvat potreban u rjeđim slučajevima kao što su neuspjeli pokušaj perkutane metode, potreba za kirurškim liječenjem drugih bolesti (npr. zamjena srčanog zalistka) ili opsežne vegetacije zalistka, kada je perkutana metoda nepogodna zbog mogućih embolijskih incidenata. Razvijeno je nekoliko tehnika perkutane transvenske metode ekstrakcije.

### TRAKCIJA

Postupak trakcije najjednostavnija je metoda uklanjanja elektrode koja se primjenjuje zadnjih četrdeset godina. U elektrodi se postavi standardni stilet te se postupnom primjenom sile izvuce elektroda. Ta je metoda načelno ograničena na postupak eksplantacije; pri ekstrakciji starije elektrode koja je fibrozno inkapsulirana može doći do raspada. Moguće su komplikacije

## Introduction

Pacemakers have an important role in heart disease treatment, and we are witnessing a significant increase in the number of implanted devices. There are more than 4.3 million patients globally that have been implanted with one of several types of pacemakers, and their number grows daily. These devices include those used to treat bradycardia, implantable cardioverter defibrillators, or heart resynchronization devices. Due to the significant increase in implantations and the fact that the patients in question are often older and with an increasing number of comorbidities, the number of possible complications and consequently the number of necessary extractions is growing as well. The most common indications for lead extraction are localized or systemic infections (pocket infection, valve vegetation, sepsis), fractures, i.e. lead malfunctions, system upgrades, a retained lead or its part, and vein obstruction.

Removing a pacemaker system consists of two phases: removing the pulse generator, which is followed by the removal of one or more leads, including all additional parts of the system such as adapters, sutures, etc. Removing the generator is a fairly simple procedure, but when a pocket infection is present a broad resection must be made as well as debridement of the infected tissue. Transvenous lead extraction of recently implanted leads (less than 3 months since implantation – this is called **explantation**) can be achieved using the method of direct traction, but older leads that have undergone fibrous encapsulation (more than a year since implantation – this is called **extraction**). Adhesions are present at the point of contact between the lead and the myocardium but also at other points of contact in the venous system, valve and endocardial areas, which means that the traction procedure is not sufficient and, if attempted, can lead to disintegration of the lead which further complicates the procedure. Due to the above, new methods and tools for safe transvenous removal have been developing during the last twenty years.

## Short overview of the tools and procedures used in lead extraction

The main principle in lead explantation/extraction is that the risk from the procedure must be lower than the possible complications of retaining the implant. Today, most procedures are performed using the percutaneous transvenous method. Surgical procedures are necessary in rare cases, such as unsuccessful attempts at using the percutaneous method, when surgical treatment is needed to treat other diseases (e.g. replacing the valve), or in cases of significant vegetation on the valve which makes the percutaneous method inappropriate due to possible embolic incidents. Several techniques of percutaneous transvenous extraction have been developed.

### TRACTION

The traction procedure is the simplest method of lead removal that has been applied over the last forty years. A standard stylet is inserted into the lead which is then extracted through gradual application of pulling force. This method is generally

ovog postupka invaginacija ili ruptura miokarda, artimije i teška trikuspidalna regurgitacije zbog avulzije zalistka.

### „LOCKING” STILET

Ovom se tehnikom u lumen elektrode uvede posebni trakcijski stilet kojim se smanjuje rizik od raspada elektrode. Prije toga se ukloni proksimalni kraj elektrode, nakon čega se u lumen uvede stilet koji je moguće uglaviti u bilo kojem dijelu lumena. Poželjno je da stilet bude što bliže distalnom kraju, jer, u suprotnom, može doći do neželjenog raspada elektrode zbog njene elongacije. Moguće su komplikacije jednake kao i u postupku trakcije bez „locking” stileta.

### UVODNICE

Uvodnica je u osnovi cijev (načinjena od propilena, metala ili teflona) koja se postupno navlači na elektrodu. Pri prolasku uvodnice dolazi do djelovanja mehaničke sile na postojeće adhezivno tkivo te se elektroda oslobađa. U postupku je potreban i „locking” stilet kojim se suprotstavlja djelovanju sile uvodnice. Uvodnica se uvede do vrha elektrode te se priljubi uz miokard, što onemogućuje njegovu invaginaciju pri trakciji elektrode (s pomoću „locking” stileta).

Elektrokirurške su uvodnice posebna vrsta uvodnica koje na svom vrhu imaju dvije elektrode te se radiofrekventnom energijom obavlja disekcija fibrozna tkiva.

### LASERSKA EKSTRAKCIJA

Ovom se tehnikom koristi laserska uvodnica koja je načinjena od tankoga sloja optičkih vlakana smještenog između dvaju polimernih slojeva. Na vrhu uvodnice isporučuje se kružni laserski snop koji razgrađuje okolno fibrozno tkivo. Postupak ekstrakcije jednak je postupku pri kojemu se uporabljaju obične uvodnice.

## Komplikacije

Ekstrakcija elektroda kompleksni je zahvat koji može dovesti do niza neželjenih događaja. Komplikacije možemo podijeliti u dvije glavne skupine: teže i lakše. U teške se komplikacije ubraja smrtni ishod, avulzija odnosno razdor miokarda s posljedičnom tamponadom, avulzija ili razdor velikih vena, plućna embolija koja zahtijeva kiruršku intervenciju itd. Lakše komplikacije koje mogu nastati jesu perikardijalni izljev koji ne zahtijeva perikardiocentezu ili kirurški zahvat, hematotoraks koji ne zahtijeva torakalni dren, oteklina gornjeg ekstremiteta ili tromboza vene putem koje je elektroda bila uvedena, zračna embolija, pneumotoraks itd.<sup>1,2</sup>

## Preduvjeti za ekstrakcije elektroda

Ekstrakcija elektrode ubraja se u invazivne postupke koji zahtijevaju adekvatnu edukaciju i iskustvo kako bi se osigurala kvalitetna i sigurna skrb za bolesnika. Kao i za svaku invazivnu proceduru postoji krivulja učenja do postizanja potrebne kompetencije. Sadašnje smjernice američkog i europskog aritmološkog

confined to explants; when extracting older fibrously encapsulated leads there is a risk of disintegration. Possible complications of this procedure include myocardial invagination or rupture, arrhythmia, and severe tricuspid regurgitation due to valve avulsion.

### LOCKING STILET

In this technique, a special traction stylet is introduced into the lumen of the lead, reducing risk of lead disintegration. The proximal end of the lead is removed, after which the stylet is introduced into any part of the lumen. It is preferable for the stylet to be as close to the distal end as possible, because otherwise unwanted disintegration of the lead may occur due to elongation. Possible complications are the same as in the traction method without a locking stylet.

### SHEATHS

A sheath is basically a tube (made of propylene, metal, or Teflon) which is gradually passed over the lead. This creates mechanical force that acts on the existing adhesive tissue and releases the lead. The procedure also requires a locking stylet which is used to oppose the force of the sheath. The sheath is brought to the tip of the lead until it touches the myocardium, which prevents invagination during lead traction (using a locking stylet).

Electrosurgical sheaths are a special type of sheath with two electrodes at their tip that use radiofrequency energy to dissect the fibrous tissue.

### LASER EXTRACTION

This technique uses a laser sheath constructed from a thin layer of optical fibers placed between two polymer layers. A circular laser beam is delivered at the tip of the sheath that removes surrounding fibrous tissue. The extraction procedure is the same as with other sheaths.

## Complications

Lead extraction is a complex procedure that can cause many unwanted complications. We can divide the complications into two main groups: less serious and serious. Serious complications include death, avulsion or tearing of the myocardium with consequent tamponade, avulsion or tearing of the large veins, pulmonary embolism that requires surgical intervention, etc. Less serious complications that can occur are pericardial effusion which does not require pericardiocentesis or surgical intervention, hemothorax that does not require a thoracic drainage, swelling of upper extremities, or thrombosis of the vein through which the lead was introduced, air embolism, pneumothorax, etc.<sup>1,2</sup>

## Prerequisites for lead extraction

Lead extraction is considered an invasive procedure that requires adequate training and experience to ensure quality care and safety for the patient. As with any invasive proce-

udruženja preporučuju minimalne uvjete u vezi s operaterom i centrom u kojemu se mogu izvoditi navedeni zahvati.<sup>3,4</sup>

### UVJETI ZA OPERATERA

1. Operater mora biti potpuno osposobljeni implanter kardiovaskularnih implantabilnih električnih uređaja (CIED) s većim volumenom implantacija godišnje.
2. Mora učiniti najmanje 40 ekstrakcija elektroda u 30 različitih zahvata kao primarni operater pod nadzorom kvalificiranog operatera. Ekstrakcije moraju obuhvatiti barem 10 slučajeva ekstrakcija najmanje dviju elektroda, 10 zahvata ekstrakcije defibrilatorskih elektroda i 10 zahvata ekstrakcija elektroda implantiranih prije više od 6 godina.
3. Nakon obavljenoga treninga operater mora izvoditi najmanje 15 procedura godišnje kao prvi operater s ekstrakcijom najmanje 20 elektroda.

### EKSTRAKCIJSKI CENTAR

1. Ekstrakcijski centar mora biti kvalificirani viskofrekventni centar za implantaciju svih vrsta kardiovaskularnih električnih uređaja.
2. U centru se mora izvoditi najmanje 15 procedura ekstrakcija godišnje uz ekstrakciju najmanje 20 elektroda.
3. Članovi tima za ekstrakciju moraju biti upoznati s procedurom, alatima za ekstrakciju, mogućim komplikacijama i hitnim postupcima pri njihovu rješavanju.
4. U centru u kojemu ekstrakcije izvode kardiolozi mora biti dostupan kardiokirurški tim osposobljen za rješavanje hitnih, za život opasnih komplikacija koje zahtijevaju kiruršku intervenciju uz dostupnost uređaja za ekstrakorporalnu cirkulaciju. Najopasnija je komplikacija laceracija gornje šuplje vene koja zahtijeva kiruršku intervenciju s otvaranjem prsnog koša unutar 10 min.
5. Anesteziološki suport osposobljen za vođenje anestezije u kardiokirurškim operacijama mora biti hitno dostupan u slučaju nastupa komplikacija.
6. Zahvati se moraju izvoditi u elektrofiziološkom laboratoriju / operacijskoj dvorani s kvalitetnim rendgenskim uređajem. Moraju biti dostupni razni alati za ekstrakciju elektroda, set za perikardiocentezu i za privremenu elektrostimulaciju te uređaj za ehokardiografiju.

Nakon dvaju recentnih istraživanja provedenih u SAD-u i Europi pokazalo se da velik broj centara u kojima se izvode postupci ekstrakcija elektroda još uvijek ne zadovoljava navedene uvjete, no Radna skupina za ekstrakcije i dalje stoji iza svojih preporuka.<sup>5,6</sup>

## Program uklanjanja elektroda u Kliničkom bolničkom centru Rijeka

Na Odjelu za aritmije i elektrostimulaciju Zavoda za kardiovaskularne bolesti Kliničkog bolničkog centra Rijeka početkom 2013. godine započeo je program ekstrakcija elektroda. U navedenom razdoblju od 2,5 godina (do 30. lipnja 2015.) ukupno je učinjeno 27 zahvata kojima je uklonjena ukupno 51 elektro-

de, there is a learning curve in achieving the necessary competence. Current guidelines of US and European arrhythmological societies include minimal conditions regarding the skill of the operator and equipment in the center in which the procedures are to be conducted.<sup>3,4</sup>

### OPERATOR PREREQUISITES

1. The operator must be a fully trained implanter of cardiovascular implantable electronic devices (CIED) with a large annual implantation procedure count.
2. They must perform at least 40 lead extractions in 30 different procedures as the primary operator under the supervision of a qualified operator. The extractions must include at least 10 cases of extraction of at least two leads, 10 procedures of defibrillator lead extraction, and 10 procedures where the leads were implanted more than 6 years ago.
3. After completion of the training, the operator must perform at least 15 procedures annually as the primary operator for a total of at least 20 extracted leads.

### EXTRACTION CENTER

1. The extraction center must be a qualified high-frequency center for the implantation of all types of cardiovascular electrical devices.
2. At least 15 extractions must be performed annually in the center, with a total of at least 20 extracted leads.
3. Extraction team members must be familiar with the procedure, extraction tools, possible complications, and emergency procedures.
4. The extraction center must have a surgical team available that is trained to treat urgent, life threatening complications that require surgical intervention, as well as an extracorporeal circulation device. The most dangerous complication is laceration of the superior vena cava, which requires surgical intervention with thoracotomy within 10 minutes.
5. An anesthesiological support team trained for administering anesthesia in cardiac surgeries must be available for emergency cases.
6. The procedures must be performed in an electrophysiological laboratory/operating hall with a quality X-Ray machine. Various tools for lead extraction must be available, as well as a pericardiocentesis kit and a temporary electrostimulation device as well as an echocardiography device.

Two recent studies conducted in the US and Europe showed that many centers performing lead extraction procedures still do not fulfill the abovementioned conditions, but the Task Force of Lead Extraction stands behind its guidelines.<sup>5,6</sup>

## Lead removal program in the University Hospital Centre Rijeka

The lead extraction program at the Department for Arrhythmia and Electrical Stimulation at the University Hospital Centre Rijeka was started in early 2013. In the 2.5 years since then (up to June 30, 2015), 27 procedures were performed and 51 leads were extracted. Leads were extracted in 22 proce-

**Table 1. The number and prevalence of lead extraction in the University Hospital Centre Rijeka.**

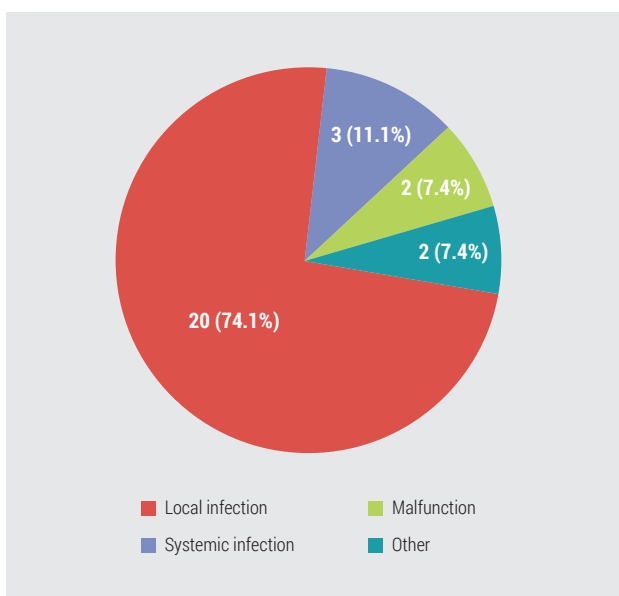
	2013	2014	2015*	Total
Number of CIED implantation	402	455	263	1120
Number of complex devices implantation (ICD, CRT)	49	61	52	162
Number of extractions	5	10	7	22
Number of extracted leads	9	19	15	43

\*Data until June 30, 2015

da. U 22 zahvata riječ je bila o ekstrakciji elektroda, dok je u ostalih 5 zahvata posrijedi bila eksplantacija (**tablica 1. i 2.**).

Prosječno vrijeme od implantacije do ekstrakcije elektroda bilo je 4,5 godina, dok je prosječno vrijeme kod eksplantacije bilo 2 mjeseca. Glavni uzrok ekstrakcije elektroda bila je lokalna infekcija i/ili dekubitus lože, dok je sustavna infekcija bila mnogo rjeđa pojava. Sustavne su infekcije bile uzrokovane zlatnim stafilokokom (MRSA), a u jednog je bolesnika bio prisutan endokarditis trikuspidnog zalistka. U dvaju bolesnika elektrostimulacijski je sustav uklonjen zbog potrebe provođenja radioterapije malignoma, dok je u druge dvojice bolesnika sustav uklonjen zbog frakture elektrode (**slika 1 i 2.**).

U većine bolesnika (90 % slučajeva) uklonjene su obične elektrostimulacijske elektrode, a u dvoje bolesnika ekstrahirane su defibrilacijske elektrode. Od ukupno 43 elektrode, 42 su izvađene u potpunosti dok je jedna atrijska elektroda pukla te je zaostao retinirani dio u srcu (uspješnost 98 %). Od značajnih komplikacija u jedne bolesnice imali smo razvoj

**FIGURE 1. Etiology of lead explantation/extraction.****Table 2. The demographic characteristics of patients who underwent the procedure of extraction.**

	N (%)
Average age (years)	76.5
Male gender	16 (72%)
Prevalence of extraction	22/1120 (2%)
Number of successfully extracted leads	42/43 (98%)
Complications	1 (4.5%)
Mortality	0
Type of the extracted leads	
• Ventricular	21 (49%)
• Atrial	20 (46%)
• Defibrillator	2 (5%)

dures while the remaining five were explantation procedures (**Table 1 and 2.**).

Average time from implantation to extraction was 4.5 years, whereas the average time to explantation was 2 months. The main reason for lead extraction was local infection and/or pocket decubitus, with systemic infection being very rare. Systemic infections were caused by methicillin-resistant *Staphylococcus aureus* (MRSA), and one patient suffered from tricuspid valve endocarditis. In two patients the pacemaker system was removed to perform cancer radiotherapy, and it was removed in another two patients due to lead fractures (**Figure 1 and 2.**).

In 90% of patients standard pacemaker leads were extracted, but there were two cases of defibrillator lead extractions. Of a total of 43 leads, 42 were completely removed while one atrial lead snapped and a piece was retained in the heart (98% success). The only significant complication was a symptomatic pericardial effusion 1 cm thick in one female patient,

**FIGURE 2. Local infection and decubitus of the pocket with pacemaker protrusion.**

simptomatskoga perikardijalnog izljeva u debljini od 1 cm koji nije zahtijevao hitnu perikardiocentezu, nego je liječen konzervativno. Za sada nismo imali smrtnih ishoda.

Prevalencija ekstrakcije elektroda u centru bila je oko 2 %, što je u skladu sa svjetskim trendovima koji se kreću od 1,5 do 6 %.<sup>4</sup>

### POSTUPAK EKSTRAKCIJE

Postupak ekstrakcije izvodi se u polivalentnoj angiosali opremljenoj za izvođenje svih vrsta invazivnih kardioloških zahvata. Zahvat se izvodi u dubokoj sedaciji i analgeziji s mogućnošću konverzije u opću anesteziju uz kontinuirano praćenje vitalnih parametara. U dvorani se tijekom ekstrakcije nalaze anesteziološki aparat, ultrazvučni aparat, set za perikardiocentezu i privremenu elektrostimulaciju, a, ovisno o preoperativnoj procjeni, i stroj za ekstrakorporalnu cirkulaciju. Osim standardne pripreme kao za implantaciju elektrostimulatora, bolesnik je pripremljen i za hitnu perikardiocentezu i torakotomiju. Tijekom zahvata u pripravnosti je i kardijski kirurg za slučaj nastupa komplikacija u obliku tamponade i laceracije velikih vena.

Za ekstrakciju elektroda koristimo se tehnikom traktacije i kontrapritiska uz upotrebu „locking” stileta, fiksacijskih šavova te jednostrukih i dvostrukih uvodnica (slike 3, 4, 5 i 6). Nakon ekstrakcije učini se temeljito čišćenje lože s kompletnom ekscizijom kapsule elektrostimulatora.

### POTEŠKOĆE

Osnovne poteškoće koje susrećemo u razvoju programa ekstrakcija elektroda jest u tome što osiguravajuće društvo ne prepoznaje kompleksnost navedenih zahvata. Neadekvatno financiranje ograničava nabavu skuplje dodatne opreme koja bi olakšala i povećala efikasnost izvođenja samih zahvata kao što su mehaničke uvodnice, femoralne hvataljke i slično.

Također je u Hrvatskoj potrebno osnivanje specijaliziranih centara za ekstrakciju elektroda u koje bi se referirali bolesnici kako bi se povećao broj samih zahvata po centru i njihova kompetentnost. Ako računamo prosječan godišnji broj implantiranih uređaja u RH koji iznosi oko 2800 CIED uređaja, godišnja potreba za ekstrakcijom elektroda kreće se od 40 do



FIGURE 3. Extraction with combined use of a locking stylet and a fixation suture.

which did not require emergency pericardiocentesis and was treated conservatively. There have been no mortalities so far.

Lead extraction prevalence in our center was approximately 2%, which is in line with global trends that are between 1.5 and 6%.<sup>4</sup>

### EXTRACTION PROCEDURE

Extraction procedures take place in a multipurpose cath lab equipped for all types of invasive cardiologic procedures. The procedure takes place under heavy sedation and analgesia with the option to convert to general anesthesia and with continuous vital signs monitoring. During extraction, in the cath lab is present an anesthetic machine, an ultrasound device, a pericardiocentesis kit and a temporary electrostimulation device, and, depending on preoperative appraisal, an extracorporeal circulation device. In addition to standard preparations as with pacemaker implantation, the patient is also prepared for emergency pericardiocentesis and thoracotomy. A cardiac surgeon is on call during the procedure, in case of tamponade or large vein laceration.

We used traction and counter-pressure methods to extract the leads with the use of a locking stylet, fixating sutures, and single and double sheaths (Figures 3, 4, 5, and 6). A thorough cleaning of the pocket is performed after extraction, which includes a complete excision of the pacemaker capsule.

### DIFFICULTIES

The basic difficulty we faced in developing the lead extraction program is that health insurance does not recognize the complexity of these procedures. Inadequate financing limits the acquisition of more expensive additional equipment that would facilitate and improve performance of the procedures, such as mechanical sheaths, femoral snares, etc.

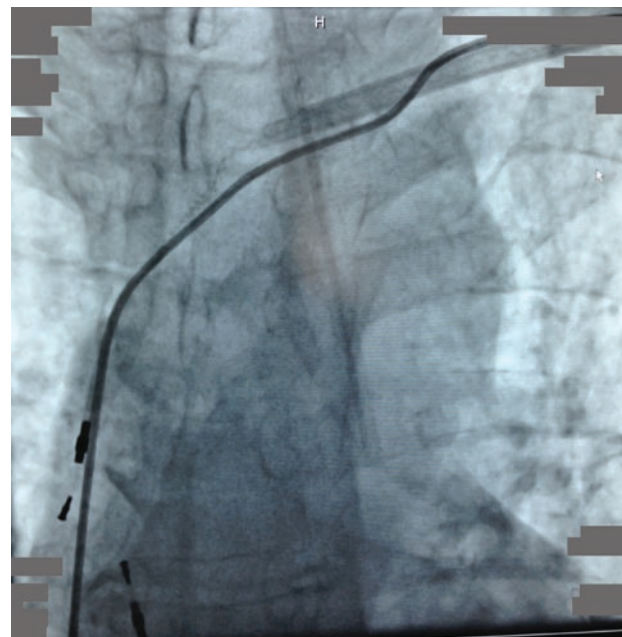
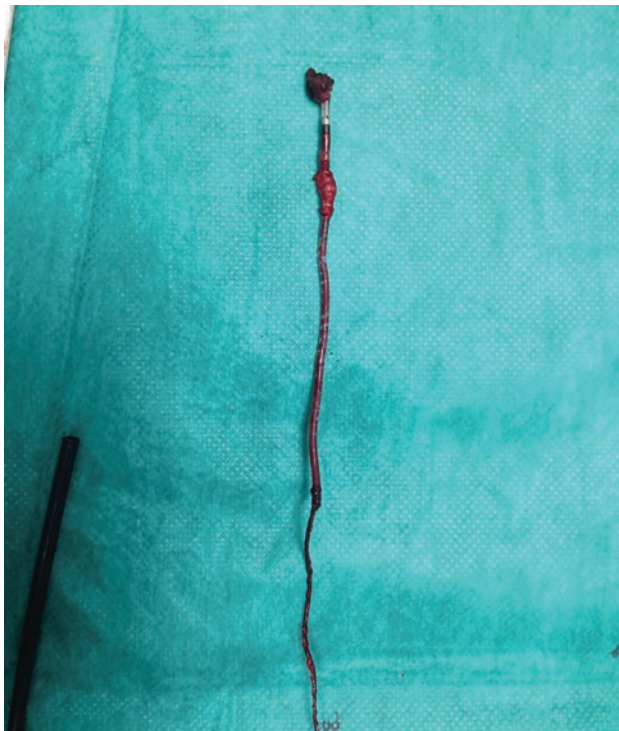


FIGURE 4. Lead removal using a sheath which mechanically disrupts the fibrotic adhesions.

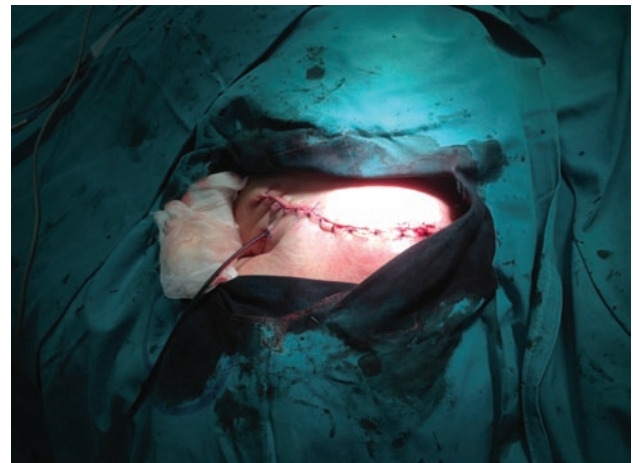


**FIGURE 5. Example of an extracted lead with clearly visible fibrotic adhesions.**

165 zahvata, što govori u prilog potrebi osnivanja 1 – 2 specijalizirana centra za ekstrakciju elektroda. Trenutačno su zahvati ekstrakcije visokorizični, neprofitabilni postupci koji se izvode sporadično u pojedinim centrima, bazirani na entuzijazmu pojedinih operatera.

## Zaključak

Postupci ekstrakcije elektroda ubrajaju se među najkompleksnije i najrizičnije zahvate iz područja kardiologije za kojima potreba svakodnevno raste. Kako bi se adekvatno izvodili navedeni zahvati, potrebno je organizirati adekvatne centre u kojima bi djelovao multidisciplinarni educirani tim opskrbljen svim potrebnim alatima, aparaturom i adekvatnim brojem zahvata.



**FIGURE 6. Example of a postoperative wound after the extraction of a defibrillator and three leads.**

In Croatia it is also necessary to form specialized lead extraction centers to which patients would be referred to in order to increase the number of procedures per center and their quality. If we take into account the 2800 CIED devices implanted in Croatia annually, the annual need for lead extraction would be between 40 and 165 procedures, which indicates the need for the formation of 1-2 specialized lead extraction centers. Currently, lead extraction is a high-risk, unprofitable procedure performed sporadically in individual centers based on the enthusiasm of individual operators.

## Conclusion

Lead extraction procedures are among the most complex and dangerous cardiologic procedures and the need for them is increasing. To properly perform these procedures, adequate centers must be organized with multidisciplinary trained teams equipped with all the necessary tools, apparatuses, and adequate procedure capacity.

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